FINAL CONFERENCE NOVEMBER 24TH - FROM 10H00 TO 12H30 CET

Data aggregation and harmonization for a sustainable built environment



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Generalitat de Catalunya Institut Català



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Housekeeping rules





 All participants are automatically muted by the webinar administrators



• Please submit your questions using the Q&A feature which is visible on the Zoom Webinar control panel.



• The webinar is being recorded.



 The slides and the recording will be publicly available on our website (<u>https://www.bigg-project.eu/</u>) in the upcoming days



Agenda



10:00 - 10:05	Welcome & Introduction
10:05 - 10:15	Opening by the European Commission
10:15 - 10:30	Introduction to BIGG project and its objectives
10:30 - 11:15	Introduction to BIGG Business Cases and Q&A
11:15 - 11:25	Coffee break
11:25 - 12:00	Ontology and AI Toolbox – Panel discussion
12:00 - 12:25	#SmartEnergyCluster: 3 LIFE projects
12:25 - 12:30	Conclusion





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Opening by the EC

Eleftherios Bourdakis

Project Advisor

European Climate, Infrastructure and Environment Executive Agency (CINEA)



The importance of data in the built environment

BIGG Final Event: Data aggregation and harmonization for a sustainable built environment

Eleftherios Bourdakis Project Adviser CINEA

The importance of data

- **Efficient Operations:** Leading to cost savings and improved sustainability.
- **User Experience:** Understanding occupant behavior and preferences allows for the customisation of spaces, optimising comfort, and increasing productivity.

The Ten years on: banking after the crisis Economist South Korea's unfinished revolution Biology, but without the cells The world's most valuable resource

Theresa May y Brussels



Data and the new rules of competition

- **Sustainability and Resource Management:** Supporting initiatives related to energy efficiency, waste reduction, and water conservation, contributing to sustainable and environmentally friendly practices.
- **Predictive Analytics for Planning:** Enabling authorities to make informed decisions about infrastructure development, traffic management, and zoning for optimal city functioning.



Data in the built environment in Horizon 2020

- Establishment of the Building Stock Observatory (BSO)
- Importance of data in the built environment identified during H2020 funding programme, through relevant topics
 - ICT enabled, sustainable and affordable residential building construction, design to end of life
 - Digital Building Twins
 - Big data for buildings
- Building Digital Twin Association





The European Strategy for data 1/2

- Adopted by the European Commission in 2020
- To create a single market for data ensuring Europe's global competitiveness and data sovereignty
- To ensure that more data becomes available for use in the economy, society and research
- Companies and individuals who generate the data are in control



The European Strategy for data 2/2

- Data Governance: The strategy emphasises the establishment of common European data spaces to facilitate sharing and access to data in specific sectors, promoting a common European data governance framework.
- **Data Interoperability:** A focus on creating standards and fostering interoperability to enable the free flow of data across borders and sectors, eliminating data silos, and encouraging collaboration.
- Empowering Individuals and Businesses: Promoting data sharing while ensuring privacy and security through tools like the General Data Protection Regulation (GDPR).
- Innovation and Competitiveness: Leveraging data for emerging technologies such as artificial intelligence and the Internet of Things.



Energy Data Space

- Data Integration: Integrate diverse energy-related data sources, fostering a collaborative platform for sharing and accessing information across the European Union.
- Interoperability: Create standards and protocols to ensure interoperability among various energy data systems
- Innovation and Insights: Encourage innovation in the energy sector and allow stakeholders to derive meaningful insights, driving informed decision-making and supporting the transition to sustainable energy practices.
- Policy Support: Provide a foundation for evidence-based policymaking and regulatory decisions in the field of energy.



Data in the built environment in Horizon Europe

- 2022 Smart-grid ready and smart-network ready buildings, acting as active utility nodes
- 2023 Intelligent data acquisition and analysis of materials and products in existing built works
- 2023 Innovative uses of lifecycle data for the management of buildings and buildings portfolios
- 2024 BIM-based processes and digital twins for facilitating and optimising circular energy renovation





Thank you!

- **CINEA on TWITTER**: @cinea_eu and @cleanenergy_eu
- CINEA on LINKEDIN: <u>https://www.linkedin.com/company/cinea-european-climate-infrastructure-environment-executive-agency/about/</u>
- CINEA website: https://cinea.ec.europa.eu/index_en







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Introduction to BIGG project & its objectives

María Pérez Ortega

R&D Program Manager - Inetum

Project Coordinator

Nicolas Pastorelly Head of Department - CSTB

Our objectives





The BIGG project aims at demonstrating the application of big data technologies and data analytic techniques for the complete buildings' life-cycle of more than 4000 buildings in 6 large-scale pilot test-beds.

Big Data reference architecture for buildings' data

> Harmonization of data from different sources



Open cloud-based analytics toolbox



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Our pilots and use cases







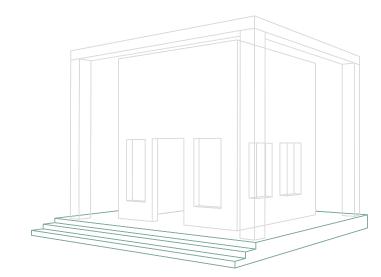
Context of the project





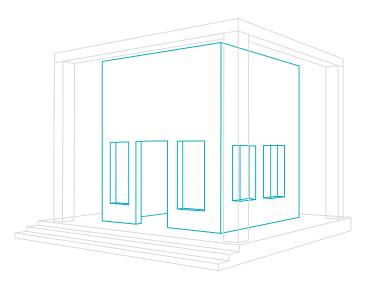
Alignment and standardization

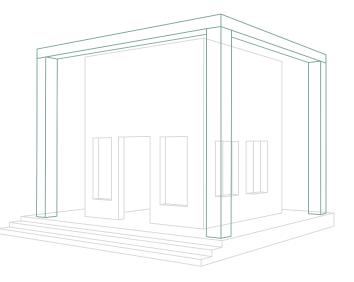




Alignment to data sources of the platform

Necessary to establish data exchange.





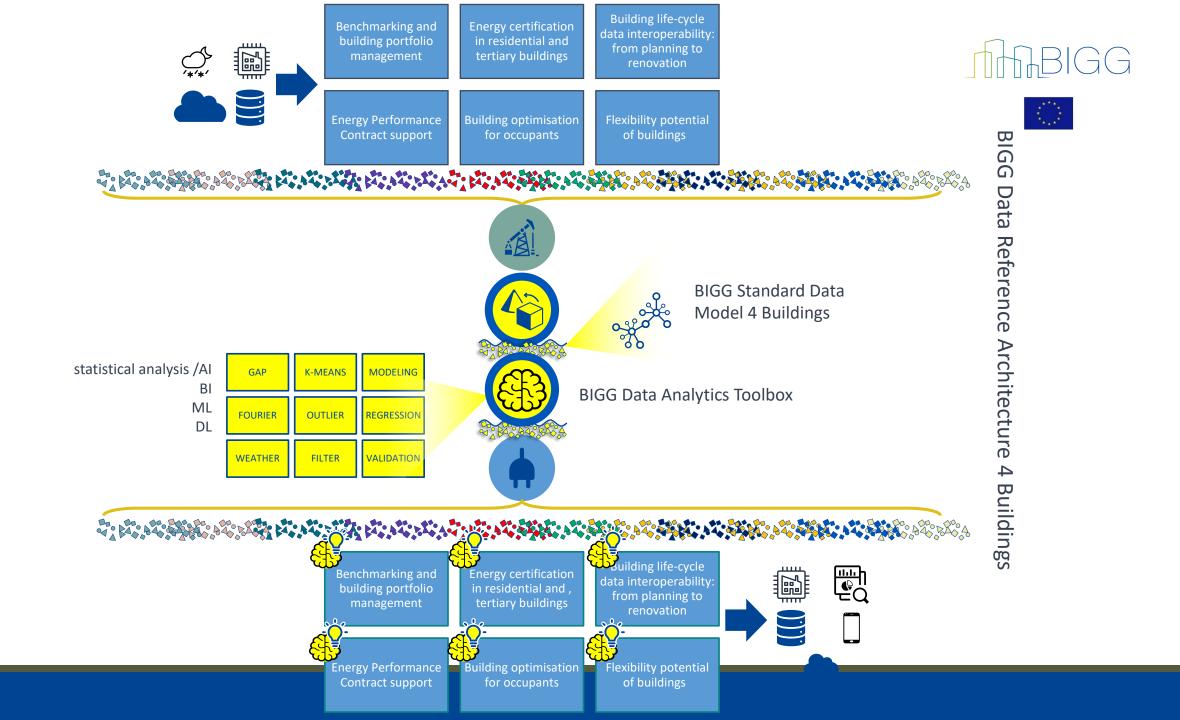
Mapping to a data dictionary

To associate the platform terminology to a standard and facilitate future harmonization.

Alignment to an ontology

To map data relations and hierarchies and **fully standardize** the model.

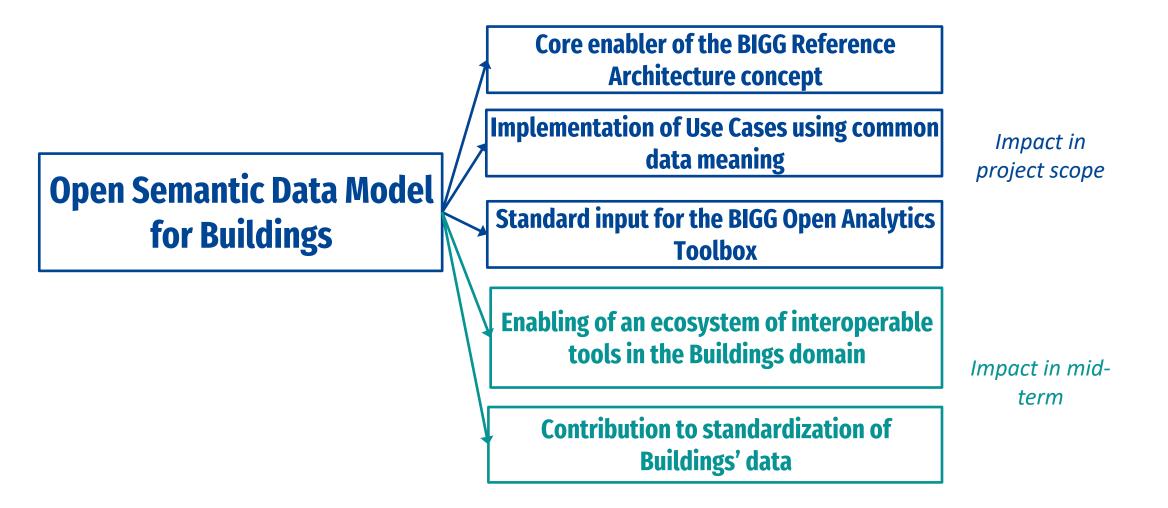
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Sensitivity: Company

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Positive digital flow

BIGG Partners

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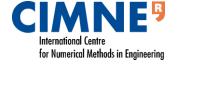
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ENVIRONMENT

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Sensitivity: Company





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Generalitat de Catalunya

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Introduction to **BIGG Business Cases**

Business Case 1: Benchmarking and Energy Efficiency tracking in Public Building



BC1: The seed of the project





Generalitat de Catalunya

Generalitat de Catalunya Institut Català d'Energia

- 4,000+ buildings
- 14 government departments (ministries)
- Hundreds of energy efficiency measures implemented each year

BC1: The seed of the project

TH BIGC



Information

Generalitat de Catalunya

- 4,000+ buildings
- 14 government departments (ministries)
- Hundreds of energy efficiency measures implemented each year

The energy/building challenge:

Target

 Several data sources (internal and external): energy use, building information, weather data...

Generalitat de Catalunya Institut Català d'Energia

- Hundreds of energy/building managers
- Energy transition

Skilled workforce

BC1: Definition and objectives



- Obtain the greatest value from the energy information
 - Improve the identification of energy efficiency measures in most of public buildings by monitoring their consumptions.
 - Facilitate energy management

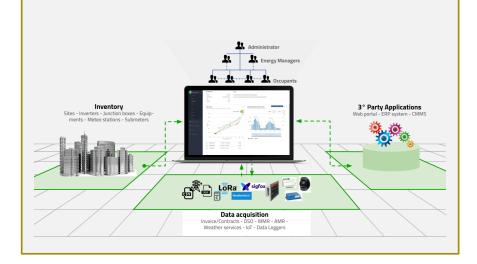
Main features are:

- Open big data infrastructure for storing all building data in one place and monitor performance.
- Energy benchmarking using data analytics developed in the project.
- Continuous gathering of data from different sources, energy consumption, investments in energy measures, information on users, building information, etc.

BC1: Benchmarking and Energy Efficiency tracking in Public Building



Benchmarking & building portfolio management



Use case 1: Benchmarking and monitoring of energy consumption.

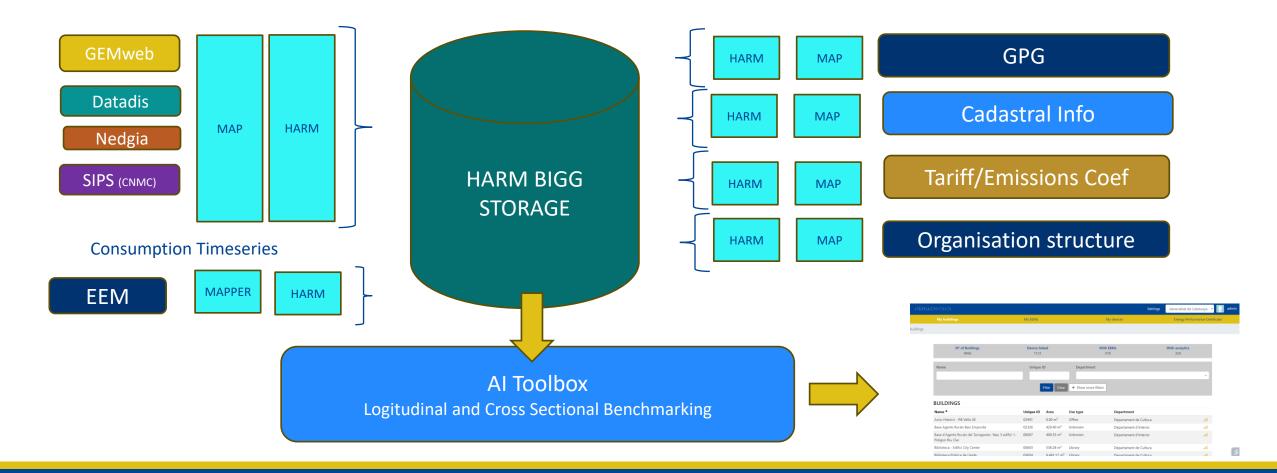
Similar buildings comparisons and evaluation of changes in the consumption trends.

Use case 2: Energy Efficiency Measures (EEM) registration and evaluation. Continuous registration and evaluation of the implementation of energy efficiency measures in buildings.

BC1: Input data processing







Use case 1: Benchmarking and monitoring of energy consumption



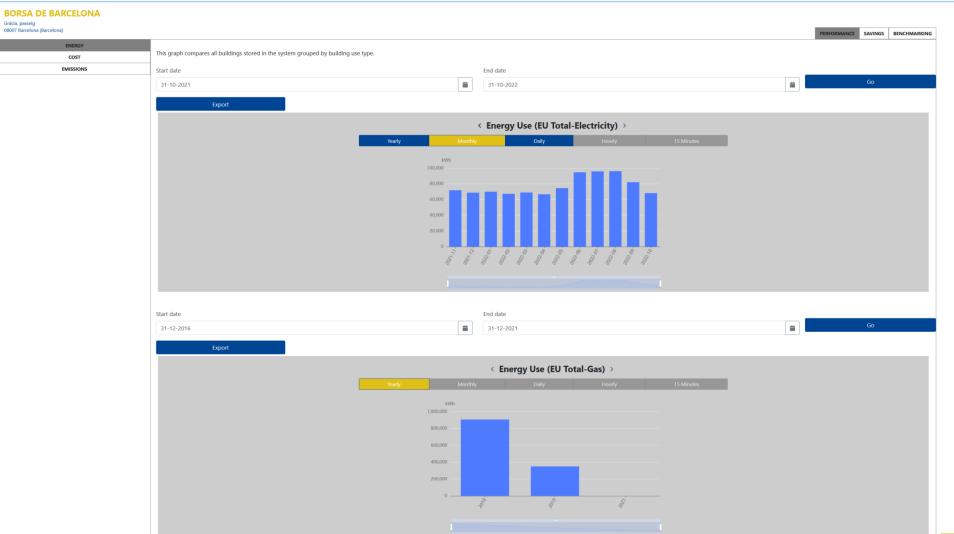
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My buildings	My EEMs			Supplies
ildings				
	N° of Buildings	Device linked	With EEMs	With anatytics
	17	16	9	3
	Name	Unique ID	Department	
			Ports de la Generalitat	× *
		Filter Clea	ar + Show more filters	
	BUILDINGS			
	Name [▲]	Unique ID Area	a Use type	Department
	Generic(Ports de la Generalitat)	FE245	0.00 Unknown	Ports de la Generalitat
	Port Arenys de Mar	06061	0.00 Port Building	Ports de la Generalitat
	Port Cases d'Alcanar	11035	0.00 Port Building	Ports de la Generalitat
	Port de Blanes	06062	0.00 Port Building	Ports de la Generalitat
	Port de Cambrils	06063	0.00 Port Building	Ports de la Generalitat
	Port de l'Ametila de Mar	06058	0.00 Port Building	Ports de la Generalitat
	Port de L'Ampolla	06059	0.00 Port Building	Ports de la Generalitat
	Port de la Vilanova i la Geltrú	06066	154,532.00 Port Building	Ports de la Generalitat
	Port de l'Escala	06064	0.00 Port Building	Ports de la Generalitat
	Port de l'Estartit	06065	0.00 Port Building	Ports de la Generalitat
	Port de Llançà	06067	0.00 Port Building	Ports de la Generalitat
	Port del Port de la Selva	06069	0.00 Port Building	Ports de la Generalitat
	Port de Palamós	06068	0.00 Port Building	Ports de la Generalitat
	Port de Roses	06070	0.00 Port Building	Ports de la Generalitat
	Port de Sant Feliu de Guíxols	06071	0.00 Port Building	Ports de la Generalitat
	Port pesquer de Deltebre	05749	579.00 Port Building	Ports de la Generalitat
	Port Sant Carles Marina	06060	0.00 Port Building	Ports de la Generalitat
	Showing results since 1 to 17 of 17			



