



Joint Workshop

“Digitalisation of energy performance assessment to enable retrofits”

**"Closing the Performance Gap":
Data Driven Building Performance Assessment
in the CHRONICLE project**



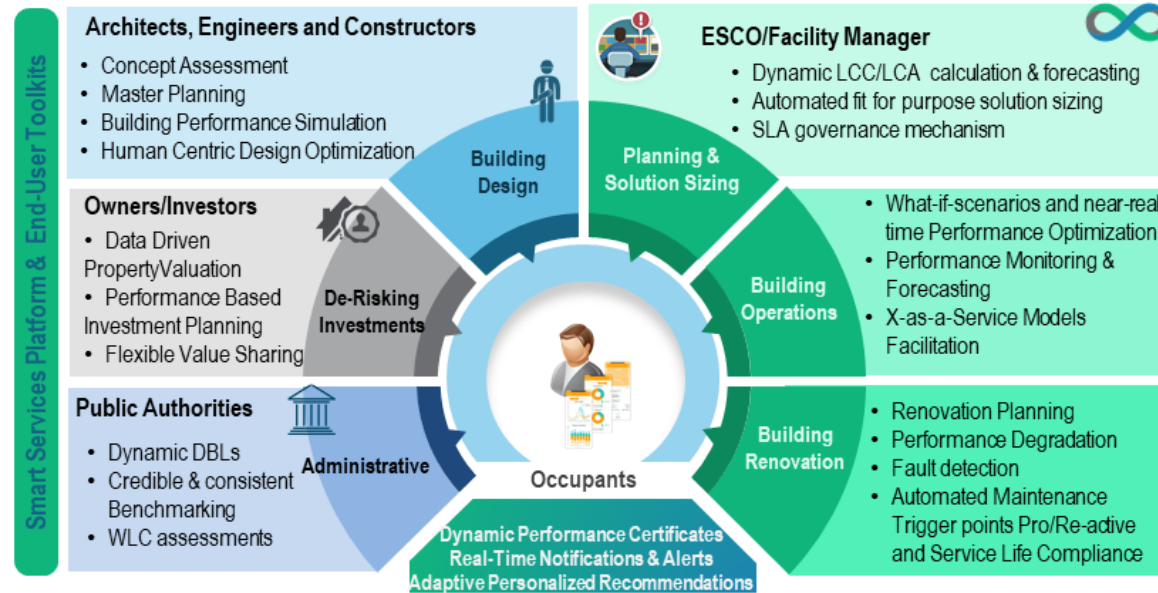
Dr. Christos Malavazos
Hypertech Energy Labs (HSRT)



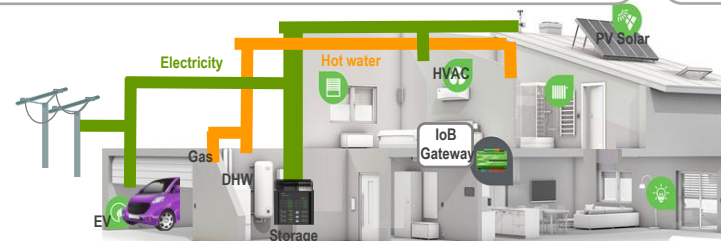
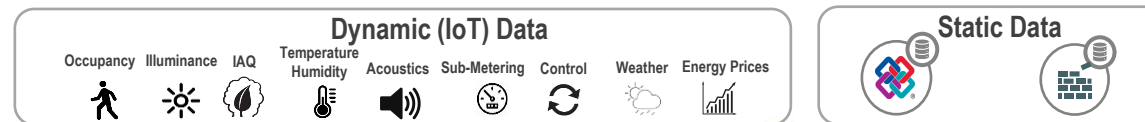
Funded by
the European Union

Madrid, 15/6/2023

CHRONICLE "in a nutshell"



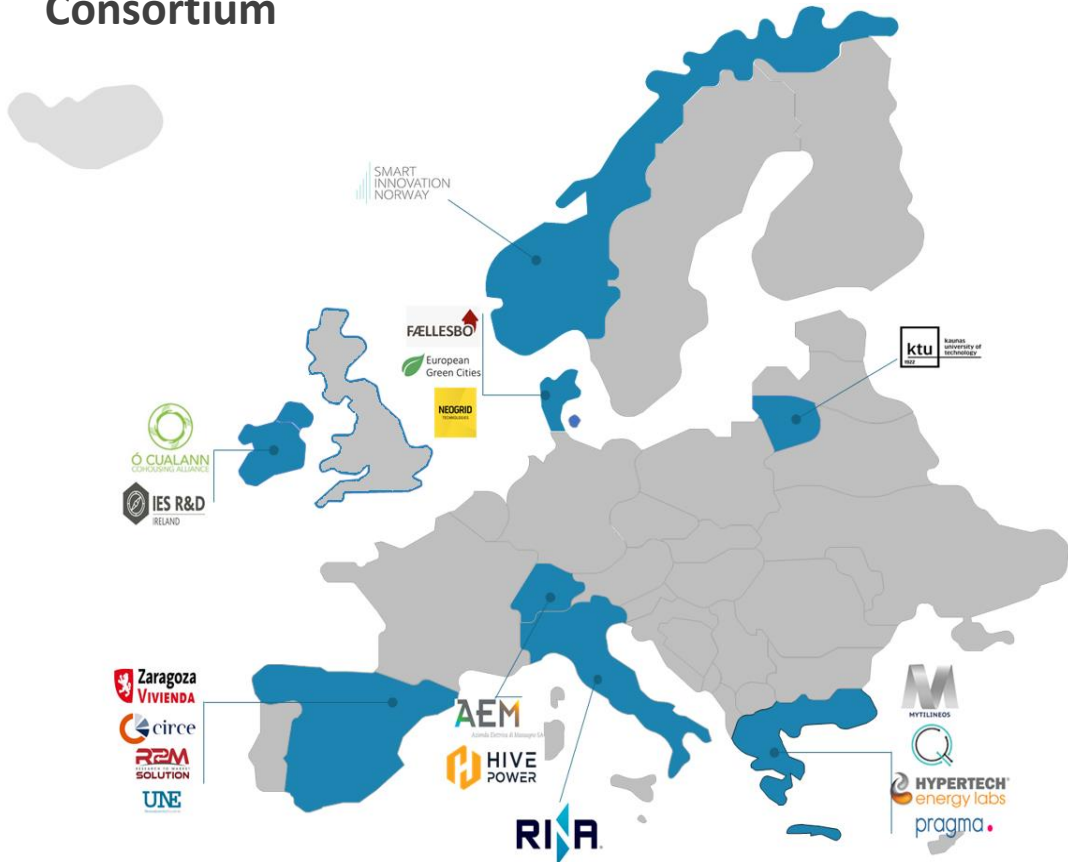
CHRONICLE Common Data Environment



CHRONICLE "in a nutshell"



Consortium



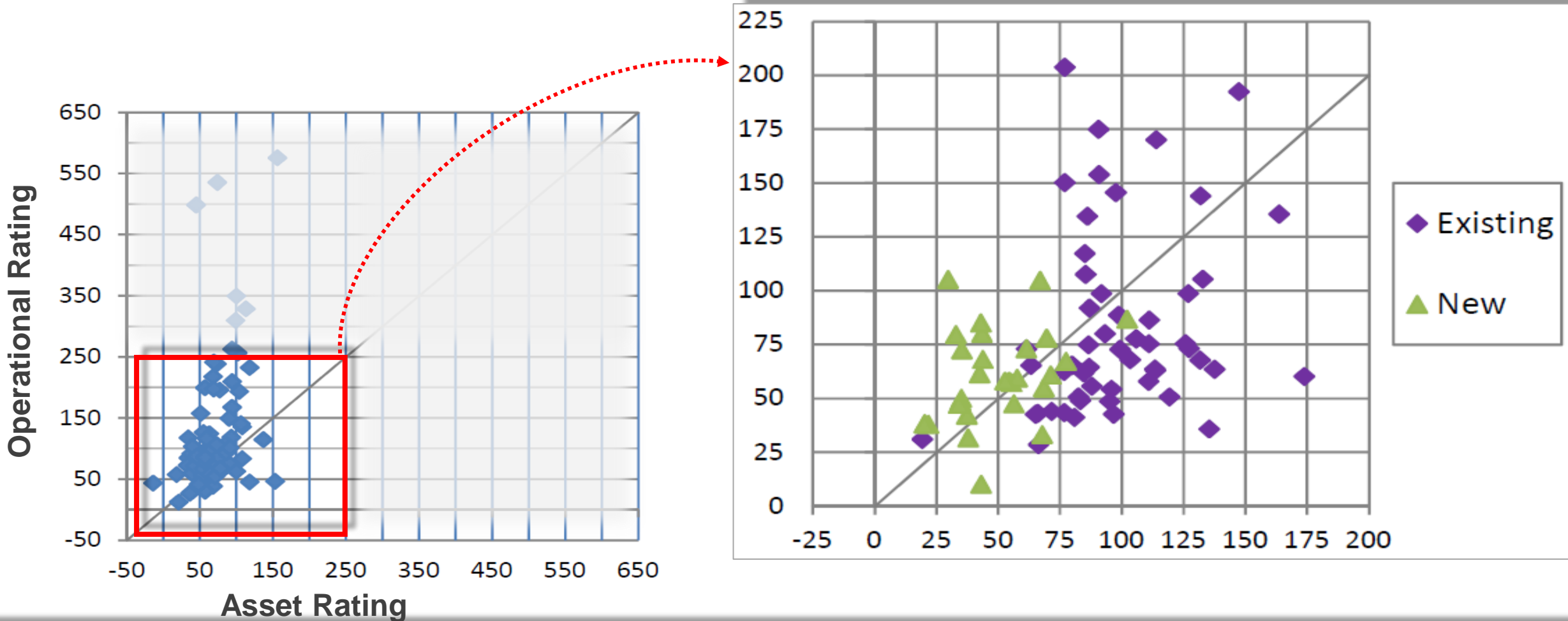
Demonstration Sites



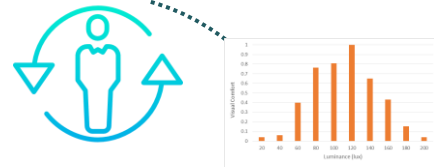
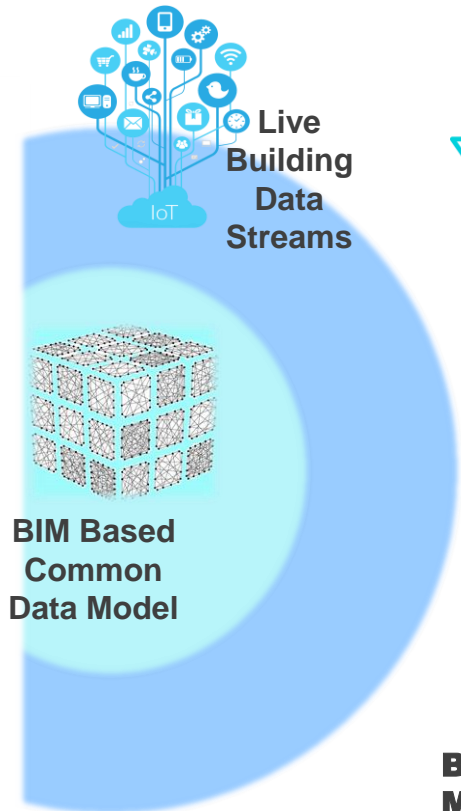
18 Partners	8 Countries	42 Months	4.95M €
-------------	-------------	-----------	---------

5 Full Scale Pilots	2 Pre-Validation Sites	~250 Dwellings	~24 Months
---------------------	------------------------	----------------	------------

CHRONICLE Main Challenge : *Reducing the “performance gap”*

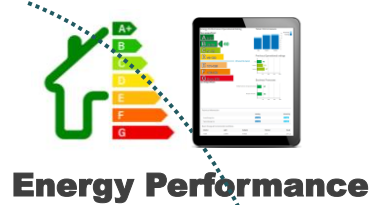
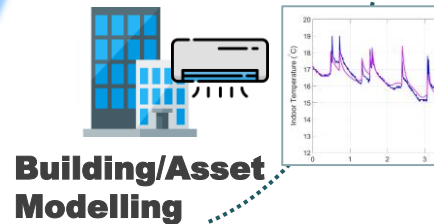


Holistic Performance Framework



Human Centric

- Occupancy
- Thermal Comfort
- Visual Comfort
- Acoustic Comfort
- IAQ
- Social LCA



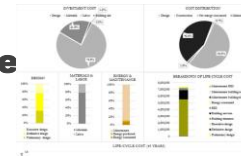
- Data-Driven OR
- BIM-Based AR
- Dynamic Assessment
- Intuitive EPCs



Flexibility

- Human Centric
- Dynamic Flex Profiles
- Highly Granular Flex Profiles
- Multi-purpose Flex Profiles

Operational Performance



SRI+



- Automated Self-Assessment
 - BIM-to-SRI
 - Dynamic Weighting
- Outcome-Based SRI