Use case 1: Performance tracking

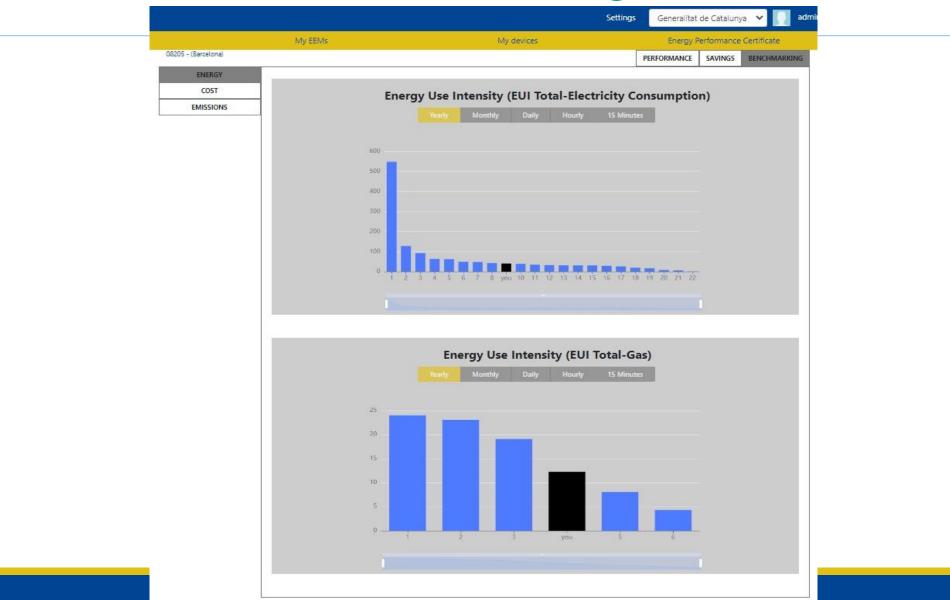




Sensitivity: Company

Use case 1: Benchmarking





Use case 2: Energy Efficiency Measures (EEM) registration and evaluation





Improvement measure

- Lighting Measure

-- Lighting Indoor Measure

--- Indoor Lighting Operational Optimization ---- Indoor Occupancy Sensor Installation

EEM Types

199869			
My buildings	My EEMs	Supplies	
EEMs / NewEEM			

Recull de millores de sostenibilitat Energètica any 20XX (EEM gathering tool). Institut Català d'Energia (ICAEN)

Departament / Entitat	Departament de Cultura		
Edifici (Espai) - Codi Ens (GPG)	Instal-Jació millorada (NIVELL 1)	Tipus de millora (NIVELL 2)	Tipus de millora (NIVELL 3)
Arxiu Històric de Girona - 02494	Millora de l'envolupant de l'edifici	Millores al sostre i coberta	Impermeabilització del sostre
Arxiu Històric de Lleida - 10404	Millora en condicionament tèrmic i ACS	Millora del sistema de refrigeració	Millora del sistema de distribució i emmaga
Biblioteca - Edifici City Center - 00603	Millora d'aprofitament de l'energia renovable solar i e	 tal·lació solar fotovoltaica 	
NO GPG: Districte Public1. c/ Balmes 202, 08025	Milora d'iHuminació		
	Millora en condicionament tèrmic i ACS Millora de l'envolupant de l'edifici		
	Millora del sistema d'energia elèctrica i altres aparells elèctrics		
	Millora de gestió Millora d'aprofitament de l'energia renovable solar i eòlica		

New EEM - Unknown building

Building sel	ection *		EEN
ilters 🔨			Ligh
All use types		~	Ligh
Institut Català d`f	Energia (I ×	÷	
All cities		~	Indo
All provinces		~	Inde
A			
Search			
Filter	Clear		

M selection type * ghting Measure

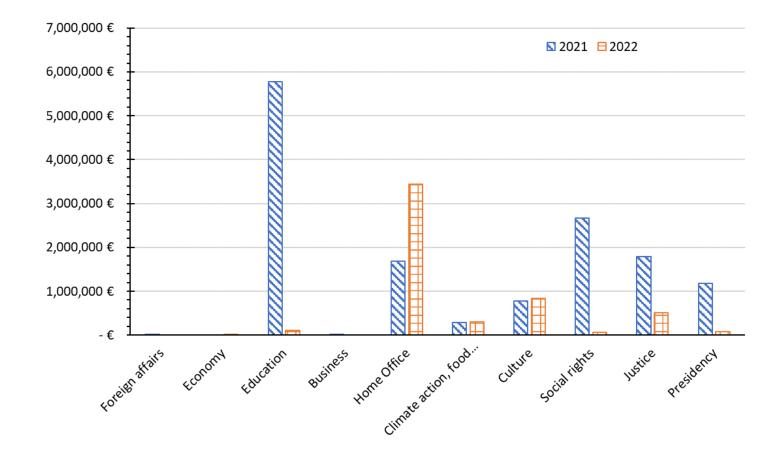
ghting Indoor Measure	~
door Lighting Operational Optimization	~
door Occupancy Sensor Installation	~

V

Type description Indoor Occupancy Sensor Installation Economic investment Investment Currency EUR Start work date Comments and notes Comments and notes Concel



Use case 2: BIGG solution results



Conclusions





- Creation of a centralised data repository (including energy use, building data, EEM information and weather conditions)
- Integration of analytical tools developed for BIGG → minimising the need of data processing by energy managers
- Streamlined EEM data collection process using the BIGG solution, minimising data errors and post-cleaning

Generalitat de Catalunya:

• BIGG solution \rightarrow 5-year post-project development of an internal tool (SIME)





Business Cases 2-3

Energy certification in residential and tertiary buildings Building life-cycle - From planning to renovation

BIGG FINAL MEETING 24TH NOVEMBER 2023



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BC2: Energy Certification (EPC) in Residential and Tertiary Buildings

Energy certification in residential, tertiary buildings



BUSINESS CASE OBJECTIVE

BC2 focuses on taking advantage of the building energy performance certifications (building EPC) and laying the groundwork for future applications and modifications of the certificates.

BC2: Use Cases





Use case 3: Integration of INSPIRE spatial data with Energy Performance Certification (EPC).

Automating the integration of the INSPIRE data with the EPC input data for completing and cross- checking the information and improving the reliability of the services.

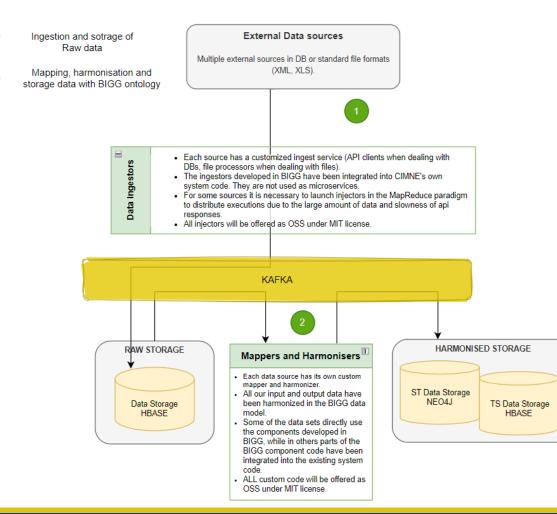
Use case 4: Adoption of the sustainability indicators of common EU framework Level(s) in building certification.

Adoption of Level(s) indicators that is possible with the currently available energy certification input data and specification of the extended input necessary for the calculation of the rest of indicators for the future evolving of the certification.

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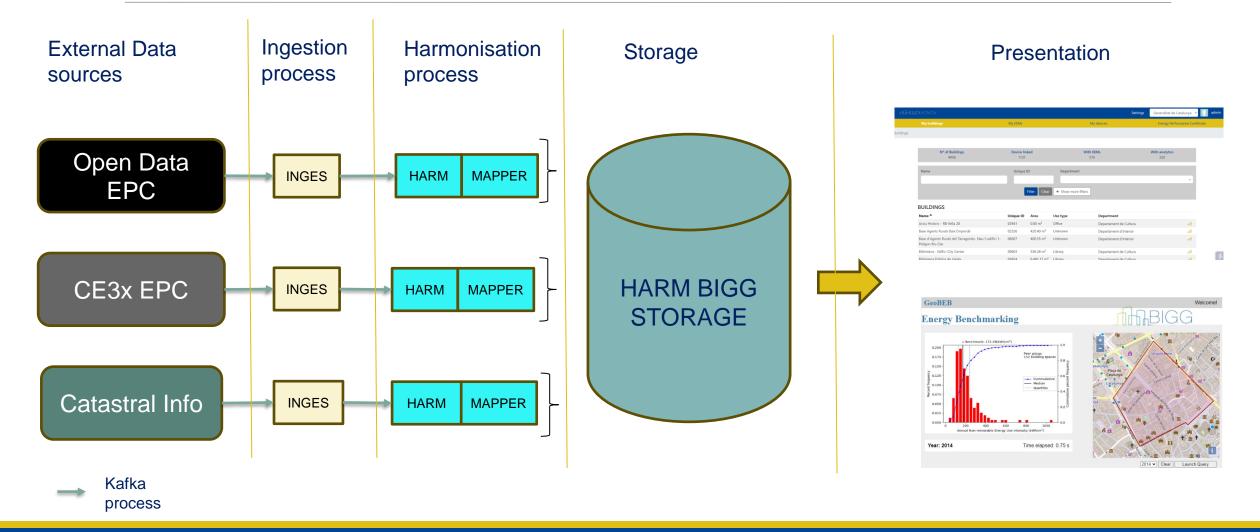


BC2: Pipeline





BC2: Infrastructure and data process





BC2: Data collecting-Ingestors



OPENDATA API

Updated July 9, 2	023		Actors		
July 9, 2	023		Tipus actor	Generalitat de Catalunya	
Data Last Updat	ed Metadata La	st Updated	Departament	Acció Climàtica, Alimentació i Agenda Rural	
July 9, 2023	July 9, 2023		Freqüència d'actualització		
Date Created May 7, 2019			Freqüència d'actualització	Setmanal	
Views	Downloads		Idioma		
22.2K	4,499		Idioma	Català	
Data Provided b		Dataset	Nombre del conjunto de datos (ES)	certificados de eficiencia energética de edificios	
Departament d'A	cció Climàtica,	Owner	Dataset name (EN)	Certificates of energetic efficiency of buildings	
Alimentació i Ag	enda Rural	Dades Obertes Catalunya	Àmbit geogràfic		
			Àmbit geogràfic	Catalunya	
	ontact Dataset O	wner	Informació geogràfica	Coordenades	
			Informació de gènere o sexe		
			Informació de gènere o sexe	No aplica	
					Show More
hat's in thi	s Dataset?				
Rows 1.44M	Columns 69	Each row is a Certificat			

Github- Ingestor&Harmoniser Opendata Componenet- Published

BPC results in XML (web app)

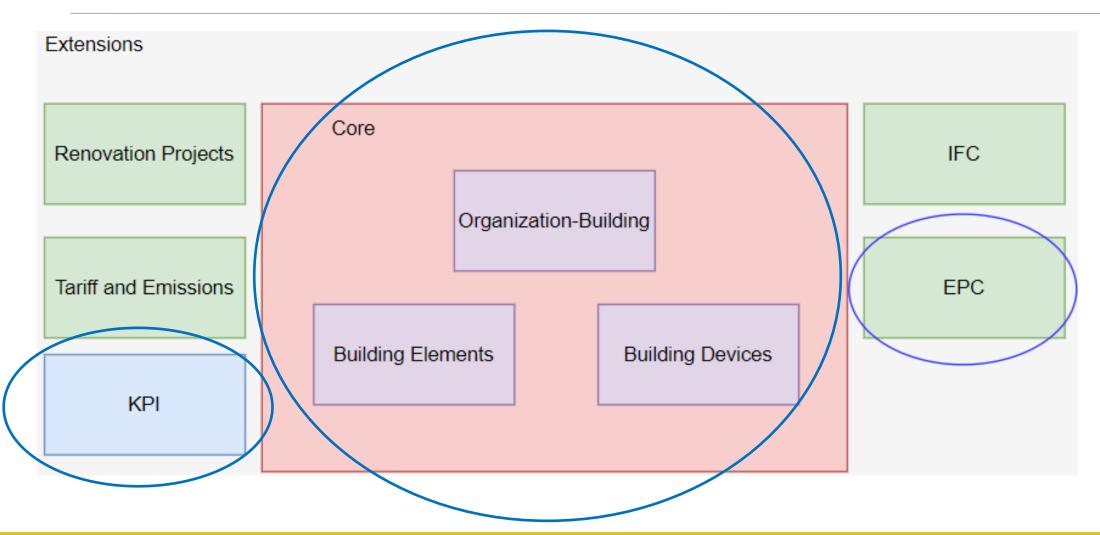
BIGG UI Web			<u>n</u>	RBIGG		
Building selection * Flee * 003306 Ab Notes Seryes & Monanara - 20 Analih Claw 1931 00331 (Ad Pan Crait - 20 Perman 11 12		enano Caribane * ara: conor * tremando 	illion V		<u>_</u> }	BIGG Platform
6028/R AVA Hwe Calders - 01 Calabrie 35 6027/R AVA Proportion - 03 Bahawa Goodar 24 26	Ille Name IS D. CARAT - SUMPRIMULERA and	Batus NOT,PROCESSED	Upland Time 2023/04/14 11:47	Processed Time		M BIGG

GitHub - Ingestor&Harmoniser CE3X Componenet- Published



BC2: BIGG Ontology

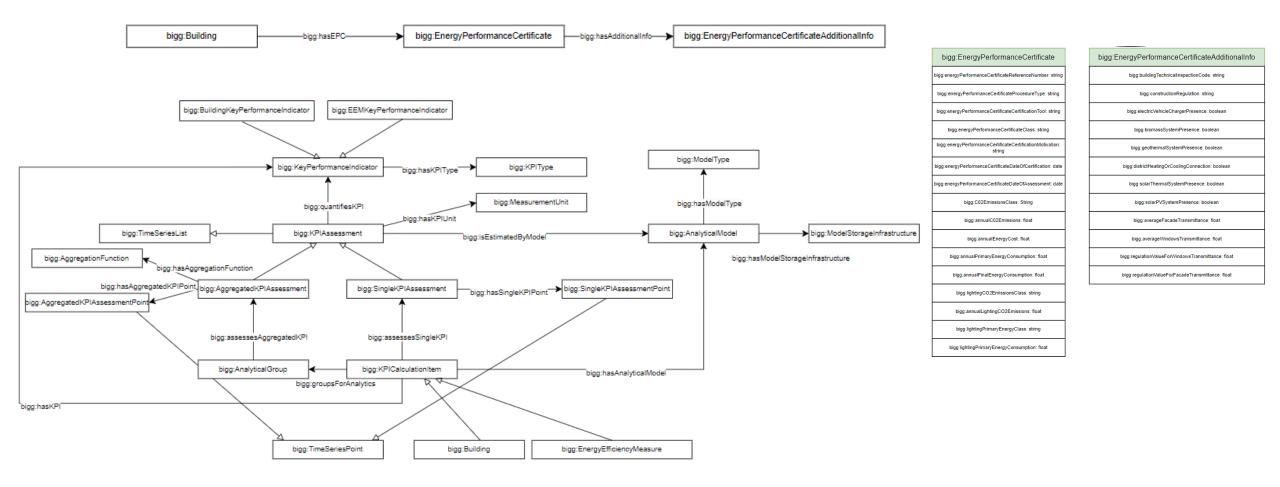








BC2: BIGG Ontology



BC2: BIGG Harmonisation



BIGG

LocationInfo

Origin	Harmonization
adre_a	addressStreetName
numero	addressStreetNumber
codi_postal	addressPostalCode
longitud	addressLongitude
latitud	addressLatitude
nom_provincia	hasAddressProvince
poblacio	hasAddressCity

Building

Origin	Harmonization
any_construccio	buildingConstructionYear

CadastralInfo

Origin	Harmonization
referencia_cadastral	landCadastralReference
metres_cadastre	landArea

EnergyPerformanceCertificate

Origin	Harmonization
num_cas	energyPerformanceCertificateReferenceNumber
qualificaci_de_consum_d	energyPerformanceCertificateClass
qualificacio_d_emissions	C02EmissionsClass
emissions_de_co2	annualC02Emissions
cost_anual_aproximat_d_energia	annualEnergyCost
consum_d_energia_final	annualFinalEnergyConsumption
eina_de_certificacio	energyPerformanceCertificateCertificationTool
emissions_refrigeraci	annualCoolingCO2Emissions
qualificaci_emissions_1	coolingCO2EmissionsClass
emissions_calefacci	annual Heating CO2E missions
qualificaci_emissions	heating CO2Emissions Class
emissions_acs	annual Hot Water CO2 Emissions
qualificaci_emissions_acs	hotWaterCO2EmissionsClass
emissions_enllumenament	annual Lighting CO2E missions
qualificaci_emissions_2	lighting CO2Emissions Class
qualificaci_energia_acs	hotWaterPrimaryEnergyClass
qualificaci_energia_1	lightingPrimaryEnergyClass
qualificaci_energia_calefacci_1	heatingEnergyDemandClass
motiu_de_la_certificacio	$energy {\it Performance} Certificate Certification Motivation$
motiu_de_la_certificacio	${\it energy} {\it Performance} {\it Certificate} {\it Certification} {\it Motivation}$

EnergyPerformanceCertificateAdditionalInfo

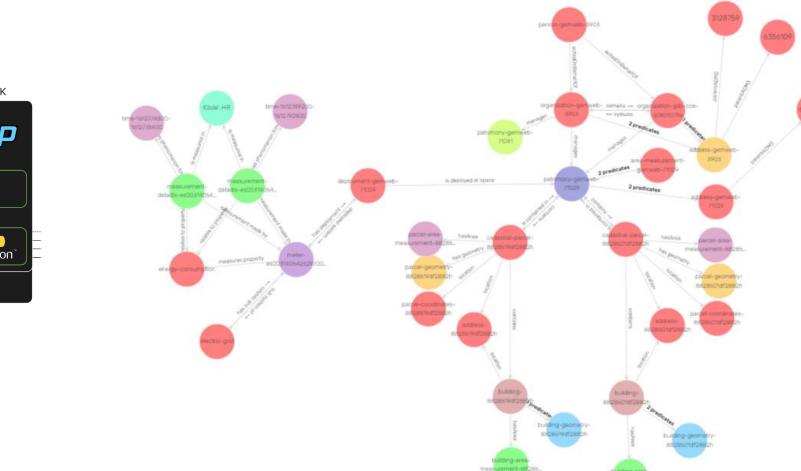
Origin	Harmonization
vehicle_electric	electricVehicleChargerPresence
solar_termica	solarThermalSystemPresence
solar_fotovoltaica	solarPVSystemPresence
sistema_biomassa	biomassSystemPresence
xarxa_districte	${\it district} {\it Heating} Or Cooling Connection$
energia_geotermica	geothermalSystemPresence
valor_finestres	averageWindowsTransmittance
valor_aillaments	averageFacadeTransmittance

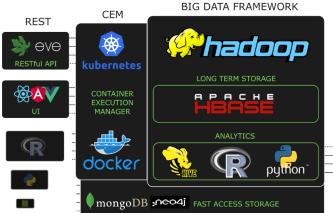
Github-Ingestro&Harmoniser Component-Published



BC2: Implementation









UC3: INSPIRE geo-spatial link



Use case 3: Integration of INSPIRE spatial data with Energy Performance Certification (EPC).

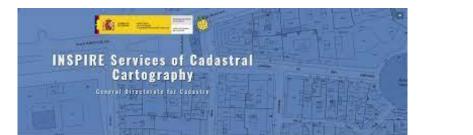
Automating the integration of the INSPIRE data with the EPC input data for completing and crosschecking the information and improving the reliability of the services.