Common Data Environment

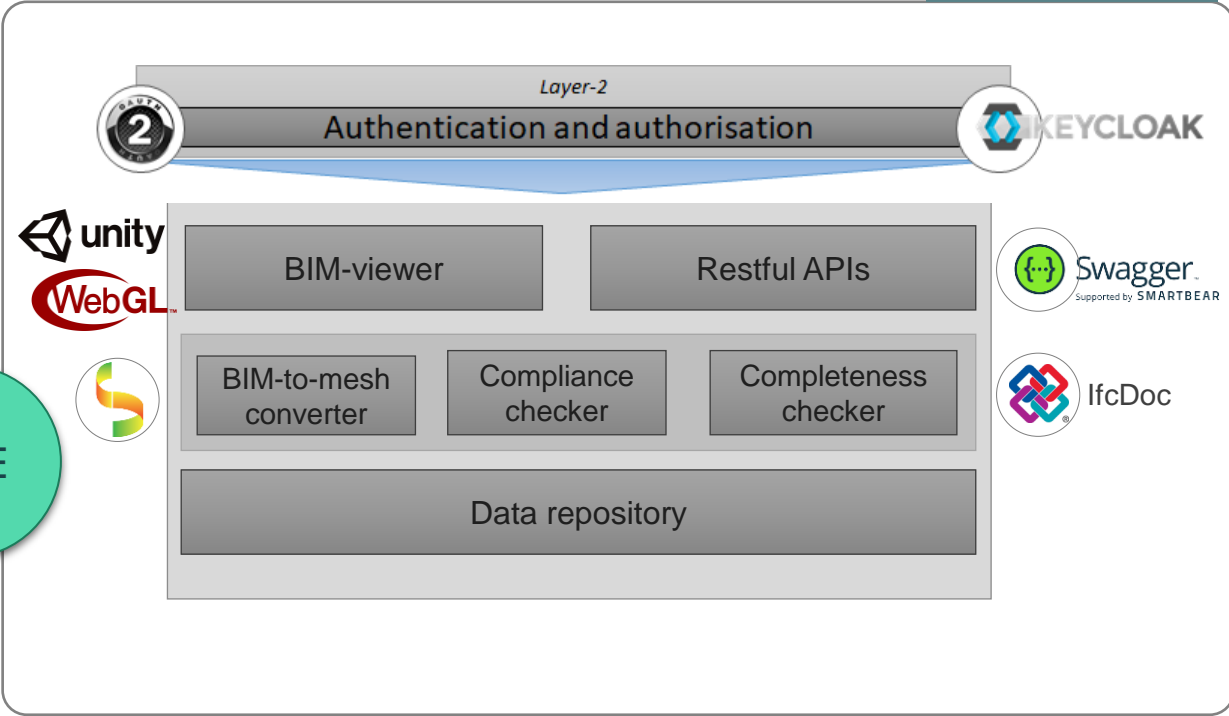
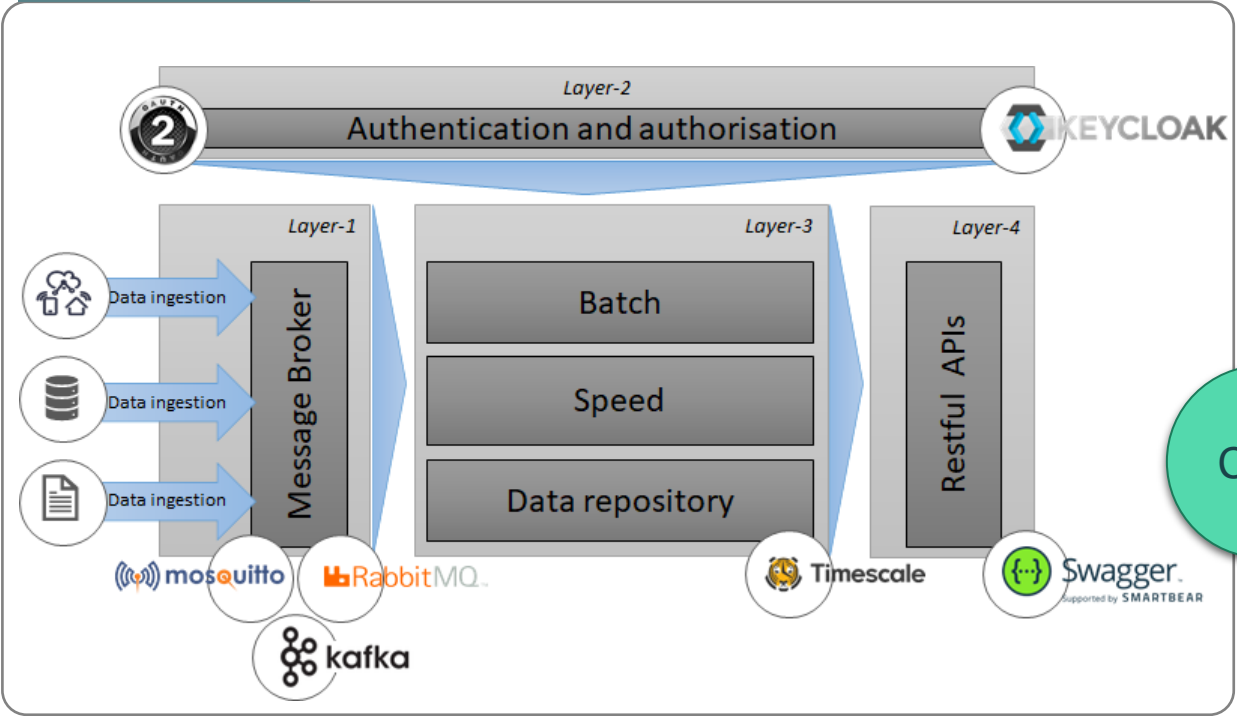
IoT Ecosystem - Distributed Data Management

openBIM fused with IoT data



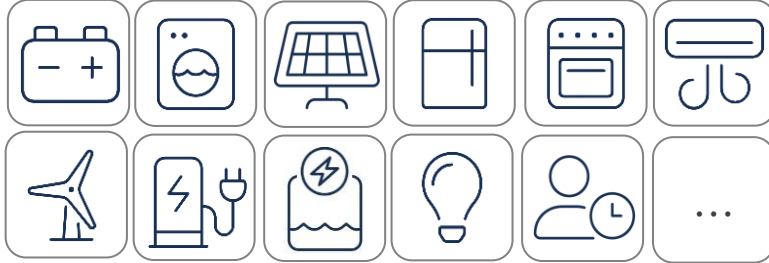
IoT data management

BIM data management



Data Driven Digital Twinning

Virtual Replicas



ETL tools and Co-simulation

BIM-to-BEP

ML-to-obXML

Physics-based co-sim



Performance Enhancement and Optimisation Services

Energy Savings

Peak load Reduction

Building-to-Grid Flex

Performance Monitoring and Assessment Services

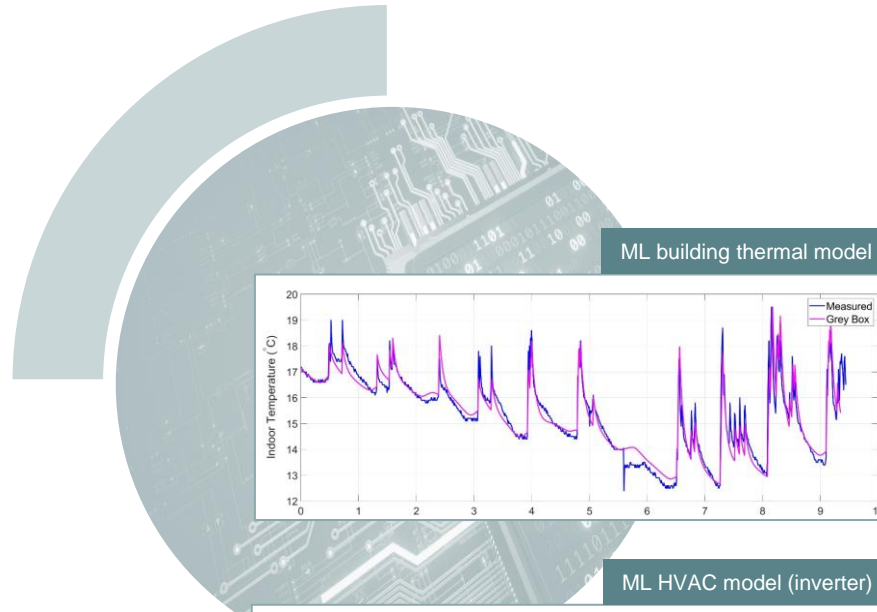
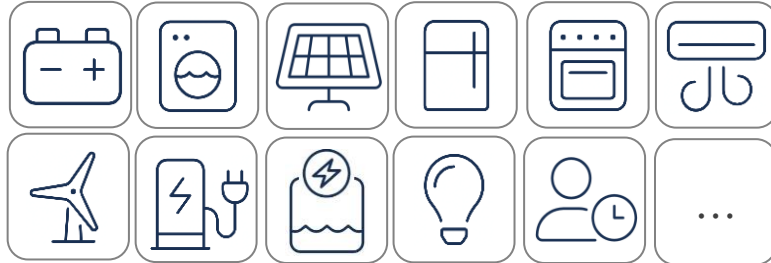
Dynamic EPC

SRI Rating

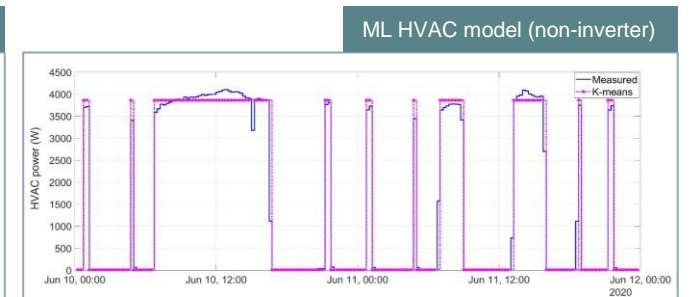
Comfort KPIs

Data Driven Digital Twinning

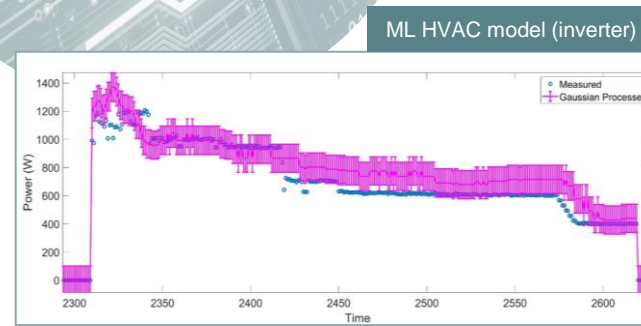
Virtual Replicas



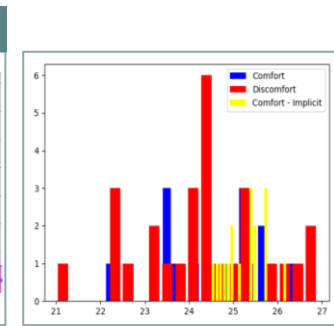
ML building thermal model



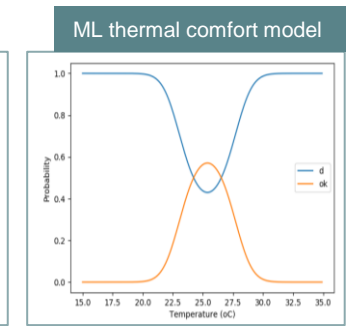
ML HVAC model (non-inverter)



ML HVAC model (inverter)

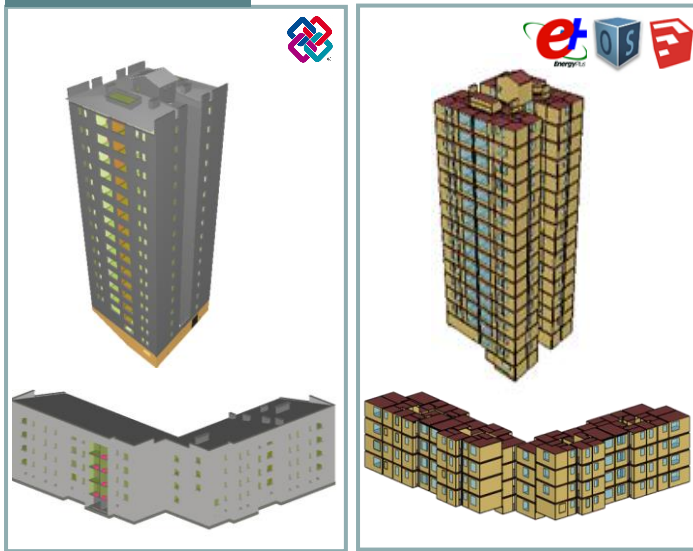


ML thermal comfort model

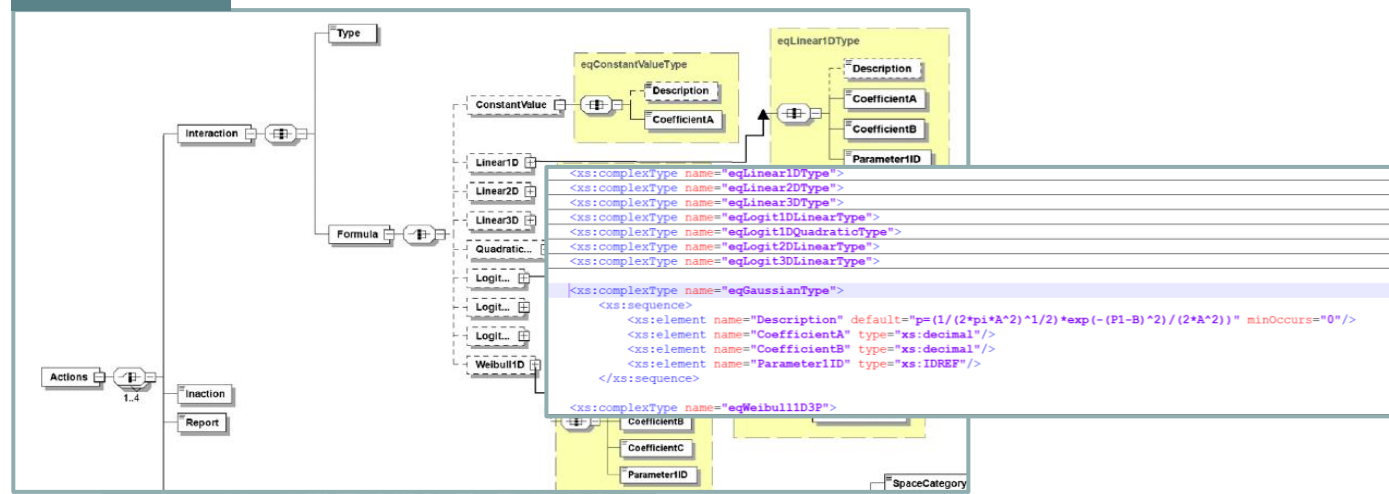


Data Driven Digital Twinning

IFC-to-IDF generator



obXML generator



ETL tools and Co-simulation

BIM-to-BEP

ML-to-obXML

Physics-based co-sim



FMU-based co-sim

Field	Units	Obs1	Obs2
Name		HC-SETPOINT-002	HC-SETPOINT-002
Zone or Zonelet Name		Zone-Pu40-002-002	Zone-Pu40-002-002
Control Type		TEMPERATURE	TEMPERATURE
Control Object Type		ThermostatDualPoint	ThermostatDualPoint
Control Name		HC-SETPOINT-002	HC-SETPOINT-002

obXML

```

    <obXML xmlns="http://www.e3.org/2012/06/obXML" version="1.0">
    <obXML:obXML xmlns="http://www.e3.org/2012/06/obXML" version="1.0">
    <obXML:obXML xmlns="http://www.e3.org/2012/06/obXML" version="1.0">
    <obXML:obXML xmlns="http://www.e3.org/2012/06/obXML" version="1.0">
    <obXML:obXML xmlns="http://www.e3.org/2012/06/obXML" version="1.0">
    </obXML:obXML>
    </obXML:obXML>
    </obXML:obXML>
    </obXML:obXML>
    </obXML>
  
```

Data Driven Digital Twinning



SRI methodology

ONE SINGLE SCORE CLASSIFIER THE BUILDING'S SMART READINESS

Impact criteria/Technical domain	Energy savings	Maintenance & fault prediction	Comfort	Convenience	Health & wellbeing	Information to occupants	Energy flexibility & storage
Heating	20,00%	20,00%	10,00%	25,00%	11,43%		
Domestic hot water			NULL	10,00%	NULL	11,43%	
Cooling		20,00%	10,00%	25,00%	11,43%		
Ventilation		20,00%	10,00%	25,00%	11,43%	NULL	
Lighting		NULL	20,00%	10,00%	NULL	NULL	NULL
Electricity			NULL	10,00%	NULL	11,43%	
Dynamic building envelope	5,00%	5,00%	20,00%	10,00%	25,00%	11,43%	NULL
Electric vehicle charging	NULL	NULL	NULL	10,00%	NULL	11,43%	5,00%
Monitoring and control	20,00%	20,00%	NULL	20,00%	NULL	20,00%	20,00%