UC3: INSPIRE geo-spatial link



58.30. 934.8



What are the municipalities of Catalonia and its geometries?



 AU name
 AU level
 AU polygon

 "Badalona"
 gn:A.ADM3
 "MULTIPOLYGON (((2.211 41.471, 2.214 41.472, ...)))"~~ geosp:wktLiteral

 "Barcelona"
 gn:A.ADM3
 "MULTIPOLYGON (((2.072 41.411, 2.073 41.411, ...)))"~~ geosp:wktLiteral

within

What are the GFA of the buildings within a postal code?



BU cadastral reference	BU GFA value	BU GFA unit	BU footprint polygon
"2734708DF3823D"	"770" ^ "xsd:float	qudt-u:M2	"POLYGON ((2.1945 41.3977, 2.1946))" "`geosp:wktLiteral
"9062517DF2896C"	"248"^"xsd:float	qudt-u:M2	"POLYGON ((2.1503 41.4229, 2.1503))" ""geosp:wktLiteral

What are the coordinates of all addresses within a postal code?



Where are the worst performing building spaces per building in a year within a postal code?

value (m^2)

KPI

	KPIa value	KPIa unit	KPIa date
	41.380 41.378 2.168 2.1		200 m 3 2.180
a	41.382	C. A. A. A.	
es per	41.384	1	

					erence	value (m)		varue		
CP cadastral reference	AD street name	AD street number	AD postal code	AD coordinates	"2381407DG7028S		bigg-res:KPI/ NonRenewable	"327.56"	bigg:KiloW- HR-PER-M2-	"2019-09- 23T00:00:00+00:
"6195911DF3869E"	"CL CARLES I"	*55*	"08917"	"POINT (2.2347 41.4529)" "`geosp:wktLiteral	0001XF"	^^xsd:float	EnergyUseIntensity	^^xsd:float	YR	^xsd:dateTime
"6587506DF3868H"	"CL MIQUEL SERVET"	*57°	"08912"	"POINT (2.2398 41.4463)" "geosp:wktLiteral	"0573506EG1707S 0020OQ"	"37.0" ^^xsd:float	bigg-res:KPI/ CO2Emissions	"55.74" ^^xsd:float	bigg:KiloGMCO2 PER-M2-YR	05T00:00:00+00: ^xsd:dateTime

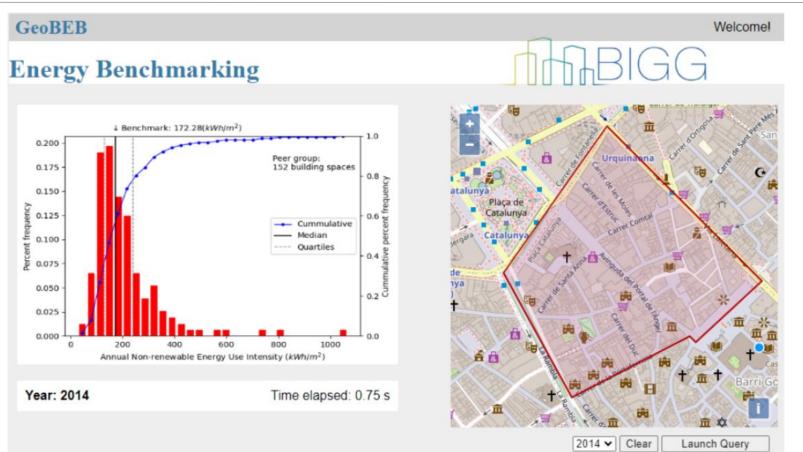
oronoo

BS cadastral ref- BS GFA



UC3: INSPIRE geo-spatial link





Barcelona's neighborhood residential building spaces cross-sectional energy benchmarking histogram (left). Map of the neighborhood's worse-performing residential building space per building (right)





UC4: Level(s) link

The work of UC4 aims to define a path towards Level(s) based on the current energy performance certificates information. In order to reach this target, the information within the energy certificates was mapped to the Level(s)'s requirements.

The goal of the mapping is to establish the necessary information to breach the gap between EPC and Level(s), therefore, the KPIs aim to understand the 6 different indicators of Level(s) and their requirements.

The work for UC4 has been carried out to understand the data requirements to map the abovementioned indicators with the EPC

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UC4: Level(s) link



Macro-objective	Indicator	Bigg KPI harmonised
1: Greenhouse gas and air pollutant	1.1 Use stage energy performance	bigg:KPI-EnergyUseIntensity
emissions along a building's life cycle	1.2 Life cycle Global Warming Potential	bigg:KPI-EnergyEmissionsIntensity
	2.1 Bill of quantities, materials and lifespans	bigg:KPI-AmountOfMaterialsIntensity
		bigg:KPI-AmountOfMaterialsInertIntensity, bigg:KPI-
2. Resource efficient and circular	2.2 Construction & demolition waste and materials	AmountOfMaterialsNonHazardIntensity, bigg:KPI-
material life cycles		AmountOfMaterialsHazardousIntensity
	2.3 Design for adaptability and renovation	-
	2.4 Design for deconstruction, reuse and recycling	bigg:KPI-CircularityScoreMass
3. Efficient use of water resources	3.1 Use stage water consumption	bigg:KPI-WaterConsumptionIntensity
	4.1 Indoor air quality	bigg:KPI-CO2IndoorAir, bigg:KPI-HRIndoorAir
4. Healthy and comfortable spaces	4.2 Time outside of thermal comfort range	bigg:KPI-OutOfThermalRange
4. Reality and contortable spaces	4.3 Lighting and visual comfort	bigg:KPI-LightingConfort
	4.4 Acoustics and protection against noise	bigg:KPI-AcousticConfort
5. Adaptation and resilience to climate	5.1 Protection of occupier health and thermal comfort	bigg:KPI-OutOfThermalRange2030, bigg:KPI-OutOfThermalRange2050
change	5.2 Increased risk of extreme weather events	Level 1 checklist (under development in Level(s))
change	5.3 Increased risk of flood events	Level 1 checklist (under development in Level(s))
6. Optimised life cycle cost and value	6.1 Life cycle costs	bigg:KPI-LifeCycleCosts
	6.2 Value creation and risk exposure	Level 1 checklist (under development in Level(s))

<u>Ontology/BIGG/dictionaries/bigg_enums/KeyPerformanceIndicator.parttl at main biggproject/Ontology (github.com)</u>





BC2: Conclusions

This BC demonstrates that the use of Bigg Data Model 4 Buildings to store and harmonize Building Energy Certification data improves exploration and offers value-added services on this data.

- The data ingestors for BPC, cadastral (inspire format) and level(s) KPIs are ready
- The data harmonizers for BPC, cadastral (inspire format) and level(s) KPIs are ready
- The Bigg Data model 4 Buildings is ready to store the BPC data.





BC3: Building Life-Cycle: From Planning to Renovation



BUSINESS CASE OBJECTIVE

BC3 focuses on demonstrating how the use of the BIGG project developments help data interoperability both within a building's existing systems and with external systems.







Use case 5: Interoperability between BIM, BMS, CMMS, and building simulation engines.

Integration of data from BIM, Building Management Systems (BMS), and Computerized Maintenance Management Systems (CMMS).

Use case 6: Interoperability of BIGG with EEFIG-DEEP.

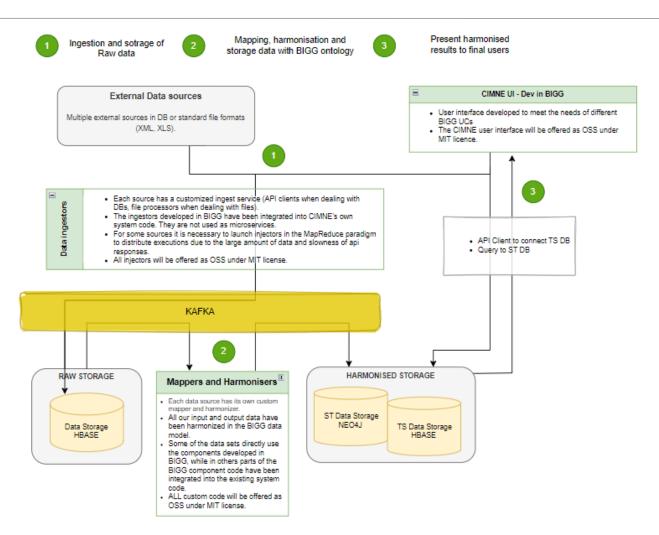
Adoption of the specifications of DEEP, its data model, and EEM definitions to ensure compatibility

Use case 7: Interoperability between EU Building Stock Observatory (EUBSO) and national/regional Energy Performance Certification (EPC) hubs through BIGG. The BIGG data model will be mapped to the EuBSO and the necessary transformations developed in order to ensure interoperability with the Catalonia EPC hub and INSPIRE

MHABIGG

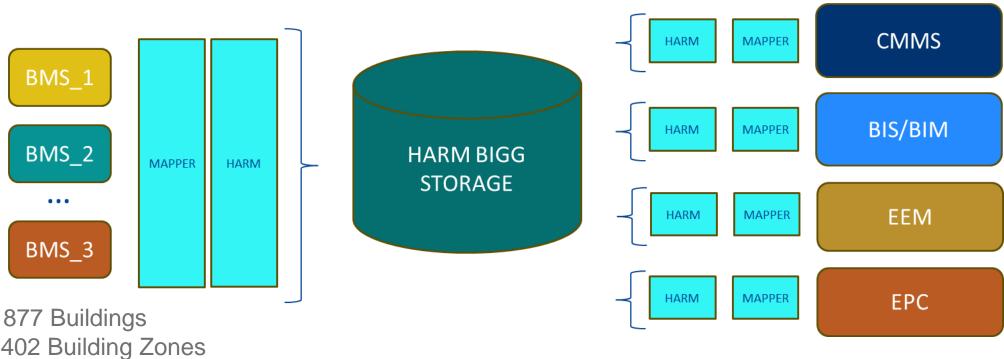
BC3: Pipeline





BC3: Input data integration

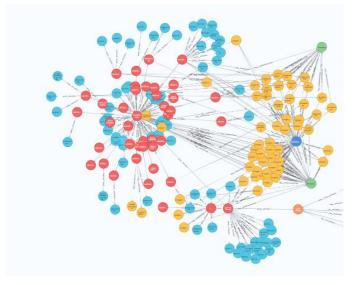




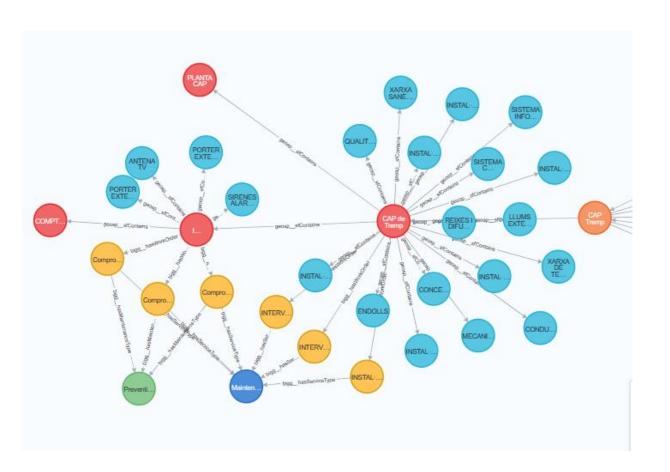
877 Buildings
36402 Building Zones
70857 Building Assets
601933 Work Orders
224512 Remote control registers



UC5: Building Systems integration

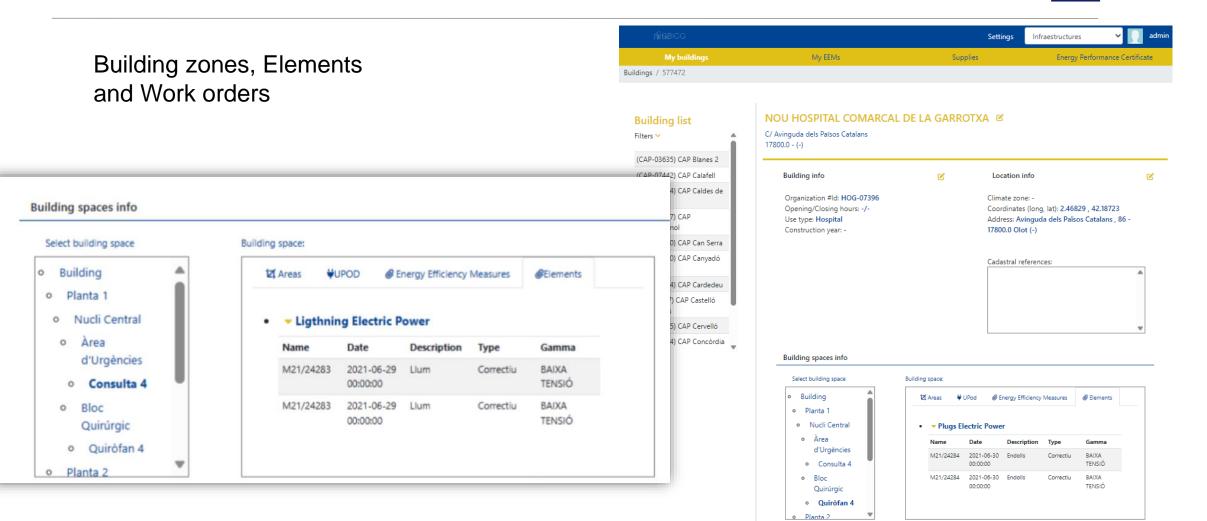


877 Buildings 36402 Building Zones 70857 Building Assets 601933 Work Orders 224512 Remote control registers





UC5: Building Systems integration



MBIGG



UC7 – Interoperability with DEEP

EEM registered

1998BIGG				Settings	Generalitat d	le Catalunya 🕚	
My buildings	N	ly EEMs	Supplies		Energy	Performance C	ertifi
N° of EEMs 972	; Total	investment (m€) 13.82	Registered this yea 357	ar	Total investmer 3.4	nt this year(m€ 46)
Туре		Building		Investment (From)	Invest	tment (To)	
All types	~						
		Filter Clear +	Show more filters				
EEMs Export DEEP						Nev	ı EB
	Building name	Department	Investment	Operational	Start work	New Creat. work	/ EE
Export DEEP Energy efficiency	Building name CGG Joan Valera	Department Departament de Dre Socials		Operational 15/07/2021	Start work 28/06/2021		
Export DEEP Energy efficiency measure	-	Departament de Dre	ets 3,963.34 EUR			Creat. work	a
Export DEEP Energy efficiency measure Indoor Relamp To LED	CGG Joan Valera	Departament de Dre Socials Departament de Dre Socials	ets 3,963.34 EUR	15/07/2021	28/06/2021	Creat. work 14/11/2022	/ EE
Export DEEP Energy efficiency measure Indoor Relamp To LED Indoor Relamp To LED Solar Photovoltaic	CGG Joan Valera CGG Balaguer - CR Urgell 5	Departament de Dre Socials Departament de Dre Socials	ets 3,963.34 EUR ets 1,704.73 EUR i de Vic 430,708.00 EUR	25/06/2021	28/06/2021 14/06/2021	Creat. work 14/11/2022 14/11/2022	al al
Export DEEP Energy efficiency measure Indoor Relamp To LED Indoor Relamp To LED Solar Photovoltaic Installation Other Hot Water Final	CGG Joan Valera CGG Balaguer - CR Urgell 5 CHV Hospital Universitari de Vic	Departament de Dre Socials Departament de Dre Socials Consorci Hospitalari Departament de Dre Socials	ets 3,963.34 EUR ets 1,704.73 EUR i de Vic 430,708.00 EUR ets 864.07 EUR	15/07/2021 25/06/2021 15/11/2022	28/06/2021 14/06/2021 01/09/2022	Creat. work 14/11/2022 14/11/2022 16/11/2022	а а

MHABIGG

UC7 – Interoperability with DEEP

DEEP EXPORT FILE

	C	D	E	F	G	н	1	1	
Simple data	a entry		_			_			
Your same	Abo	ut You, the data provider cAdministrator	_	Coloring	Deep down how o				
Tour name Your email address	5	gAdministrator Plaça Sant Jaume, 1	-	Confidential	Drop down boxes Double click cells for	Hide column co	ommen	ITS	DEEP
×			_		multiple selection	-			
Your telephone num Your organisation		CENCAT		Essential and Confidential Notions		Show column c	ommer	nts	
What is the nature of	of your	other (please specify)							EFFICIENCY PLATFOR
organisation?									
Project		Where is the investment located?		Sector I	ndicators				
0 (1) (2)		(5)	(12)	(13)	(14)	(15)	(16)	(17)	
Project ID Project 1	Titl Count	City/locality	Is the investment in a building, in industry, or in infrastructure?	Industry Sector/Organisation type	Organisation size	Building type	Ownership	Floor area of building m2	
								==	
(
1		Santa Coloma de Gramenet	Building	Public administration and defence		Health care		9.550,35	ElectricPowerSystemMeasure ElectricEquipr
i	ES	Lleida	Building	Public administration and defence		Public buildings		6.491,17	LightingMeasure LightingIndoorMeasure Inc
4	ES	Gavà	Building	Public administration and defence		Health care		4.393,00	BuildingFabricMeasure DoorsMeasure Door
4	ES	el Prat de Llobregat	Building	Public administration and defence		Health care		-	ManagementMeasure BuildingEnergyManag
4	ES	Barcelona	Building	Public administration and defence		Health care		5.248,01	ElectricPowerSystemMeasure ElectricEquipr
1	ES	el Prat de Llobregat	Building	Public administration and defence		Health care		-	HVACAndHotWaterMeasure HotWaterSystem
1	ES	el Prat de Llobregat	Building	Public administration and defence		Health care		-	ElectricPowerSystemMeasure ElectricEquipr
+	ES	Sant Llorenç Savall	Building	Public administration and defence		Health care		9.896,25	HVACAndHotWaterMeasure CombinedHeatin
1	ES	el Prat de Llobregat	Building	Public administration and defence		Public buildings		4.321,00	BuildingFabricMeasure WindowMeasure W
4	ES	Mollerussa	Building	Public administration and defence		Health care		4.911,60	ElectricPowerSystemMeasure ElectricEquipr
4	ES	Móra d'Ebre	Building	Public administration and defence		Health care		4.664,44	ElectricPowerSystemMeasure ElectricEquipr
4	ES	Tortosa	Building	Public administration and defence		Office buildings		1.271,19	ManagementMeasure BuildingEnergyManag
4	ES	l'Hospitalet de Llobregat	Building	Public administration and defence		Industry		3.517,53	ManagementMeasure BuildingEnergyManag
4	ES	Tarragona	Building	Public administration and defence		Office buildings		799,89	ManagementMeasure BuildingEnergyManag
4	ES	Valls	Building	Public administration and defence		Office buildings		2.729,00	HVACAndHotWaterMeasure CoolingSystemN
t	ES	Barcelona	Building	Public administration and defence		Office buildings		12.171,75	LightingMeasure LightingIndoorMeasure Inc
8	ES	Abrera	Building	Public administration and defence				2.370,10	ManagementMeasure BuildingEnergyManag
4	ES	Barcelona	Building	Public administration and defence		Office buildings		19.633,95	HVACAndHotWaterMeasure CoolingSystemN
i i i i i i i i i i i i i i i i i i i	ES	Barcelona	Building	Public administration and defence		Public buildings		927,00	HVACAndHotWaterMeasure CombinedHeatin
1	ES	Arenys de Mar	Building	Public administration and defence		Public buildings		-	RenewableGenerationMeasure SolarPhotov
£	ES	Granollers	Building	Public administration and defence		Public buildings		1.076,00	LightingMeasure LightingIndoorMeasure Inc
1	ES	el Prat de Llobregat	Building	Public administration and defence		Public buildings		508,00	HVACAndHotWaterMeasure CombinedHeatin
1	ES	Blanes	Building	Public administration and defence		Health care		1.156,25	HVACAndHotWaterMeasure CombinedHeatin
4	ES	Sant Cugat del Vallès	Building	Public administration and defence		Office buildings		28.774,70	HVACAndHotWaterMeasure CoolingSystemN
6	ES	Tàrrega	Building	Public administration and defence		Public buildings		1.636,00	HVACAndHotWaterMeasure CoolingSystemN
+	ES	Sant Adrià de Besòs	Building	Public administration and defence		Educational buildings		1.897,00	HVACAndHotWaterMeasure HeatingSystemN
8	ES	Ripoll	Building	Public administration and defence		Public buildings		-	HVACAndHotWaterMeasure HeatingSystemN
	ES	les Borges Blanques	Building	Public administration and defence		Public buildings		461,62	ManagementMeasure BuildingEnergyManag



UC7 – Interoperability with EUBSO

EPC imported



		Settings	Infræstructures 🛛 👻 👤 admin
Mybuidings MyBE	EM s	Supplies	Energy Performance Certificate
EPCs			
N ^e of EPCs: 1.453.256			
EPCs			New EPC
Building name	Certificate Class	Certificate Date	Upload Date
Oficines del Departament de Territori i Sostenibilitat (edifici Nestlé)) D	25/03/2021	12/06/2023
Serveis Territorials de Treball	С	04/09/2020	12/06/2023
CEE Sant Joan de la Creu	D	15/07/2022	12/05/2023
Oficines de la Sindicatura de Comptes, de l'Autoritat Catalana de la Competència i del Servei Català de Trànsit	D	02/02/2021	12/06/2023
Viver Forestal Brugueres	А	26/07/2021	12/05/2023
Elenc 1037 - Aiguamolis de l'Empordà	F	30/1/2020	12/06/2023
Institut L'Alzina	D	02/12/2021	12/05/2023
Edifici Portal de Santa Madrona	E	11/09/2022	12/06/2023
Institut L'Alzina	с	26/03/2023	12/05/2023
Edifici Portal de Santa Madrona	С	06/04/2021	12/05/2023
Escola de Capacitació Agrària del Solsonès	E	12/11/2022	12/06/2023
Complex Penitenciari Can Brians 1 i Can Brians 2 - DI Can Duran S	F	23/05/2020	12/06/2023
CIFO loc de la Bola	E.	05/12/2022	12/05/2023

UC7 - EUBSO (ex. Data fields)



BIGG

Construction period	EPC label	-	Energy bin	Energy system	Technology	Energy carrie
) - 1945	A		0-25	Heating	District heating	Heat
1945-1969	В		26-50	Heating	Boiler	Electricity
1970-1979	С		51-75	Heating	Boiler	Natural gas
1980-1989	D		76-100	Heating	Boiler	Oil
						Solid fossil
1990-1999	E		101-150	Heating	Boiler	fuels
2000-2010	F		151-200	Heating	Boiler	Renewables
2011 - now .	G		201-250	Heating	Heat pump	Electricity
	-		251-300	Heating	Other	Electricity
Building use	EPC trigger	Ŧ	301-350	Heating	Other	Natural gas
Single-family buildings	Construction		351-400	Heating	Other	Oil
						Solid fossil
Multi-family buildings	Transfer of ownership		401-450	Heating	Other	fuels
Appartment buildings	Renovation		451-500	Heating	Other	Renewables
ducational buildings	Other		501-600	Cooling	District cooling	Heat
tealth buildings	L		601-700	Cooling	Heat pump	Electricity
lotels and Restaurants	Building energy status	Ψ.	701-800	Cooling	Other	Any
Offices	NZEB		801-900	DHW	Solar thermal pan	el Renewables
rade buildings	Not NZEB		901-1000	DHW	Boiler	Electricity
Other non-residential buildings	;		>=1001	DHW	Boiler	Natural gas
	Building GHG emission sta	tu 🝸		DHW	Boiler	Oil
						Solid fossil
Building ownership	Zero-emission			DHW	Boiler	fuels
Public buildings	Not zero-emission			DHW	Boiler	Renewables
Private buildings	L	-		DHW	Heat pump	Electricity
	Living conditions	Ψ.		DHW	Other	Any
Building user	Adequate			Electricity product	io:Solar PV panels	Renewables
Owners	Inadequate			Electricity product	io: Other	Any
enants .	· · ·	-				
	Building occupancy	¥				
Building protection	Primary residence					
Protected	Secondary residence					
rotected						

Type of financing	~	Renovation de
Owner's contribution		Light
Private loan		Medium
Public loan		Deep
Public grant		

easuring and control With smart meters Without smart meters

LocationInfo	0

Origin	Harmonization	Cadastralinfo d	2
adre_a	addressStreetName	Origin	
numero	addressStreetNumber	referencia_cadastr	ral
codi_postal	addressPostalCode	metres_cadastre	
longitud	addressLongitude	Building @	
latitud	addressLatitude		
nom_provincia	hasAddressProvince	Origin	
poblacio	hasAddressCity	any_construccio	ł

EnergyPerformanceCertificateAdditionalInfo &

Origin	Harmonization
vehicle_electric	electricVehicleChargerPresence
solar_termica	solarThermalSystemPresence
solar_fotovoltaica	solarPVSystemPresence
sistema_biomassa	biomassSystemPresence
xarxa_districte	districtHeatingOrCoolingConnection
energia_geotermica	geothermalSystemPresence
valor_finestres	averageWindowsTransmittance
valor_aillaments	averageFacadeTransmittance

EnergyPerformanceCertificate &

Harmonization

landCadastralReference

Harmonization

buildingConstructionYear

landArea

Origin	Harmonization
num_cas	. energyPerformanceCertificateReferenceNumber
qualificaci_de_consum_d	energyPerformanceCertificateClass
qualificacio_d_emissions	C02EmissionsClass
emissions_de_co2	annualC02Emissions
cost_anual_aproximat_d_energia	annualEnergyCost
consum_d_energia_final	annualFinalEnergyConsumption
eina_de_certificacio	energyPerformanceCertificateCertificationTool
emissions_refrigeraci	annualCoolingCO2Emissions
qualificaci_emissions_1	coolingCO2EmissionsClass
emissions_calefacci	annualHeatingCO2Emissions
qualificaci_emissions	heatingCO2EmissionsClass
emissions_acs	annualHotWaterCO2Emissions
qualificaci_emissions_acs	hotWaterCO2EmissionsClass
emissions_enllumenament	annualLightingCO2Emissions
qualificaci_emissions_2	lightingCO2EmissionsClass
qualificaci_energia_acs	hotWaterPrimaryEnergyClass
qualificaci_energia_1	lightingPrimaryEnergyClass
qualificaci_energia_calefacci_1	heatingEnergyDemandClass
motiu_de_la_certificacio	energyPerformanceCertificateCertificationMotivation
motiu_de_la_certificacio	energyPerformanceCertificateCertificationMotivation





BC3: Conclusions

This BC demonstrates that the use of Bigg Data Model 4 Buildings improves the interoperability between individual building systems and also between external application

- The data ingestors for BC inputs are ready.
- The data harmonizers for BC inputs are ready
- The Bigg Data model 4 Buildings is ready to store the necessary data.

Business Case 4 - EnPC management LARGE COMMERCIAL Building (ATHENS)



Business Case 4 - solution provided

Energy Performance Contract-based savings in commercial buildings







Collection & standardisation of EnPC & client data

It is essential to be able to **collect**, **analyze** and **highlight** all the data of different kinds, both in the context of the EnPC and in the day-to-day life of the building.

ESCo knowledge into **metering equipment** installation is combined with the Energy Management system to monitor **energy consumption** and **influential factors** (weather data, production, occupancy ...).

Monitoring and performance measurement plan

Real time tracking of energy performance guarantee

Follow-up of measurable data, changes in the conditions set in the reference situation (for example, in the event of changes in climatic conditions or the volume of activity in the building).



BIGG – BC4 & BC5 Sensitivity: Company

Business Case 4 – direct application

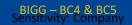
Energy Performance Contract-based savings in commercial buildings





- Tested on 3 pilot EnPCs (2 at Cordia, 1 at Helexia)
- Also applied in other contexts than EPC to track the savings generated from EEMs, and in particular from BC5







Business Case 5 – Comfort case LARGE COMMERCIAL Building (ATHENS)



Business Case 5 – solution provided

Buildings for occupants: Comfort case





Optimisation using weather forecasts

Optimisation using weather forecasts considers weather forecast 24 hours in advance. Weather conditions have a direct impact on the energy demand of buildings (e.g. necessity of heating/cooling) and the RES production (e.g. solar PV). Forecasted weather conditions will allow to proactively match energy demand and supply (e.g. heat less if large solar gains are expected later).

Optimisation using occupancy forecasts



Optimisation using occupancy forecasts adds occupancy to the optimization logic. In optimum conditions, thermal conditions of a building should adapt to its occupancy. A forecasted occupancy allow thermal conditions to be adjusted proactively.



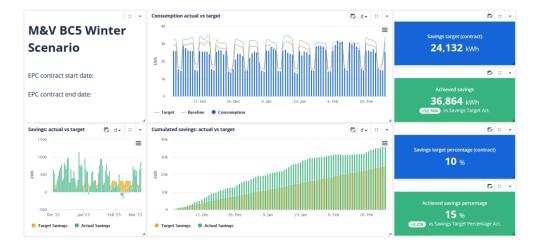
Optimisation using price forecasts

Optimisation using price forecasts adds energy prices information on top of the weather and occupancy forecasts to allow using always the most sustainable and/or cheapest energy available

BIGG – BC4 & BC5 Sensitivity: Company

Buildings for occupants: Comfort case





	Winter ★ 📽			
	Location		Variables	Occupancy (CO2 and Activity) ~
CORDIA			TAG Description	
CONDIA			AC Activity Count	450 ppm 150
Interamerican - 124 Syg	Interamerican - 124 Syggrou Avenue, Athens, Greece			400 com 2023 01-10 06:53:00
				- C02 level: 374 ppm -50
1. TR > 23 °C \Rightarrow boiler off			OF Occupancy Forecast	350 ppm
	0 °C & OF(1) > 0 & WH = 0 ⇒ boile	er & ahu on (pre-	PV PV Production	
	heating) AC = $0 \& AC(-1) = 0 \& AC(-2) = 0 \Rightarrow$ boiler off (no occupancy)		TE External Temperature	Temperature
4. WH = $0 \Rightarrow$ boiler off (out		ncy)	TF Temperature Forecast	10 °C
	$/H = 1 \Rightarrow$ boiler off (thermal inert	ia)	TR Room Temperature	
6. TR ≤ 21 & AC > 0 & OF(1	1) > 0 & OF(2) > 0 \Rightarrow boiler on (sa	fe comfort)	WH Working Hours	20.02
			e.g. OF(1) = Occupancy Forecast	Ihr Indoor Temperature — Outdoor Temperature — Temperature Forecast (i) — Working Hours State Read
PMV (ASHRAE)	PPD (ASHRAE)	"Feels Like" Temper	ature Boiler1 ON/OF	
PMV (ASHRAE)	PPD (ASHRAE)	'Feels Like' Temper	ature Boiler1 ON/OF	
pmv (ashrae) 0.1	ppd (Ashrae) 5.10%	'Feels Like' Temper		2
	5.10%			2
	5.10%	21.8		2
0.1	5.10%	21.8		2 2 4 5 6 6 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7
0.1	5.10%	21.8		2 2 4 5 6 6 6 6 6 6 6 6 6 6 6 6 6
0.1	5.10%	21.8		2 2 4 5 6 6 6 6 7 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7
0.1	5.10%	21.8		1 544 5645 564

- Tested on 1 pilot site (Interamerican from Cordia)
- Reached savings estimated at 15% of the consumption compared to the situation without controller











Business Case 6 Technical Developments and User Interfaces







BC6: Flexibility potential of Residential consumers on Electricity and Natural gas

BUSINESS CASE OBJECTIVE

BC6 focuses on demonstrating and exploiting the flexibility potential of residential buildings across the two main energy vectors of electricity and natural gas.

BC6: Use Cases





Use case 14: Electricity

 focus on electricity consumers that participate in implicit demand response schemes.

Use case 15: Natural Gas

 focus on end consumers using natural gas boilers for space heating and participate in **explicit** demand response schemes to: (a) improve the energy efficiency through load reduction and (b) contribute to realtime gas balancing services.





UC14: Flexibility potential of Residential consumers on Electricity

Information Classified as Genera

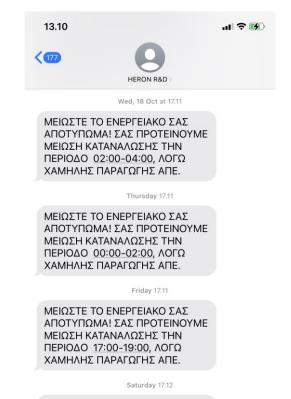
UC14: Implicit DR as service



HERON offers recommendations to pilot participants on when they should decrease their electric consumption within the forthcoming day via an SMS,

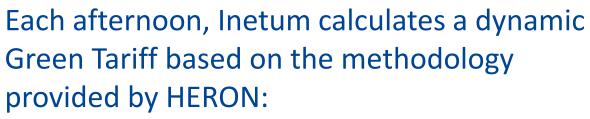
The aim of the service is to decrease the carbon footprint of residential electricity demand, by shifting heavy loads (white goods, A/C etc) outside the time periods in which RES share is the lowest,

An SMS sent from 17.00 to 17.30 advices consumers on when to reduce their electric loads.



ΜΕΙΩΣΤΕ ΤΟ ΕΝΕΡΓΕΙΑΚΟ ΣΑΣ ΑΠΟΤΥΠΩΜΑ! ΣΑΣ ΠΡΟΤΕΙΝΟΥΜΕ ΜΕΙΩΣΗ ΚΑΤΑΝΑΛΩΣΗΣ ΤΗΝ ΠΕΡΙΟΔΟ 22:00-00:00, ΛΟΓΩ ΧΑΜΗΛΗΣ ΠΑΡΑΓΩΓΗΣ ΑΠΕ.

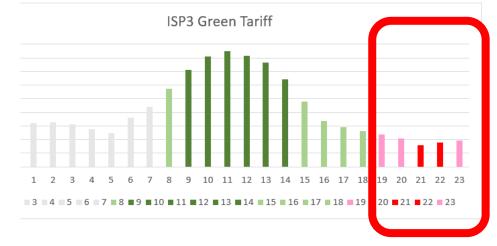
UC14: Green Tariff



- Green Tariff relies on the calculation of the percentage of System Load satisfied by RES+HYDRO, drawn from Load and RES generation from the Integrated Scheduling Programming (ISP) provided by the TSO.
- The ISP is carried out by TSOs that use Central Dispatch Systems. The process aims at covering the forecasted generation/demand imbalances and procuring the required reserves.
- ISP is executed at three scheduled times for each Dispatch Day defining also the timeline of the service



5 4 5 0 7 8 5 10 11 12 15 14 15 10 17 18 15 20 21 22 25



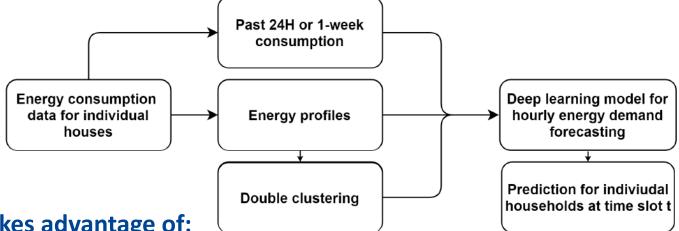


MBIGG

UC14: ML Algorithm



A ML algorithm developed by Inetum estimates residential consumption for the following 24 hours by combining a Recurrent Neural Network (RNN) encoder and a Multilayer Perceptron (MLP)



The approach takes advantage of:

household energy profiles to learn the differences between the consumption patterns and characteristics of individual consumers.

And implements:

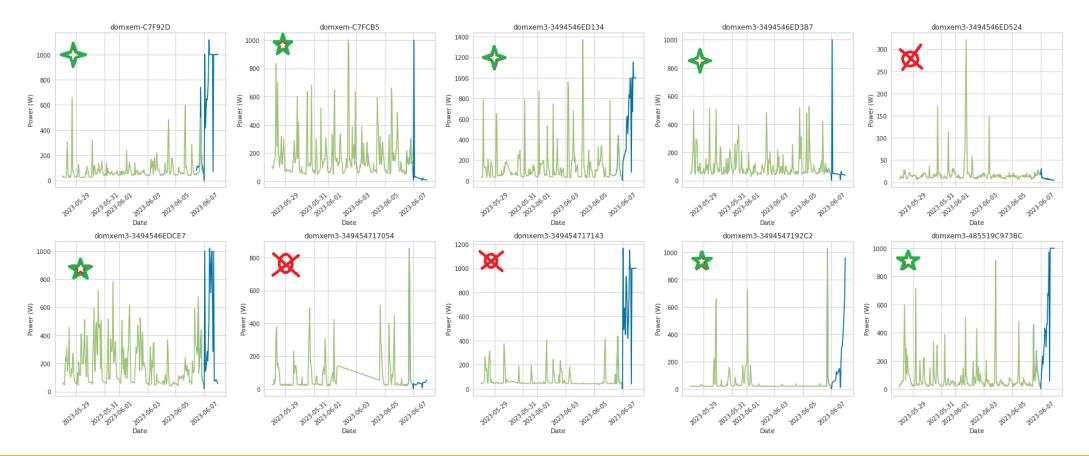
a double clustering procedure to group households with similar energy profiles, leading to an encoding for each energy profile based on its distance from each cluster's centroid.