DD SRI weights re-adjustment

3-key functionalities	Energy savings and operation	Energy flexibility	Respond to user needs			Energy savings and operation	Respond to user needs
	Energy efficiency	Energy flexibility and storage	Comfort	Convenience	Health, well-being and accessibility	Maintenance and fault prediction	Information to occupants
Heating	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0,33	0,20	0,33	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0,20
Domestic hot water	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0	0,20	0	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0,20
Cooling	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0,33	0,20	0,33	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0,20
Ventilation	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0	0,33	0,20	0,33	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0,20
Lighting	0	0	0	0	0	0	0
Electricity	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0	0,20	0	$(\frac{Q_{heat}}{Q_{total}} + \frac{Q_{cooling}}{Q_{total}}) / 2$	0,20
Dynamic building envelope	0	0	0	0	0	0	0
Electric vehicle charging	0	0	0	0	0	0	0
Monitoring and control	0	0	0	0	0	0	0

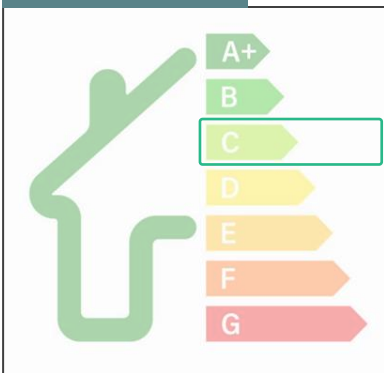
BIM-based SRI input collection

```

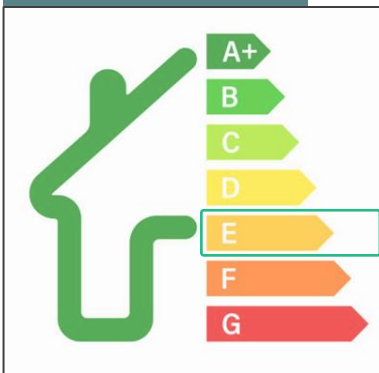
# CHRONICLE
# User Defined PropertySet Definition File
# Format:
# PropertySet: <Inst Name> I[instance]/T[type] <element list separated by ','>
# <Property Name 1> <Data type> <[opt] Revit parameter name, if different from IFC>
# <Property Name 2> <Data type> <[opt] Revit parameter name, if different from IFC>
# ...
# Data types supported: Area, Boolean, ClassificationReference, ColorTemperature, Count, Currency,
# ElectricalCurrent, ElectricalEfficiency, ElectricalVoltage, Force, Frequency, Identifier,
# Illuminance, Integer, Label, Length, Logical, LuminousFlux, LuminousIntensity,
# NormalizedRatio, PlaneAngle, PositiveLength, PositivePlaneAngle, PositiveRatio, Power,
# Pressure, Ratio, Real, Text, ThermalTransmittance, ThermodynamicTemperature, Volume,
# VolumetricFlowRate

# CHRONICLE
HEATING DOMAIN
PropertySet: Pset_HeatEmissionControl I IFCunitaryControlElement
PropertySet: Pset_HeatGeneratorControl I IFCunitaryEquipment, IFCspaceheater
PropertySet: Pset_HeatPumpControl I IFCunitaryEquipment
PropertySet: Pset_HeatControl I IFCunitaryEquipment
PropertySet: Pset_HeatMultiStageControl I IFCunitaryEquipment
PropertySet: Pset_HeatVariableTempControlLoad I IFCunitaryEquipment
PropertySet: Pset_HeatVariableTempControlOutdoorTemp I IFCunitaryEquipment
PropertySet: Pset_HeatVariableTempControlLoad I IFCunitaryEquipment
PropertySet: Pset_HeatVariableTempControlOutdoorTemp I IFCunitaryEquipment
PropertySet: Pset_HeatVariableTempControlLoad I IFCunitaryEquipment
PropertySet: Pset_HeatVariableTempControlOutdoorTemp I IFCunitaryEquipment
    
```

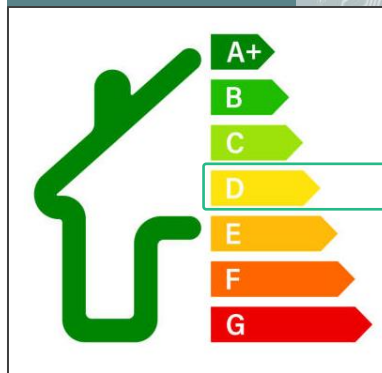
EPC Asset Rating



EPC Operational Rating



EPC Rating (DTs co-sim)



Performance Monitoring and Assessment Services

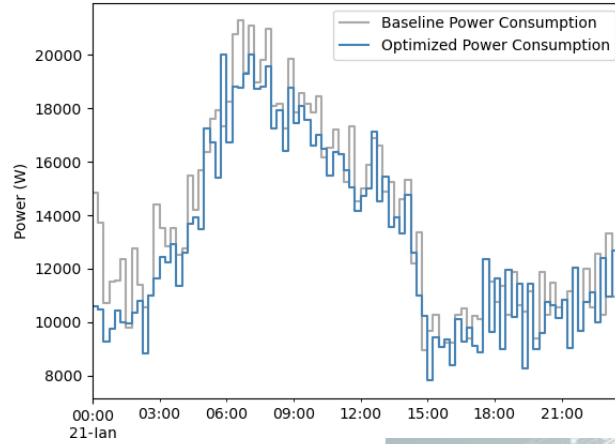
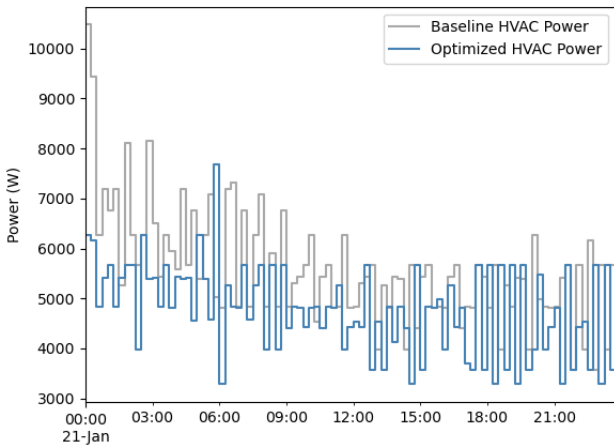
Dynamic EPC

SRI Rating

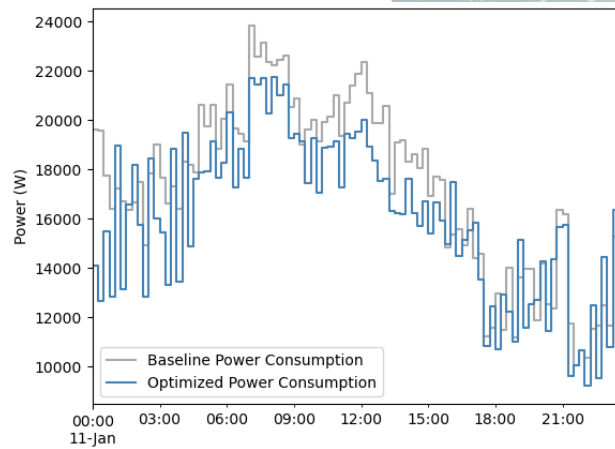
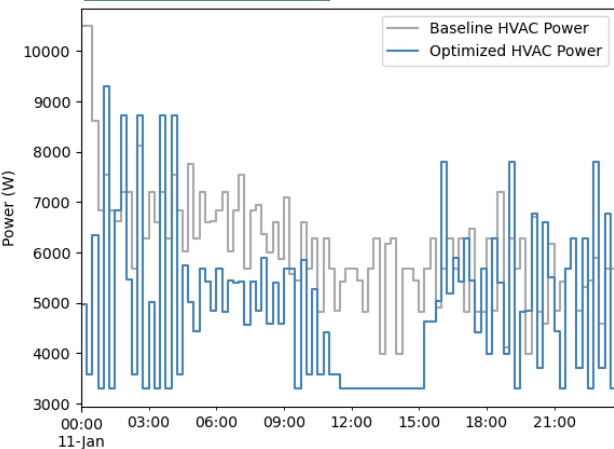
Comfort KPIs