UC14: ML Algorithm



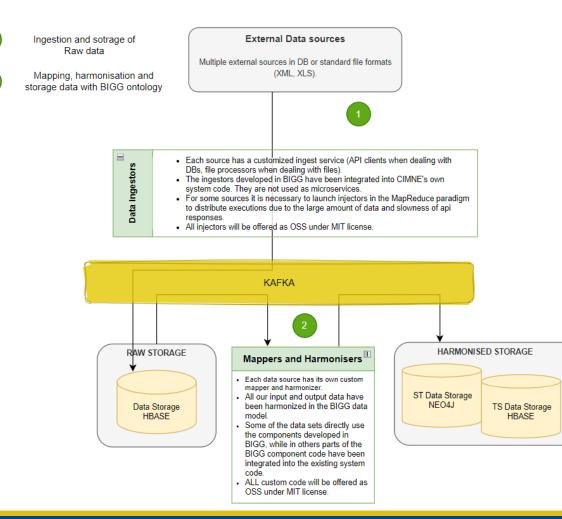
Some predictions for BIGG:



MBIGG



UC14: Status





UC14: Data collecting-Ingestors



OPENDATA API

Updated	000		Actors		
July 9, 2	023		Tipus actor	Generalitat de Catalunya	
Data Last Updat	ed Metadata Las	t Updated	Departament	Acció Climàtica, Alimentació i Agenda Rural	
July 9, 2023 July 9, 2023 Date Created May 7, 2019			Freqüència d'actualització		
			Freqüència d'actualització	Setmanal	
Views	Downloads		Idioma		
22.2K	4,499		Idioma	Català	
Departament d'Acció Climàtica, Ow Alimentació i Agenda Rural Da Ob		Dataset Owner Dades Obertes Catalunya	Nombre del conjunto de datos (ES)	certificados de eficiencia energética de edificios	
			Dataset name (EN)	Certificates of energetic efficiency of buildings	
			Àmbit geogràfic		
			Àmbit geogràfic	Catalunya	
	ontact Dataset O	wher	Informació geogràfica	Coordenades	
			Informació de gènere o sexe		
			Informació de gènere o sexe	No aplica	
					Show More
hat's in thi	s Dataset?				
Rows 1.44M	Columns	Each row is a			

Github-Ingestor&Harmoniser Opendata Componenet-Published

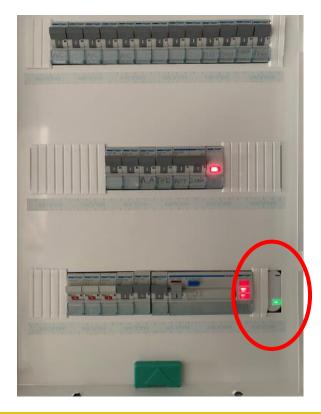
BPC results in XML (web app)

BIGG UI Web			<u>n</u>	RBIGG		
Building selection * Flees * CONVAN Instructions Surgers dhe Mananarata - Chilavaine Clave 1911 CONVAN Proc Crash - Chil Permana 11 11	Samp forfermanic Contrars - Control (a) in Control - Control Accession - H Control (Control - Control - Co		BIGG Platform			
(S2218) AVA Peer Caldero - Ch Cantello 15 (S2279) AVA Proportari - Ch Batana: Gradar 24 26	He Name ES EL CARAT - ESTRATADURA INT	Nor, PROCESSED	Upland Time 2023/04/14 11:47	Processed Time		M BIGG

GitHub - Ingestor&Harmoniser CE3X Componenet- Published

UC14: IoT Equipment

Smart Meters: Consumption real- time monitoring



Smart Plugs: Consumption real-time monitoring of appliances attached to them



Smart Relay:

- Consumption real-time monitoring of a specific phase in which a boiler is attached.
- Remote on off capability





UC14: User Interfaces





Smart Meter data: power, energy, voltage real- time monitoring + timeseries

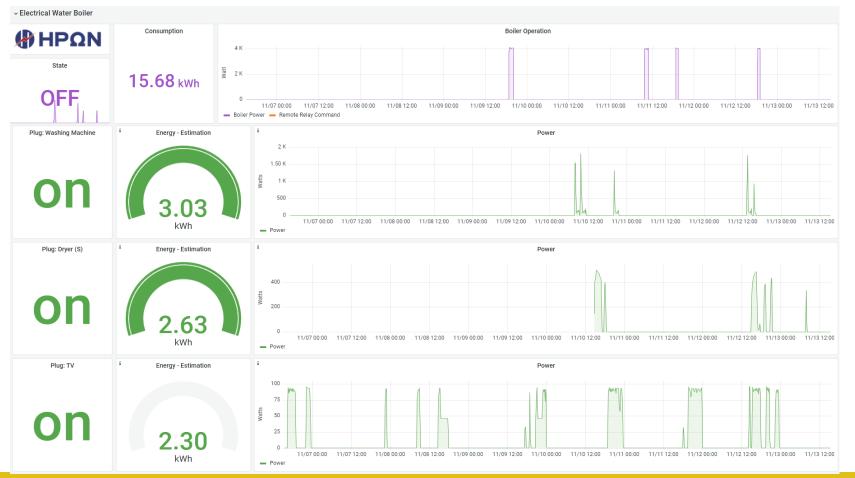


MBIGG

UC14: User Interfaces



Smart meter Relay + smart plug: power, energy, monitoring + timeseries



UC14: User Recommendations





मार्गे htt	tps://greekpilot.azurewebsites.net/api/bigguc14	$\overline{\Box}$ Add to collection $\langle \rangle$	Code snippet
GET	https://greekpilot.azurewebsites.net/api/bigguc14	Send 🗸	cURL ~ ট্রে
Params	Auth Headers (6) Body Pre-req. Tests Settings	Cookies	<pre>1 curllocation 'https://greekpilot.</pre>
Body 🗸	(€a 200 OK 329 m	s 2.62 KB Save Response 🗸	
Pretty	Raw Preview Visualize JSON ~ =	E Q	
1 2 3 4 5	<pre> "domxem-C7F92D": ["2023-06-12 23:00:00"], "domxem-C7FCB5": [</pre>		(177) HERON R&D
6	"2023-06-12 01:00:00"		Text Message
8], "domxem3-3494546ED134": [Tue, 3 Oct at 12.59
9	"2023-06-12 23:00:00"		
10],		Dealers a series and an factoriat last
11	"domxem3-3494546ED3B7": [Reduce your carbon footprint by
12	"2023-06-12 01:00:00",		limiting consumption during
13	"2023-06-12 02:00:00",		•
14	"2023-06-12 03:00:00",		<u>00:00-02:00</u> , due to low shares of
15 16	"2023-06-12 04:00:00", "2023-06-12 23:00:00"		renewables in the energy mix.
16	2023-06-12 23:00:00		Terrewables in the energy mix.
18	"domxem3-3494546EDCE7": [
19	"2023-06-12 01:00:00",		
20	"2023-06-12 02:00:00",		
21	"2023-06-12 03:00:00",		
22	"2023-06-12 04:00:00"		
23],		

BIGG implementation: shift consumption outside peak times

- 1. Identify up to 2 hours with lowest RES : under P1
- 2. If only hour in P1, pick up an adjacent P2.
- 3. If not available adjacent, pick a P2 outside the 02:00 – 06:00 zone





UC14: Conclusions

This UC demonstrated that the use of Bigg Data Model 4 Buildings to store and harmonize smart heating data to promote the delivery of Energy efficiency and DR services for the Electricity vector:

 Given the current and mid-term regulatory framework in Greece and the lack of DSO deployed smart-metering infrastructure, the focus of the electricity Use Case (UC14) is to make electricity consumption "greener" by shifting it towards time interval dominated by RES generation.





UC15: Flexibility potential of Residential consumers on Natural Gas

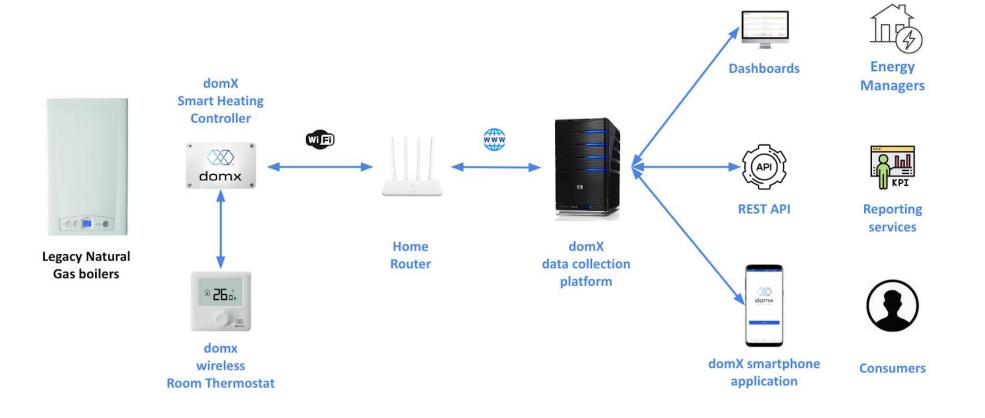
Information Classified as General

UC15: Pilot setup



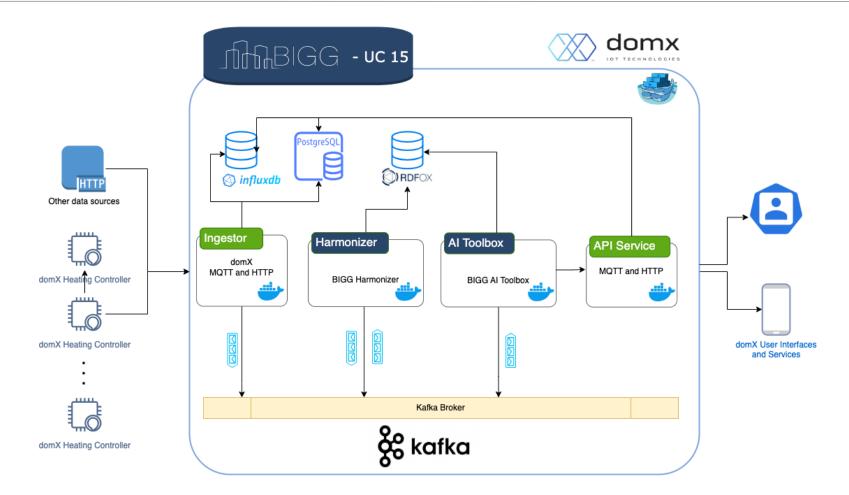


• 100 households equipped with legacy natural gas boilers are upgraded through the domx smart heating controller to enable the optimal management of space heating





UC15: Infrastructure and data process





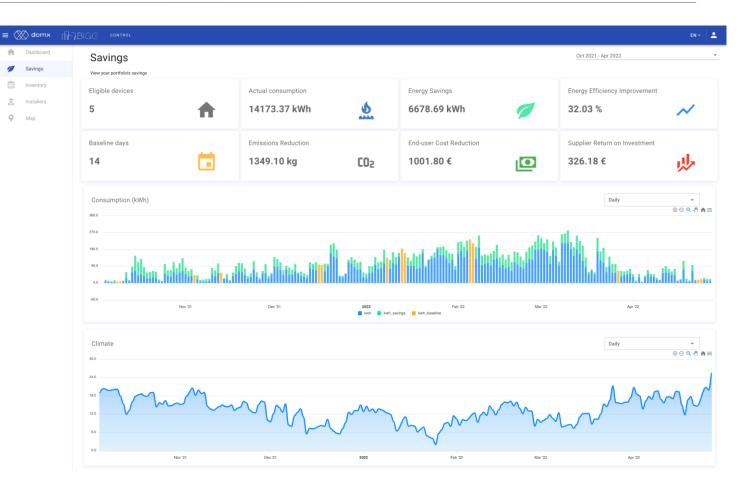
UC15: User Interfaces

(Ê)





Smartphone application for the end consumers



Portfolio Management dashboard for the energy supplier

Energy efficiency trials







Energy efficiency trials have been executed over the winters of **21'-22'** and **22'-23'**:

- **102** participating households
- **31 + 40** households with valuable baseline
- 239 + 277 baseline heating days
- Up to **35%** achieved savings
- Average thermal comfort of **94%**

Energy efficiency service

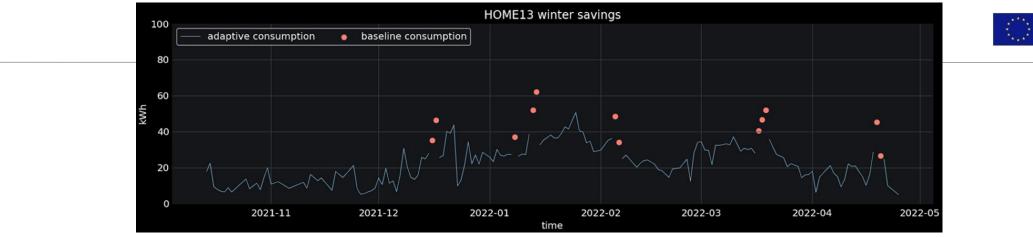




Real Adaptive Consumption per day + 12 Baseline days over the entire heating season

Energy efficiency service









Real Adaptive + Simulated Baseline Consumption per day over the entire heating season

Energy efficiency service







Home 13 Estimated Winter Savings 32.15%



CONFIDENTIAL

Heatpump Management











DOMX developed a variant of the smart heating controller to support the optimal management of electrical heat pumps as well.

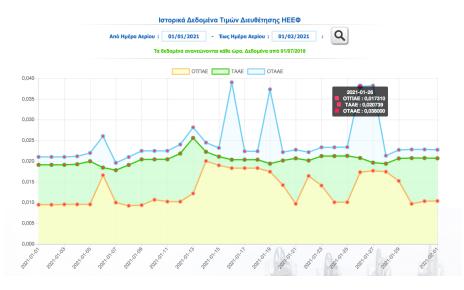
- Integration with multiple HP vendors, including:
 Midea, LG, Hitachi and others.
- Three pilot installations within BIGG, for testing the integration with HPs of different vendors.
- All collected energy consumption and heating usage data are fed to the:
 - Domx Smartphone Appplication
 - Domx Energy supplier's dashboard

Flexibility service

Flexibility services are offered to the gas supplier during gas days with:

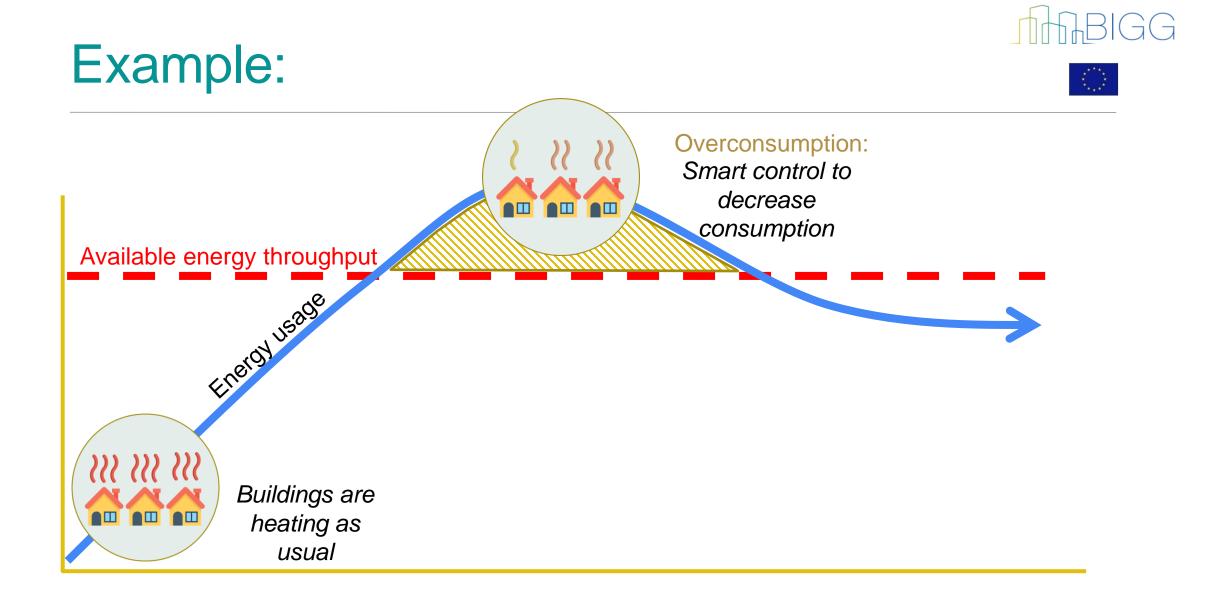
- high upward price and/or shortage of natural gas supply
 - => consumers need to reduce gas consumption
- low downward price and/or excess of natural gas supply
 - => consumers **need to increase** gas consumption
- while user comfort limits need to be constantly guaranteed:
 - target temperature
 - min temperature increase rate limit

The supplier calculates the total imbalance and estimates the amount of imbalance that cannot be corrected through bilateral contracts, which is the target imbalance for the flexibility service.



Historical Gas imbalance prices dataset available





MBIGG

Control Strategy



Periodically (e.g., at midnight):

V	

Train a reinforcement learning (RL) agent for each household (policy evaluation)

At DR-event:



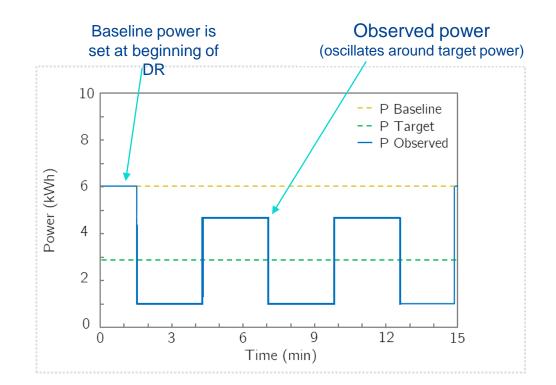
Assess expected consumption based on recent past 12 hours & <u>Calculate required power</u> for next 15min (e.g., to stay within energy limit)



Rank the boilers by their highest expected gas savings, estimated with the RL agent, and taking comfort constraints into account



Continuously control the boilers, such that the power usage drops towards the target power: *Expected behavior:*

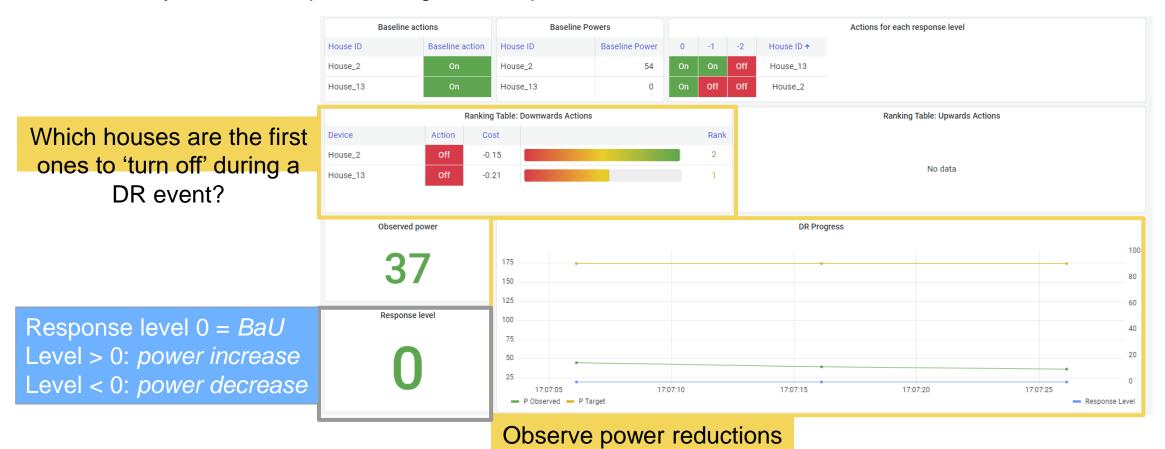


MBIGG

Monitoring approach



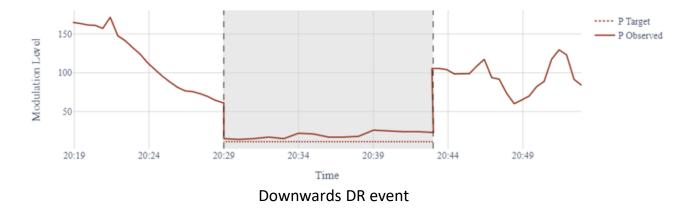
Closely monitor the power usage and dispatched control actions for each household



nformation Classified as General

Gas DR events

DR-event on 2023-02-03 between (20:29 - 20:43)



DR-event on 2023-02-14 between (07:32 - 07:41)



Demand Response trials have been executed during **February 23'**:

- **10** available households
- 8 active participants
- 80 DR events were executed, each lasting for 10 minutes.









UC15: Conclusions

This UC demonstrated that the use of Bigg Data Model 4 Buildings to store and harmonize smart heating data to promote the delivery of Energy efficiency and DR services for the Natural Gas vector:

- Besides the lack of DSO deployed smart-metering infrastructure for Natural Gas (as in Electricity Use Case), Natural Gas Use Case (UC15) can utilize smart heating, gas consumption, weather and gas market data to achieve:
 - energy and cost savings through load reduction
 - monetary savings through participation in flexibility markets, while respecting the user comfort levels.



Q&A





Funded by the Horizon Framework Programme of the European Unio

Ontology and AI Toolbox

Sampath Mukherjee

Data & AI Consultant at Inetum-Realdolmen

Edgar Alexis

Data Scientist at CIMNE



Building Information aGGregation, harmonization and analytics platform

BIGG Final Event

Ontology and AITB



Sensitivity: Company



H2020-LC-SC3-EE-2020-1/LC-SC3-B4E-6-2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957047. Big data for buildings



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research and innovation programme under grant agreement No 957047. H2020-LC-SC3-EE-2020-1/LC-SC3-B4E-6-2020

Big data for buildings

MBIGG

THABIGG

Building Information aGGregation, harmonization and analytics platform

Project Nº 957047

WHITE PAPER

"Validation of the BIGG Data Analytics Toolbox over the BIGG Data Reference Architecture in 6 Business Cases in Spain and Greece"

Responsible:	onsible:
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Version: 1.0 Date:

Sensitivity: Company

FIREBIGG

Building Information aGGregation, harmonization and analytics platform

Project Nº 957047

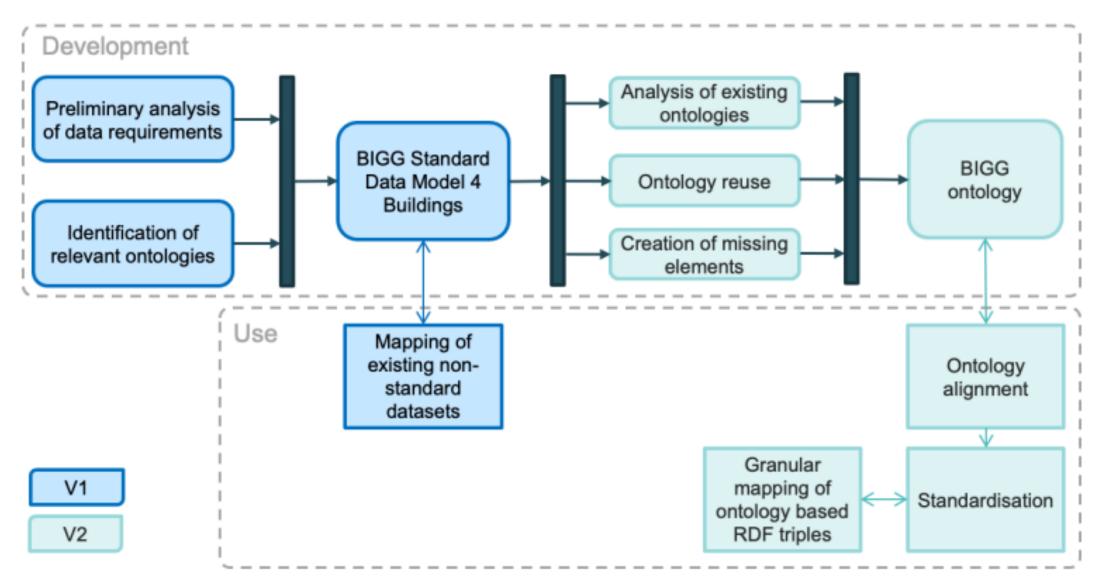
WHITE PAPER II -

BIGG: The need for harmonizing input data and AI Toolbox Revolution in Building Management

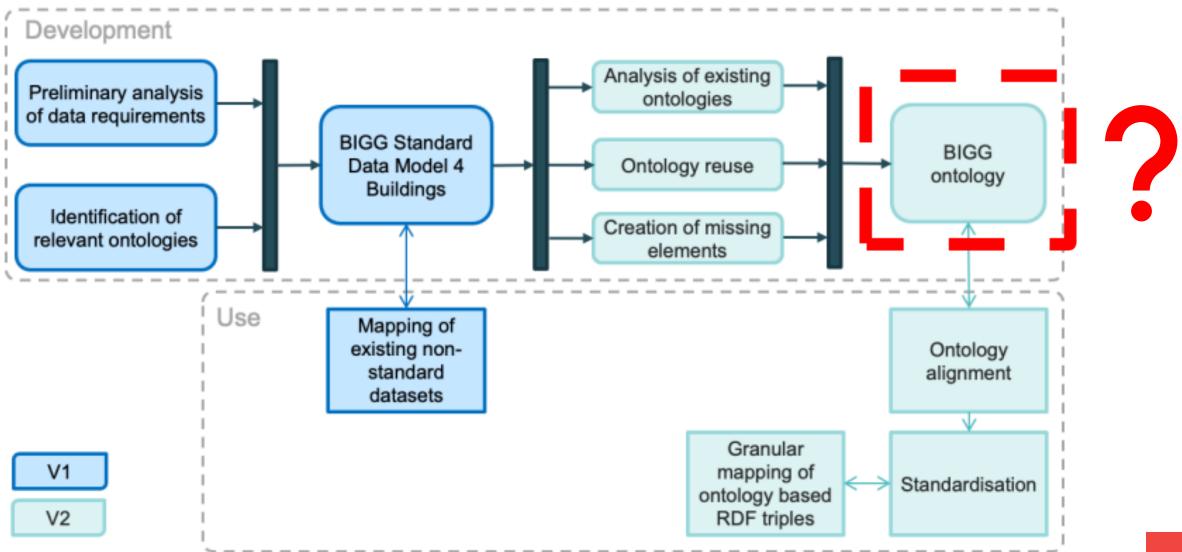
Responsible: Inetum

Dissemination Level: Public Version: 1.0 Date: 21/08/2023 White Papers I & II published

BIGG Data Harmonization layer

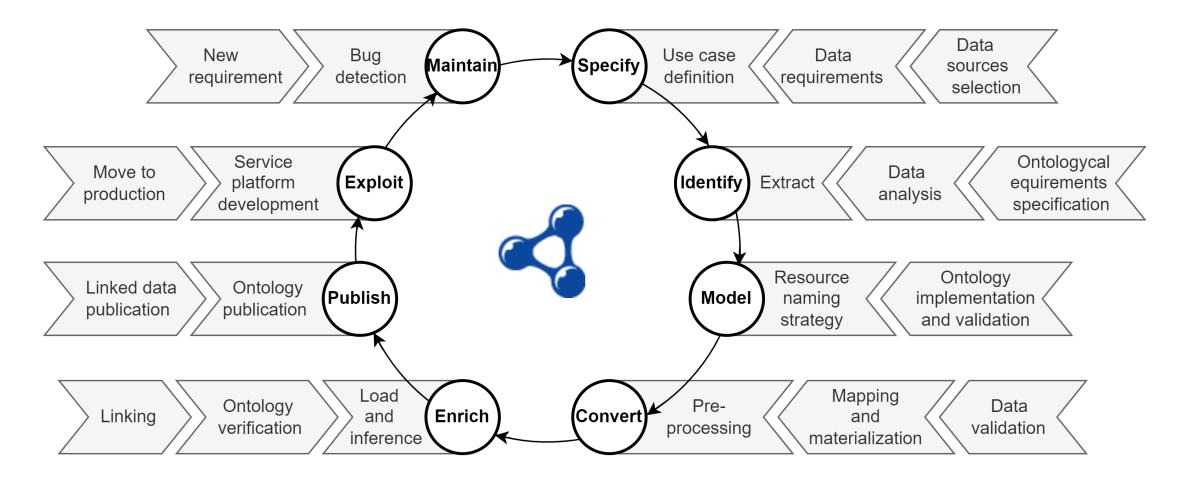


BIGG Data Harmonization layer



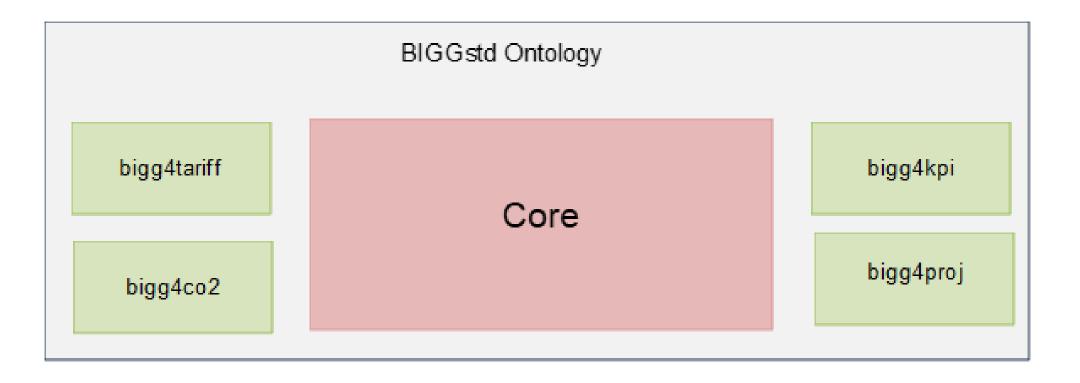
The Linked Data cycle

MBIGG



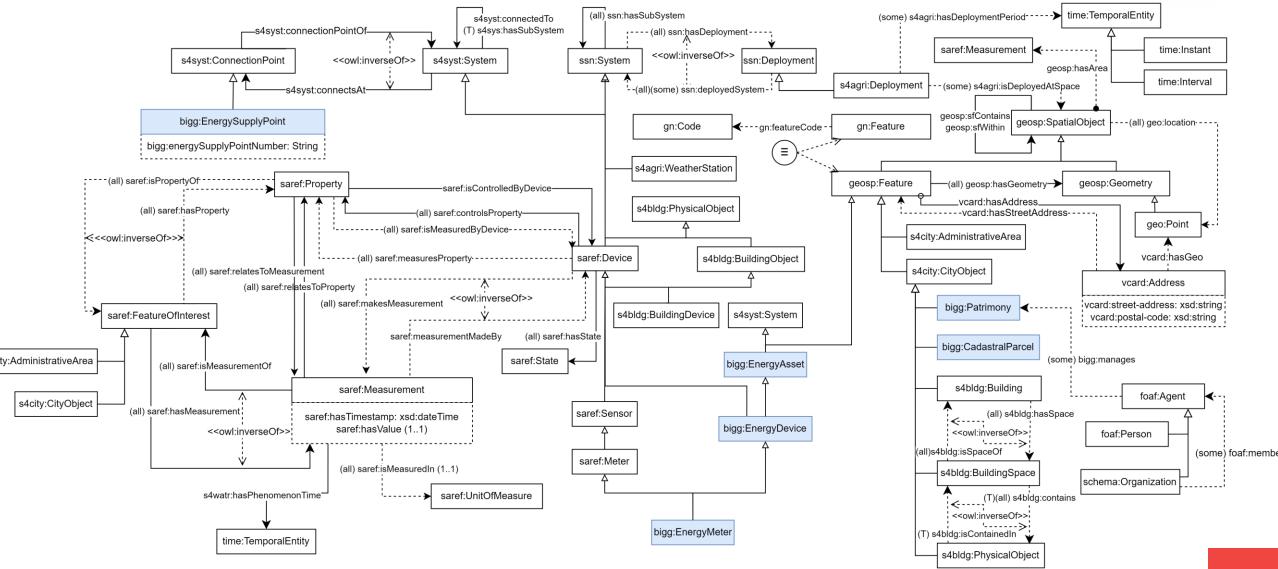
BIGG Ontology



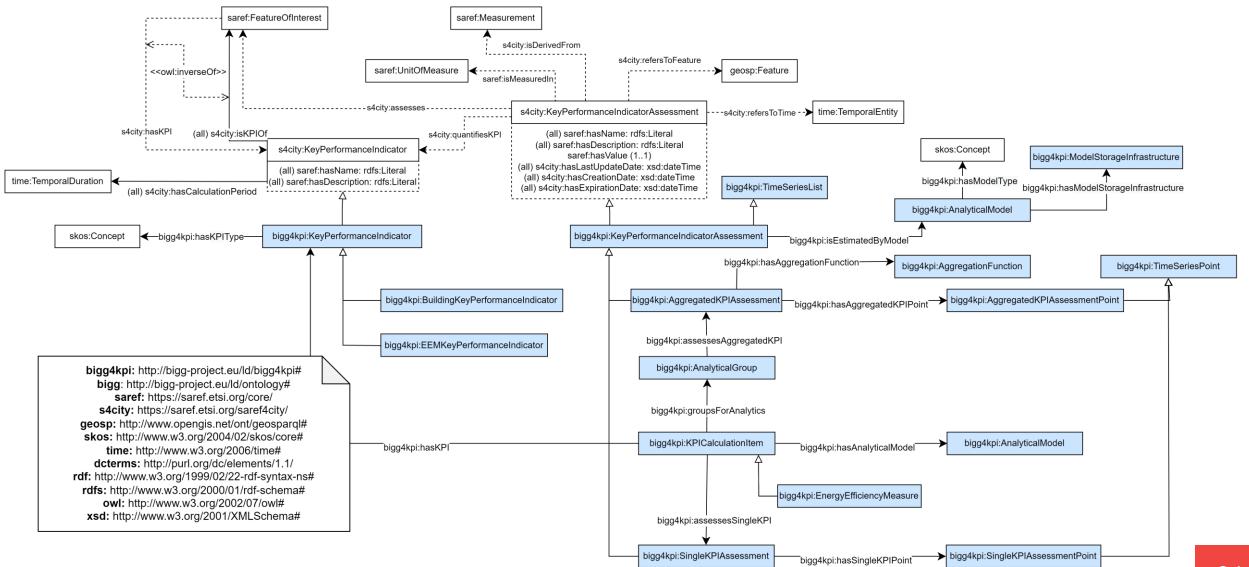


MBIGG

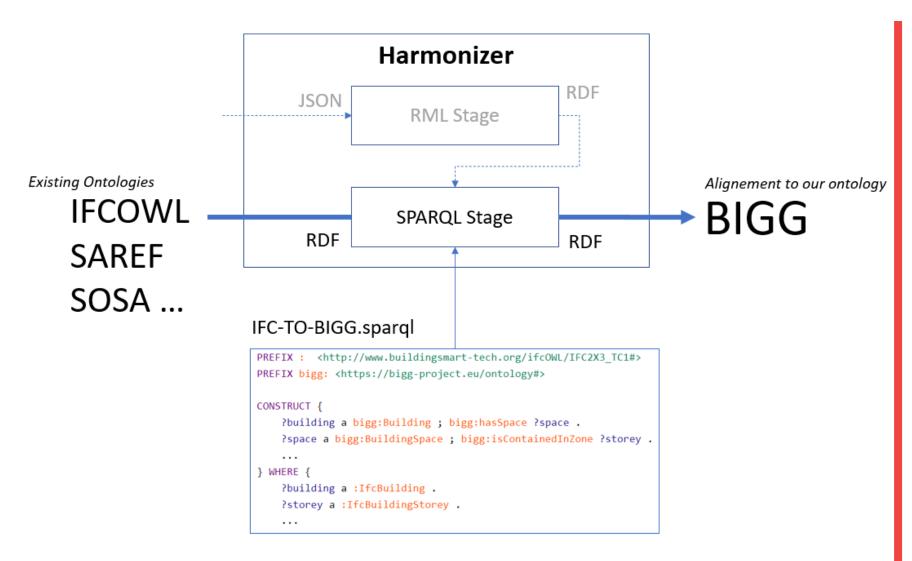
BIGG Ontology: core



BIGG Ontology: KPI extension



BIGG Harmonizer



✤ Main Features

- ✓ <u>Conversion of data:</u> From JSON to RDF/Turtle format.
- \checkmark Tool implemented in Python





AITB: Artificial Intelligence Toolbox



Sensitivity: Company

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Why AI?: Shift from Conventional to ML BIGG

Complexity of modern challenges

- Intricate interdependencies and nonlinear relationships
- **Evolution of the information landscape**
 - Vast volumes of diverse and unstructured data

Pace of change demands agile forecasting

• Adaptability of ML and AI tools

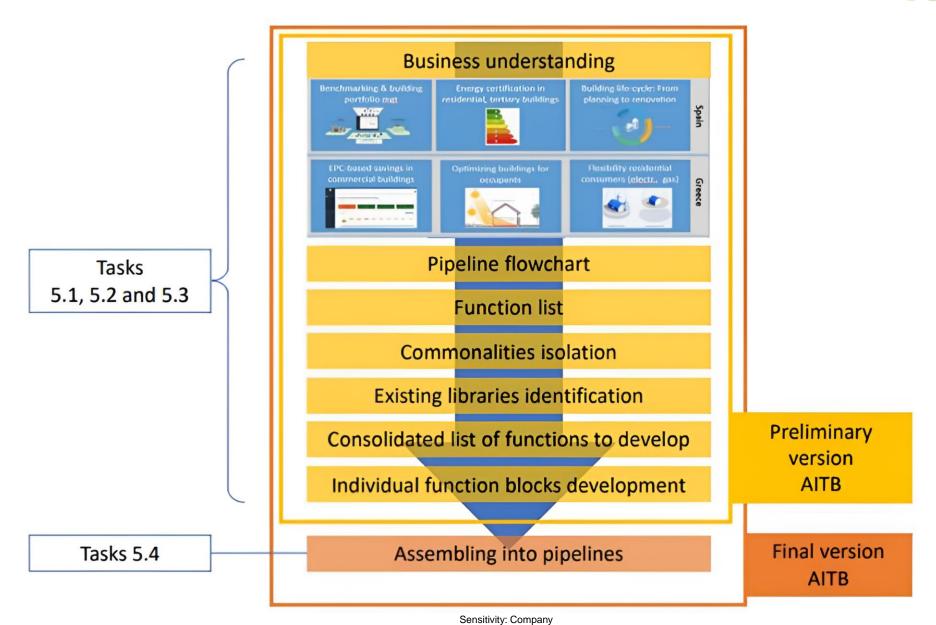
Augmentation of human capabilities

- ML and AI sift through massive datasets
- Identifying subtle trends and generating





AITB development methodology BIGG



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AI Toolbox: what does it have?