Data Driven Digital Twinning

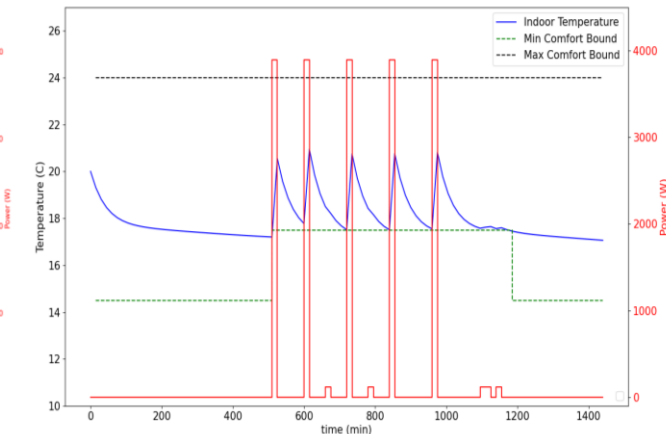
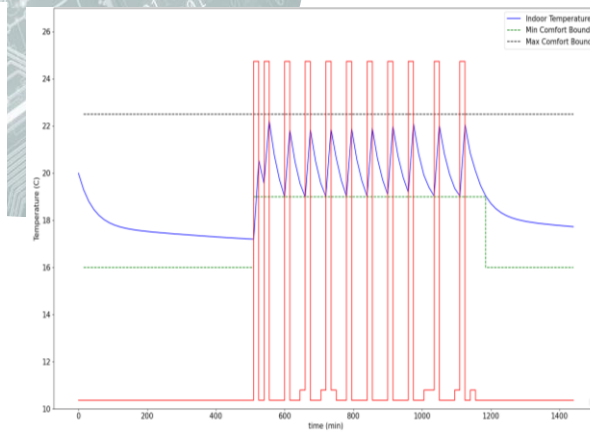
Energy Savings



Peak Load Reduction



Building-to-Grid Flex

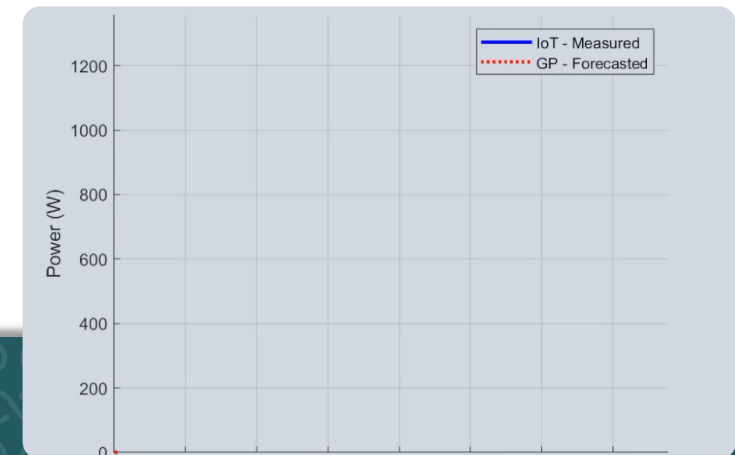
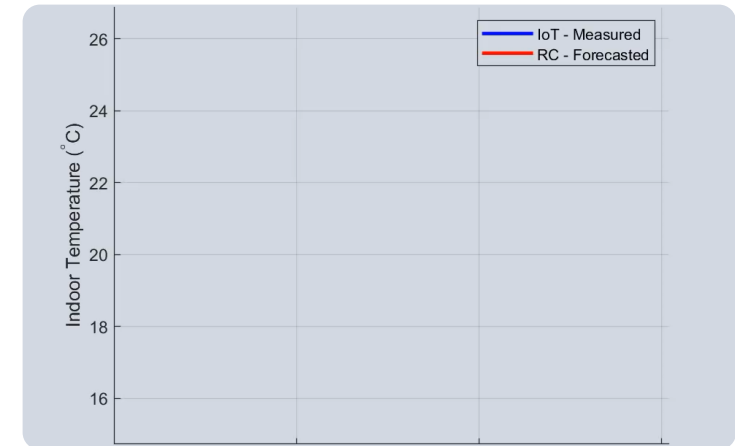
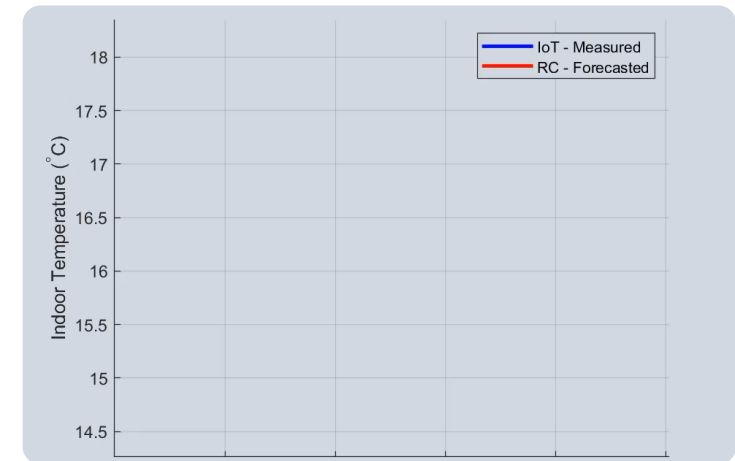
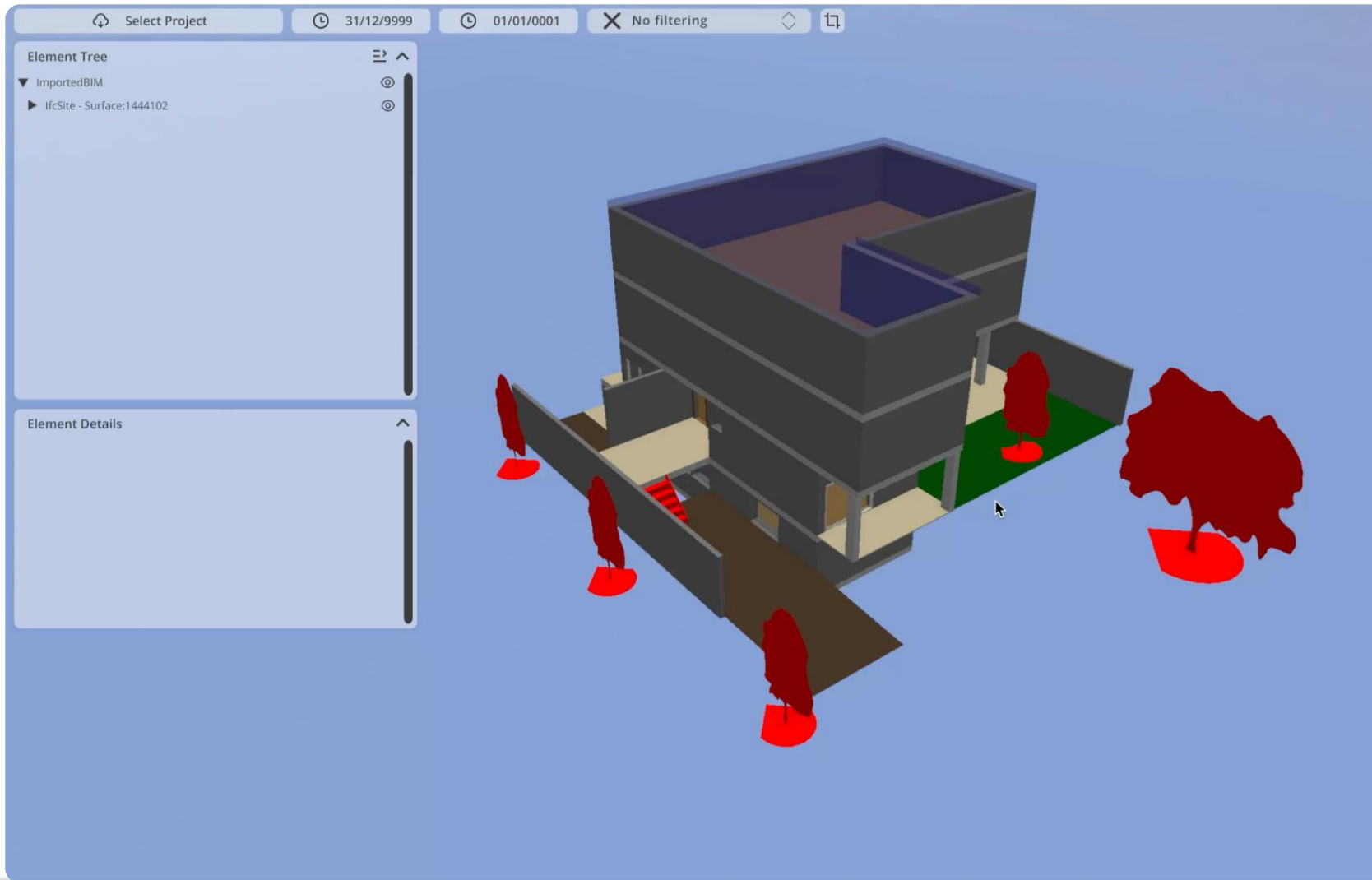