The AITB (Artificial Intelligence for Building) is composed of four function blocks :

1.Data Preparation Modules:

- 1. Synchronize with initial data management stages
- 2. Includes quality assessments, outlier identification, calender and timestamp management

2.Data Transformation Modules:

- 1. Focus on data categorization and secondary dataset management
- 2. Incorporates elements like calendar and weather data

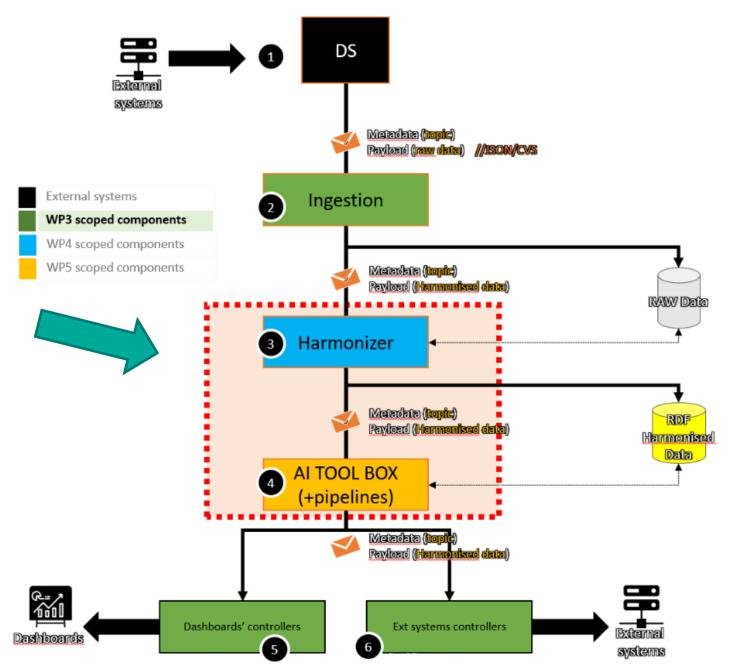
3.Modeling Modules:

- 1. Concentrate on constructing, evaluating, and testing data models
- 2. Fundamental for predictive analytics and decision support

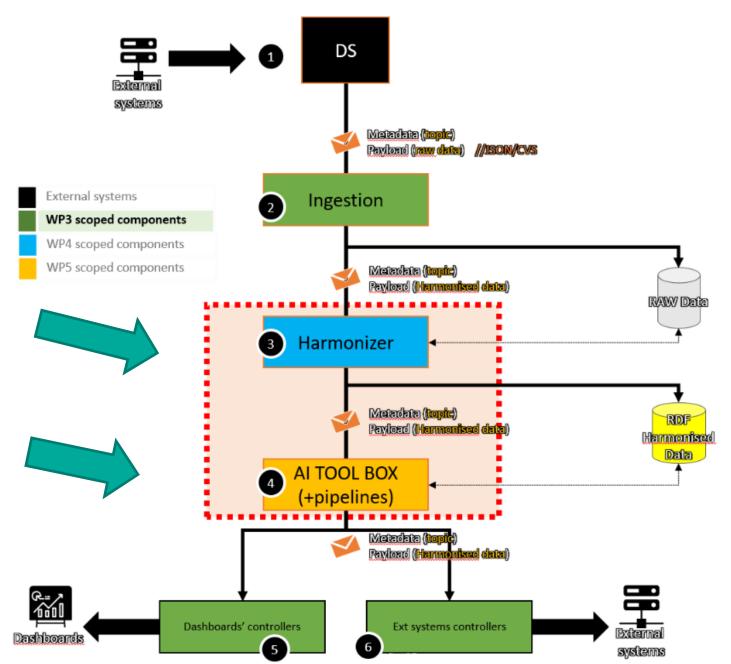
4.Reinforcement Learning Modules:

- 1. Pertains to the creation and training of reinforcement learning agents
- 2. A specialized facet of machine learning for dynamic decision-making in building scenarios

Reference Architecture



Reference Architecture



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The BIGG toolbox within publicly available GitHub

biggpy Python library of the BIGG AI toolbox ● Jupyter Notebook ☆ 2	Public	WP3-HttpIngestor source code for the ingestors in WP3 Java 🏠 1	Public
● Jupyter Notebook ☆ 1	Public	WP3-MqttIngestor ● Python ☆ 1	Public
biggr R library of the BIGG AI toolbox R	Public	biggdocs Language-agnostic documentation of the Al toolbo	Public ox of the BIGG project

- BIGG GitHub account: <u>https://github.com/biggproject</u>
- Documentation of the AI Toolbox: <u>https://github.com/biggproject/biggdocs</u>
- Python implementation of the AI Toolbox: <u>https://github.com/biggproject/biggpy</u>
- R implementation of the AI Toolbox: <u>https://github.com/biggproject/biggr</u>

GG



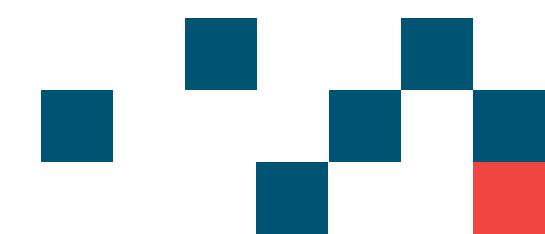


Positive digital flow

inetum.world

FRANCE | SPAIN | PORTUGAL | BELGIUM | SWITZERLAND | LUXEMBOURG | ENGLAND | POLAND | ROMANIA | MOROCCO | TUNISIA | SENEGAL | CÔTE D'IVOIRE | ANGOLA | CAMEROON | USA | BRAZIL | COLOMBIA | MEXICO | RP OF PANAMA | PERU | CHILI | COSTA RICA | DOMINICAN REPUBLIC | ARGENTINA | SINGAPORE | UAE







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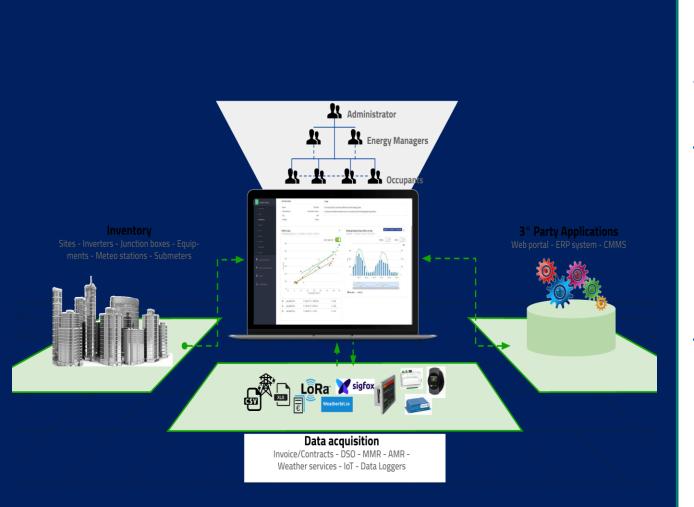


Back up slides



Sensitivity: Company

BC1: Benchmarking and Energy Efficiency tracking in Public Building



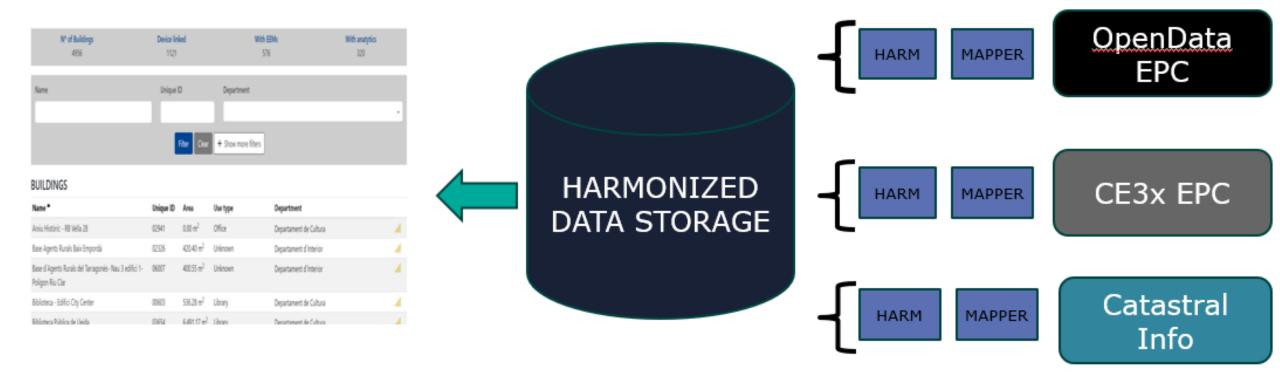
Benchmarking & building portfolio management

Use case 1: Benchmarking and monitoring of energy consumption. Similar buildings comparisons and evaluation of changes in the consumption trends.

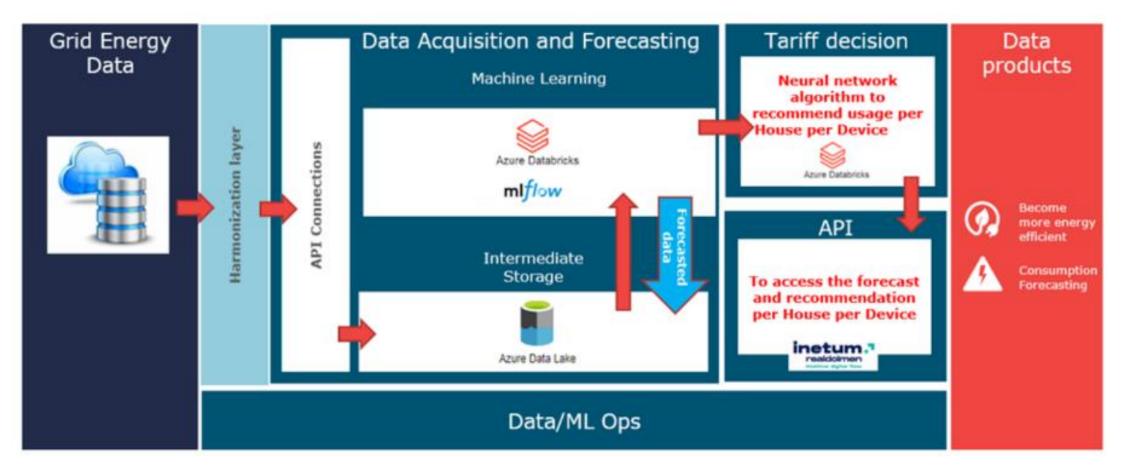
Use case 2: Energy Efficiency Measures (EEM) registration and evaluation. Continuous registration and evaluation of the implementation of energy efficiency measures in buildings.

BC2: Energy Certification (EPC) in Residential and Tertiary Buildings

Use case 3: Integration of INSPIRE spatial data with Energy Performance Certification (EPC). Automating the integration of the INSPIRE data with the EPC input data for completing and cross- checking the information and improving the reliability of the services.



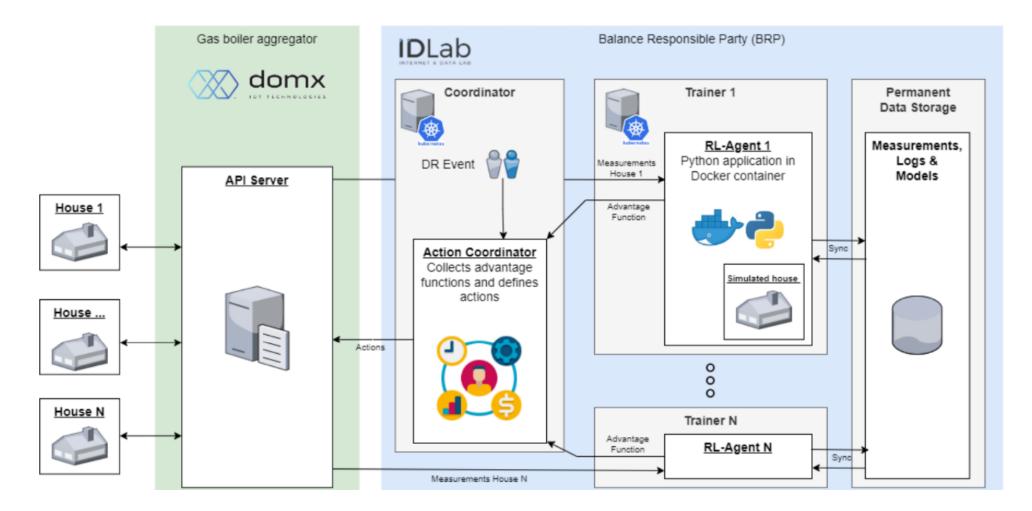
UC 14: Electricity Demand response



UC 14: Electricity Demand Response:

To forecast the electricity demand of the households. 24-48 Hour prediction.

UC15: Gas Demand response



UC 15: Gas demand response: to develop a demand response (DR) scheme exploiting gas flexibility in space heating for residential complex.

Panel discussion







Katerina Papapostolou Senior Research Associate, NTUA

ENERGATE

Dimitrios Rovas Professor in Building Simulation and Optimisation, UCL DigiBUILD **Daniele Antonucci** Senior Researcher, EURAC

MODERATE

Could you briefly present the ontologies defined within your projects?









What actions did you take to make sure that you reuse existing standardized ontologies when possible, and to push our own developments towards Linked-data communities?



Could you describe some use cases handled by your projects' ontologies?



#SmartEnergyCluster: 3 LIFE projects









Ioanna Andreaoulaki Electrical and Computer Engineer, NTUA InEExS Ioanna Makarouni Senior Researcher, NTUA AUDIT-TO-MEASURE Tomas Jezdinsky Project manager, European Copper Institute EU-MORE





InEExS – Innovative Energy (Efficiency) Service Models for Sector Integration via Blockchain

BIGG Final Event

24/11/2023 – Ioanna Andreoulaki (NTUA)



Co-funded by the European Union under project ID101077033. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.



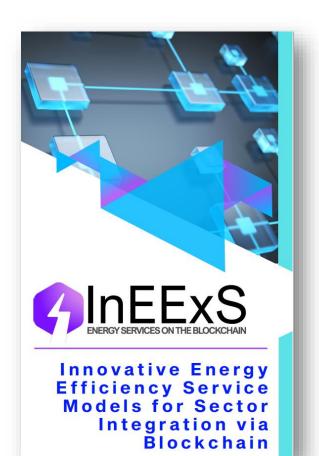
Table of Contents

- The InEExS project Overview
- Objectives & Consortium
- Scope
- Business Cases
- Blockchain platform and services



The InEExS project Overview





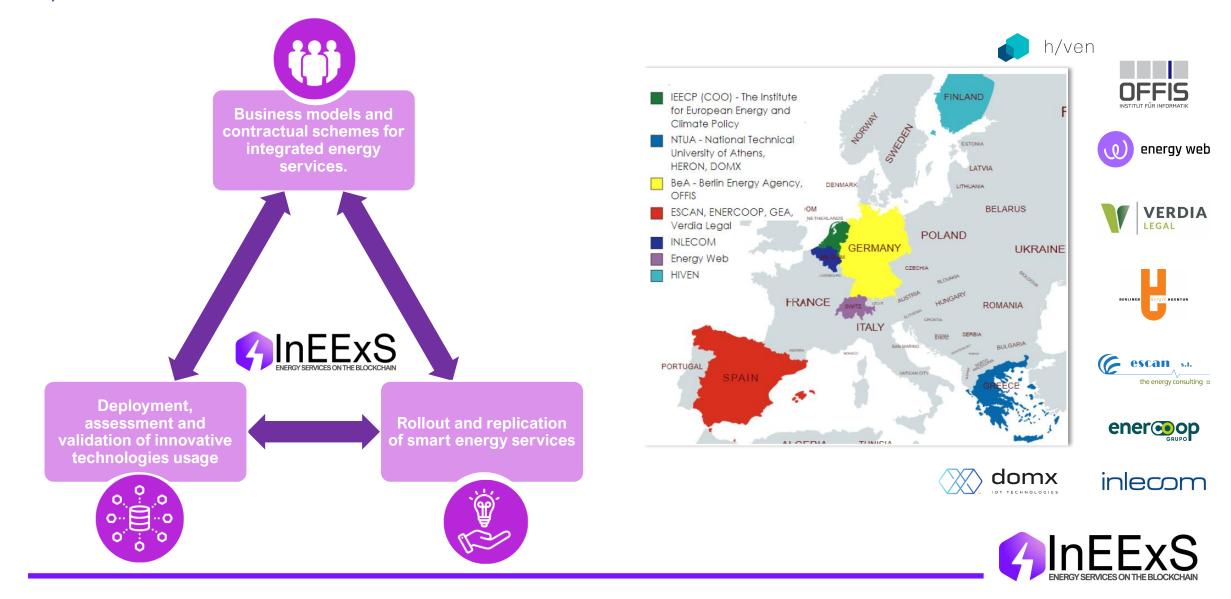
The core concept of InEExS is the deployment of integrated energy services across sectors and carriers, and the tokenisation of energy saving data in a public blockchain to facilitate cooperation among market segments and actors. InEExS improves the implementation of Energy Efficiency Directive (EED) Article 7 and supports Obligated Parties to provide integrated service offers that enable energy savings, system efficiency and include non-energy benefits.

Project coordinator: Institute for European Energy and Climate Policy (IEECP)





Objectives & Consortium







InEExS will test the innovative services, models and contracts in different EU states:

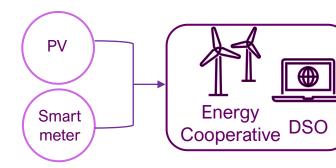
EE renovation **ESCO** Real ΡV Estate

BC1 **Energy** Performance Contracting with Pay4Performance guarantees (Berlin, Germany)

BC3



BC2

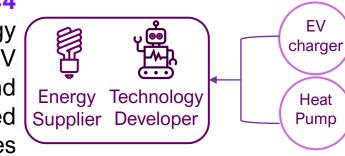


Improved selfconsumption of DER in Energy Cooperatives (Crevillent, Spain)

BC4

Smart energy management for EV chargers and electricity-based **HVAC** appliances

Larisa, Trikala, Volos)







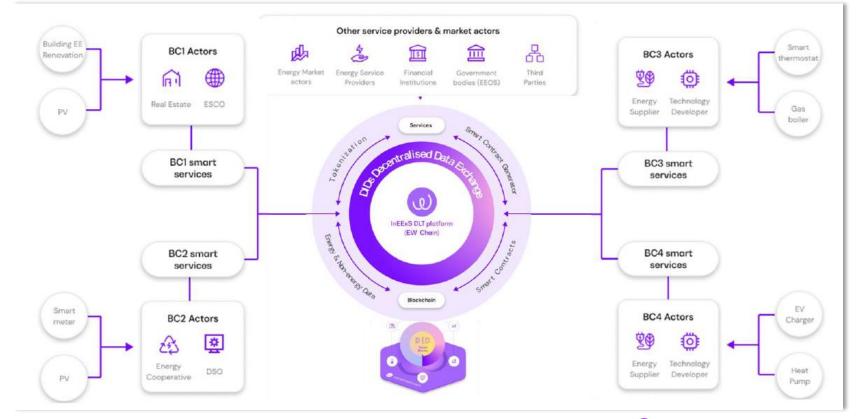
Blockchain platform and services

Key innovative DLT technologies to

- setup the common medium of exchange between all engaged stakeholders
- enable the integration of different energy services and sectors.