Performance Enhancement and Optimisation Services

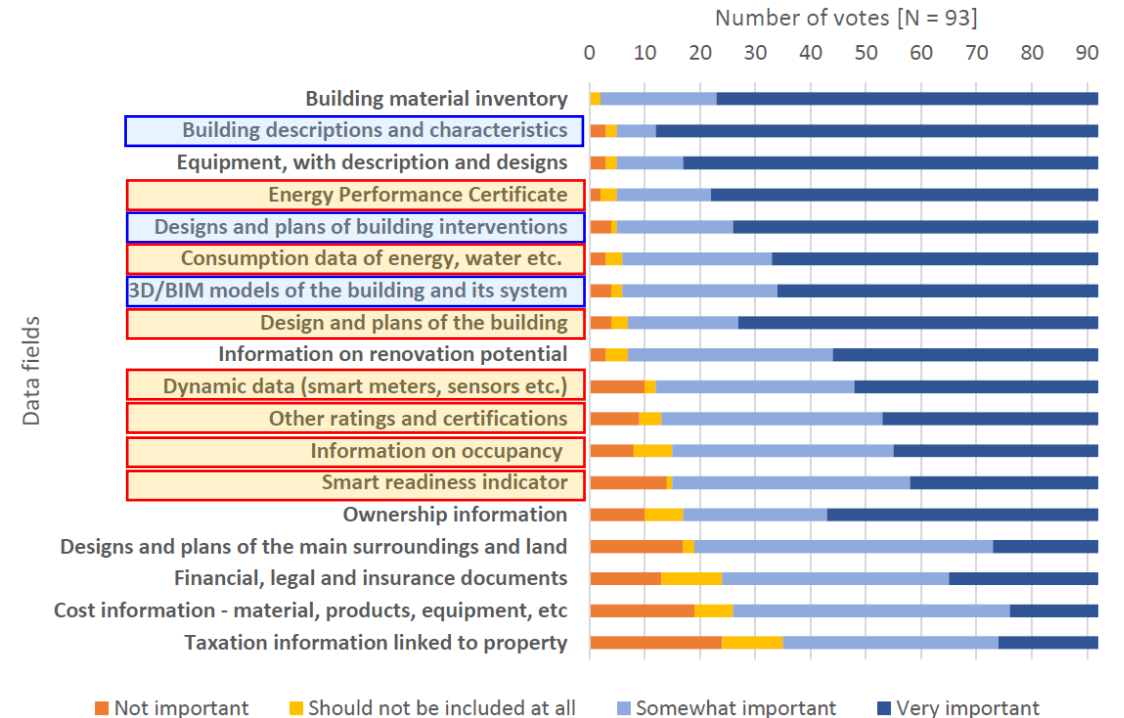
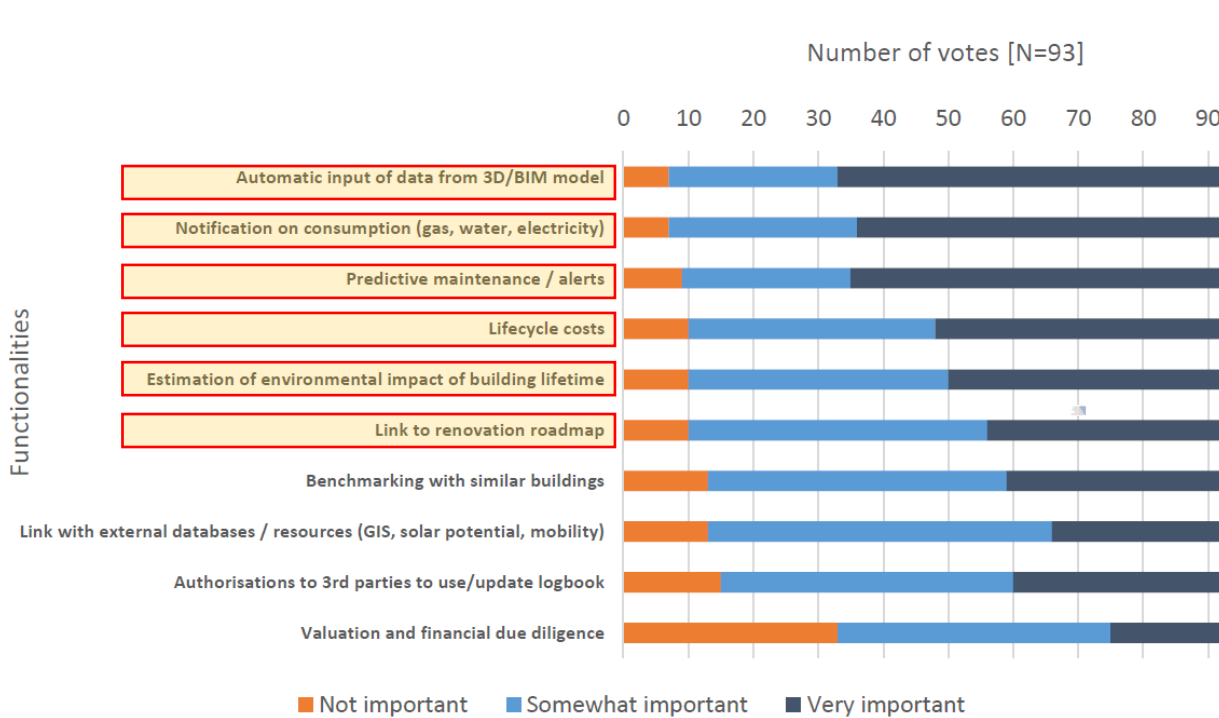
- Energy Savings
- Peak load Reduction
- Building-to-Grid Flex

Human centric approach: thermal comfort bounds are not violated

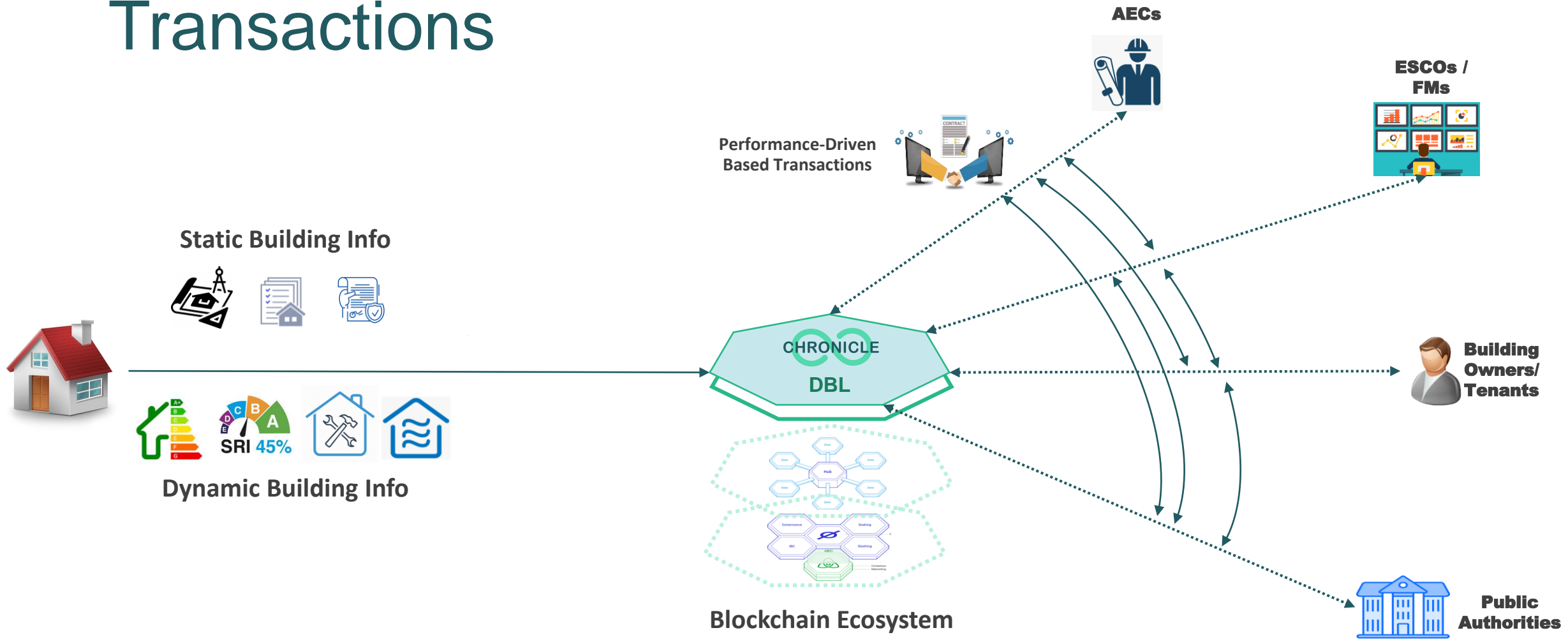
Intuitive Visualisation



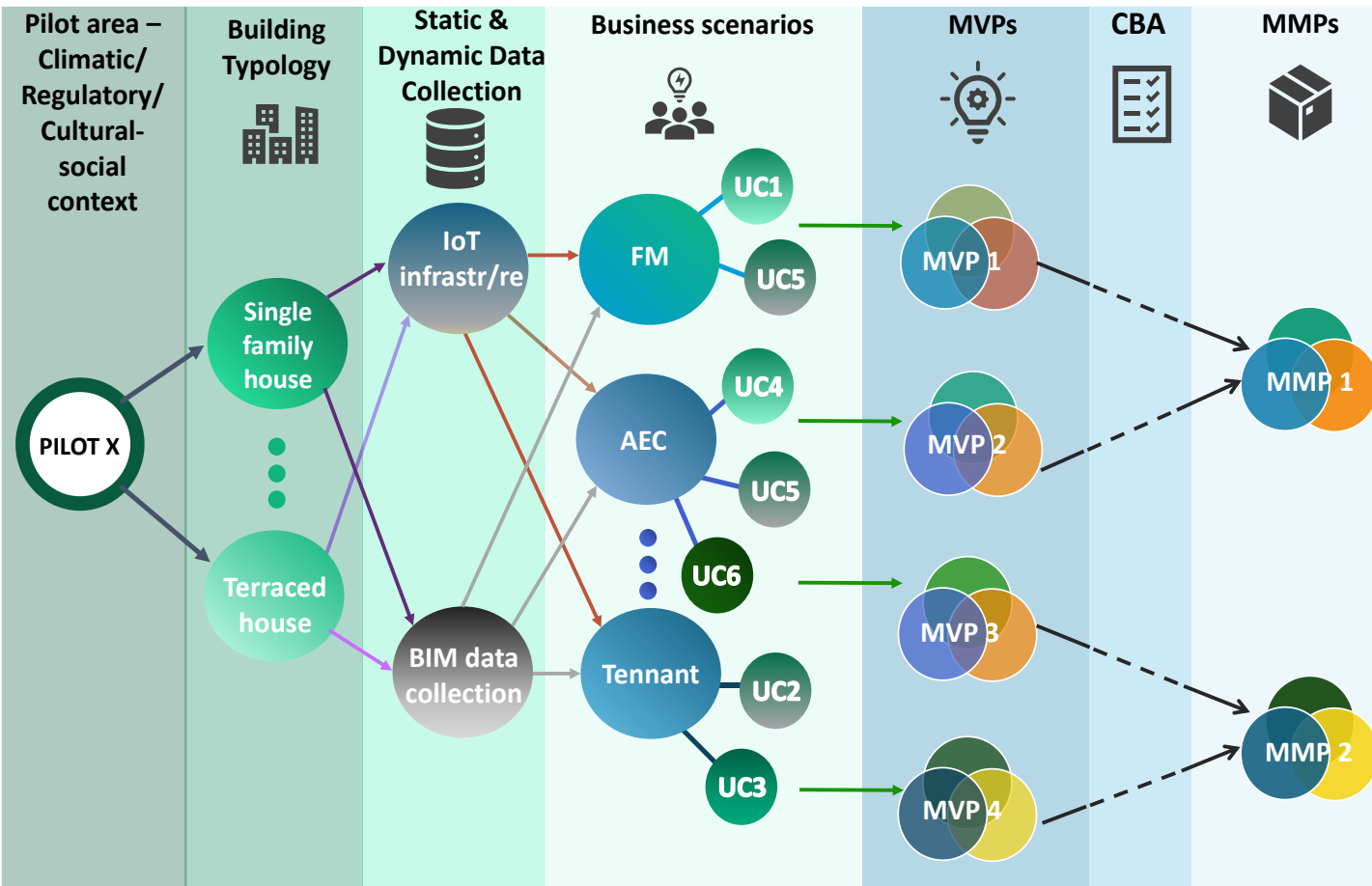
Digital Building Logbooks for Multi-actor Transactions



Digital Building Logbooks for Multi-actor Transactions



Co-creation of Innovative Business Models



Sustainable Circular Design

EPCs for People

Use for Performance / Paid for Savings Schemes

Comfort-As-A-Service

Thank you!



Contact: Christos Malavazos

c.malavazos@hypertech.gr

LinkedIn: [linkedin.com/company/chronicle-heurope](https://www.linkedin.com/company/chronicle-heurope)

Twitter: @CHRONICLEheu

Website: chronicle-project.eu