Blockchain platform: EW Chain platform is the world's first opensource, enterprise blockchain platform tailored to the needs of the energy sector.

- Smart Contracts service: The Smart Contracts generator for bridging the physical contracts with the digital world.
- Tokenization service: Allows token holders to pay for decentralized application services, by using the Energy Web Token.





22 Innovative services & methods launched to the market

43 GWh/y primary energy savings

16 m€ investments triggered by the business models

1,000

Stakeholders trained with increased skills on energy issues **43** Policy recommendations to support the adoption of directives covered under the Fit-for-55 package.







PARTNERS





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THANK YOU!

For more info, follow our hashtag, visit our website or contact us:





https://ieecp.org/projects/ineexs/





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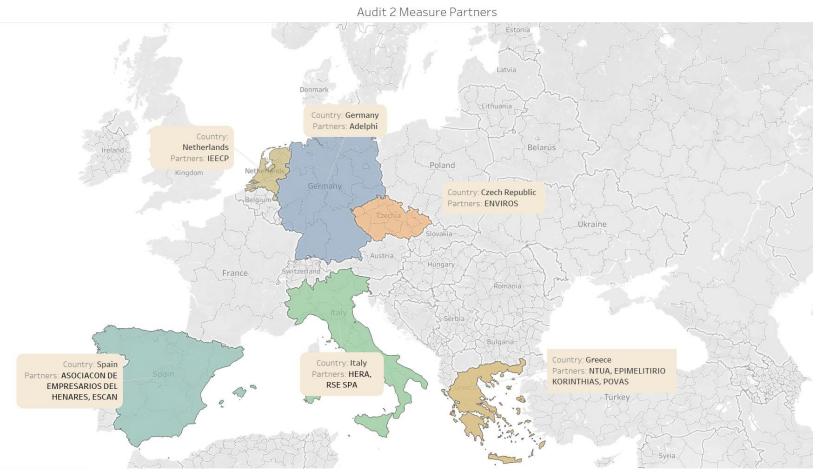
Call LIFE-2021-Clean Energy Transition CET

Leading business towards climate neutrality by speeding up the uptake of energy efficiency measures from the energy audits

Duration: 3 years Start: November 2022

10 Partners from 6 EU MSs

AUDIT TO MEASURE



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The challenge

"A small percentage of the recommended measures from the energy audits is ultimately implemented"

What the EC expects..

Targeted actions to support businesses, covering processes from energy audit to the implementation of Energy Efficiency measures.

Specialized actions for consulting and capacity development for companies' staff."

Operational Support for the companies as a service

Increasing the implementation rate of the proposed measures for Energy Efficiency.





The challenge

"A small percentage of the recommended measures from the energy audits is ultimately implemented"

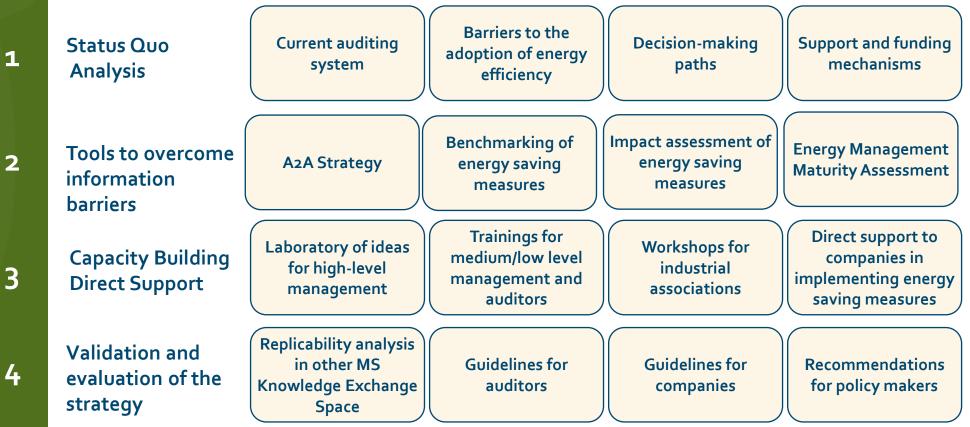
The support is free for the companies

Pushing for the uptake of Energy Saving Measures proposed in energy audits

- AUDIT-TO-MEASURE aims to develop and implement a new engagement strategy ("Audit2Action") to put into action the energy saving opportunities emerging from energy audits.
- This includes addressing barriers to the adoption of energy saving measures and developing a capacity building program to motivate decision-makers towards implementing measures for improving energy efficiency in companies.
- The project provides **direct support to the business decision makers**, increasing their interest and speeding-up the process of implementing the energy efficiency measures (EEMs) in their industries
- Tools, training and direct assessment to companies to implement energy efficiency measures

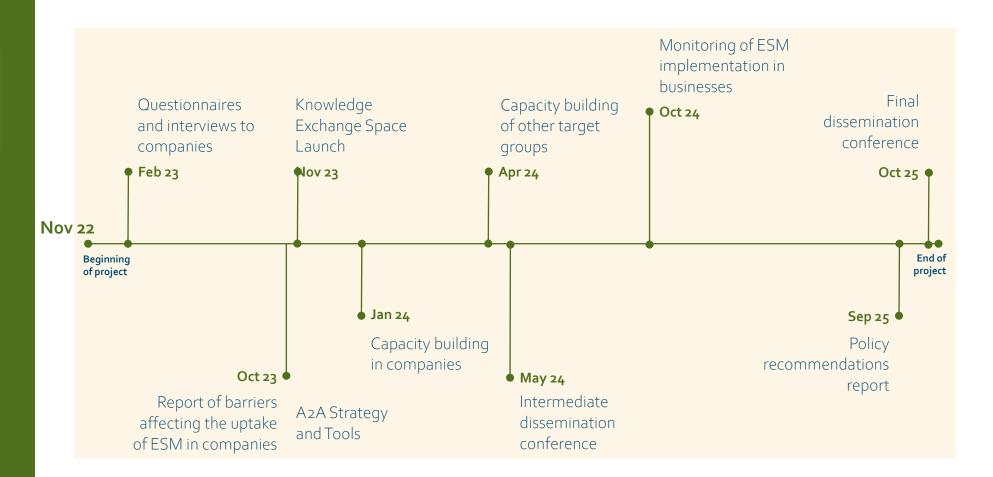


Audit2Measure methodology



Timeline



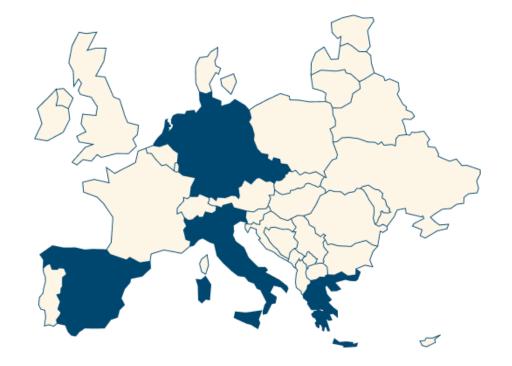




Impact

AUDIT-TO-MEASURE will facilitate the uptake of at least **125 ESM directly in companies of the industrial sector** in the EU (25 ESM in each country involved in Audit2Action).

Countries involved in Audit2Action: Spain, Italy, Greece, Netherlands, Germany, Czech Republic



Benefits for the companies



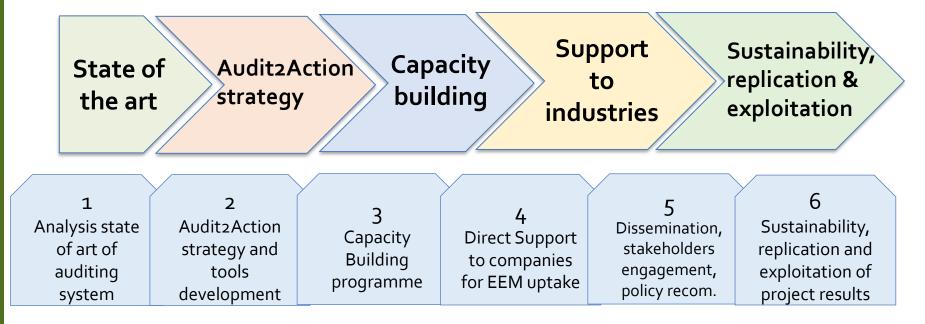
AUDIT2MEASURE project

- Improving energy audits
- Getting direct support in **technical, financial, legal** aspects about EEM
- Being invited to participate in **trainings**
- Improving corporate culture towards greener objectives
- Knowledge Exchange Space for findings, ideas and experiences of EEM
- Promotion of companies, disclosing their commitment to the environment and the reduction of CO₂ emissions, through **networking sessions**

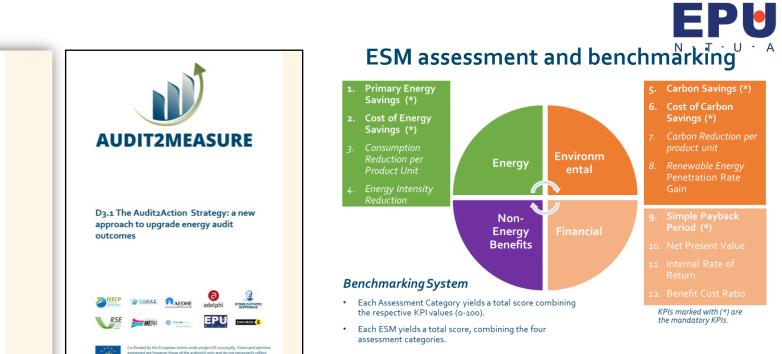


AUDIT2MEASURE project





- <u>Report of state-of-the-art auditing system and ESM implementation</u>
- <u>Top management decision process</u>
- <u>Report of barriers affecting the uptake of ESM in companies</u>
- <u>Audit2Action Strategy</u>
- ESM Assessment and A2M Database



More information online: **AUDIT2MEASURE**

D2.1 Report of state-of-

<section-header><section-header><section-header><section-header></section-header></section-header></section-header></section-header>	D3.1 The AuditzAction Strategy: a new approach to upgrade energy audit outcomes WILLIAM WILLIAM <th> Non- Energy Benefits Financial Financial 9. Simple Payback Period (*) 10. Net Present Value 11. Internal Rate of Return 12. Benefit Cost Ratio KPIs marked with (*) are the mandatory KPIs. </th>	 Non- Energy Benefits Financial Financial 9. Simple Payback Period (*) 10. Net Present Value 11. Internal Rate of Return 12. Benefit Cost Ratio KPIs marked with (*) are the mandatory KPIs. 	
FACT SHEET	The A ₂ M Database A	ssessment of Energy Management Maturity	
European auditing	EXMANDOMENTS	Aus Canada Can	
System Comparing energy audit requirements from 6 EU countries	EXMANS 1001/hrst Mill-2 drags Graumpten Mill-2 drags Mill-2 drags	the set of the se	
Authors: Berry Bourgout, * adelphi Mian Matußek - adelphi Description of the sadelphi Description of the sadelphi set of the s	Boustry Brods Steel	Energy Management Maturity Questionnaire Level Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2" Colspan="2">Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" Colspan="2" <th colspan<="" th=""></th>	



Thank you.

Dr Ioanna Makarouni

Electrical and Computer Engineer, MSc, PhD *Project Manager, Senior Research Associate (EDiP)* EPU-NTUA, Decision Support Systems Laboratory School of Electrical and Computer Engineering National Technical University of Athens E-mail: <u>imakar@epu.ntua.gr</u>, <u>www.epu.ntua.gr</u> <u>Mob: 6976407195</u>

For more info, visit our website or contact us:



www.epu.ntua.gr

AUDIT-TO-MEASURE website



a2m@epu.ntua.gr





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EU-MORE

24th Nov 2023 / Online



EUropean MOtor REnovation initiative

EU-MORE

LIFE project overview for BIGG project event, Nov 2023

Tomas Jezdinsky (ECI)

Building Information aGGregation, harmonization and analytics platform



This project has been co-funded by the European Climate Infrastructure and Environment Executive Agency under the LIFE call, LIFE-2021-CET-POLICY, with grant agreement N° 101076631.

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Intro





This LIFE-Project aims to speed up replacement of old, inefficient electric motors in industry and the service sector.

Electric motors tend to stay in service for 30 to 40 years, which is much longer than generally assumed.

With swift action, this replacement rate could be improved.

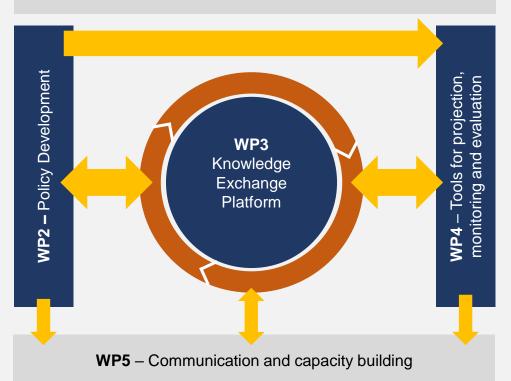
In the EU, replacing old motors faster would free up additional energy savings, on top of the savings potential of existing regulations, with all the associated benefits.



EU-MORE project structure



WP6 – Sustainability, Replication and Exploitation of project results



WP1 – Management

- WP1 involves project management and coordination
- WP2 will develop policies based on experiential analysis, identifying impacts, barriers, and best practices
- In WP3 all activities will be developed around peer-to-peer dialogue among stakeholders, structured and organised in the knowledge exchange platform
- WP4 will develop tools to calculate, monitor, evaluate, and report policy results
- WP5 covers project communication and dissemination
- and WP6 includes the projects Sustainability, Replication and Exploitation of results



EU-MORE project partners

- ISR University of Coimbra
- ECI European Copper Institute
- IEECP Institute of European Energy and Climate Policy
- AEA Austrian Energy Agency
- CRES Centre for Renewable Energy Sources and Saving
- Fraunhofer Institute for Systems and Innovation Research



Copper Institute

opper Alliance



Fraunhofer







What is the problem?





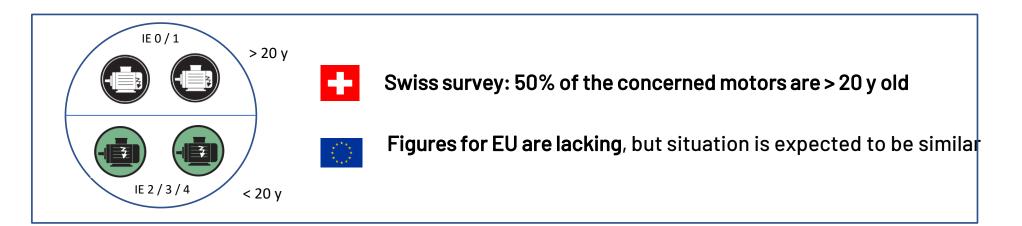
Electric motors > 50% of EU electricity consumption



A total of 8 billion motors in EU(1)



EU-MORE addresses motors > 0.75 kW representing a large share of the total consumption





Motor Lifetime



The average lifetime of motors (including repairs) in previous EU studies have been estimated to be:

12 years

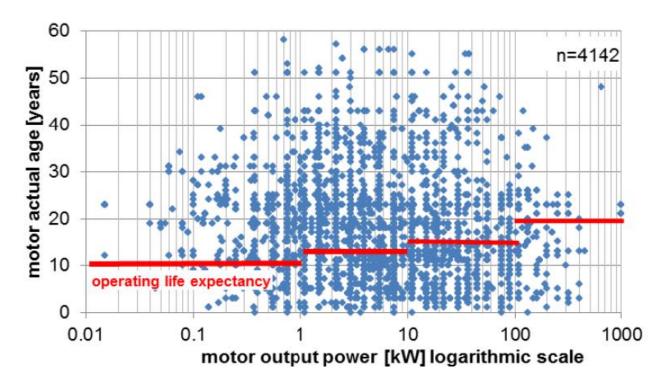
15 years

20 years

	1.0 – 7.5 kW:
	7.5 – 75 kW:
	75 – 250 kW:

Motor Lifetime





- In 2013 the Swiss Energy Agency S.A.F.E. assessed 4124 separate motor systems in 18 factories.
- The analysis shows that 56% of all motors and their respective systems were older than their expected operating lifetime (some were twice the expected age).

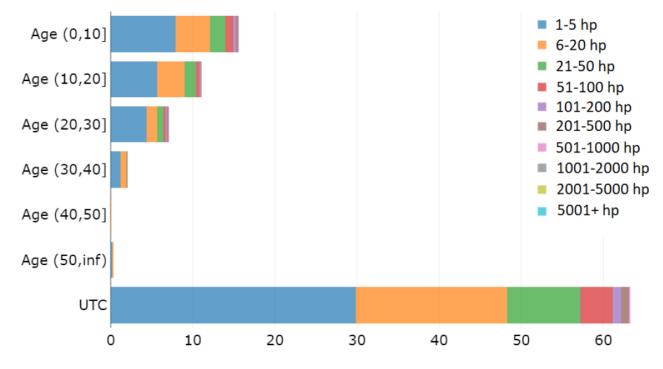
Source: Impact Energy, Switzerland, 2014



Motor Lifetime



Age of industrial motor systems broken down by size



The 2021 US MS Market Assessment found that the majority of motors is over 10 years old, even for small motors under 20hp

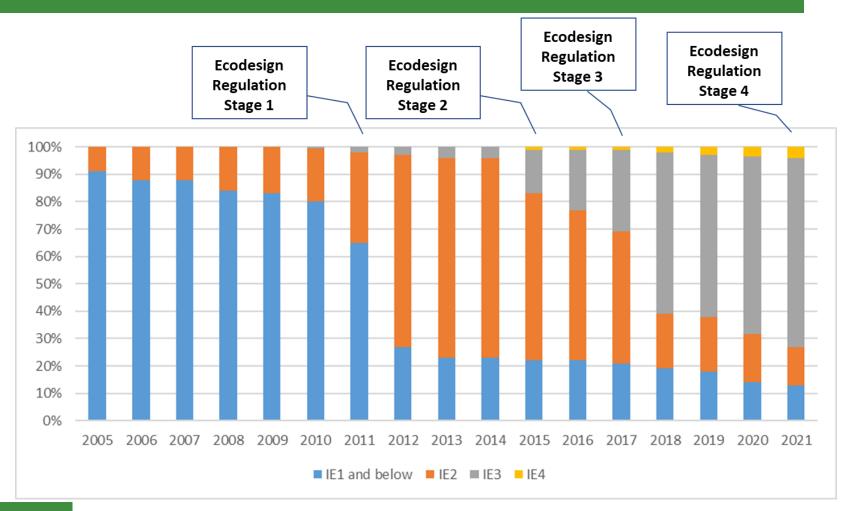
% of Total Motor Counts

Source: (DoE, 2021) US Motor System Market Assessment

Electric motor market



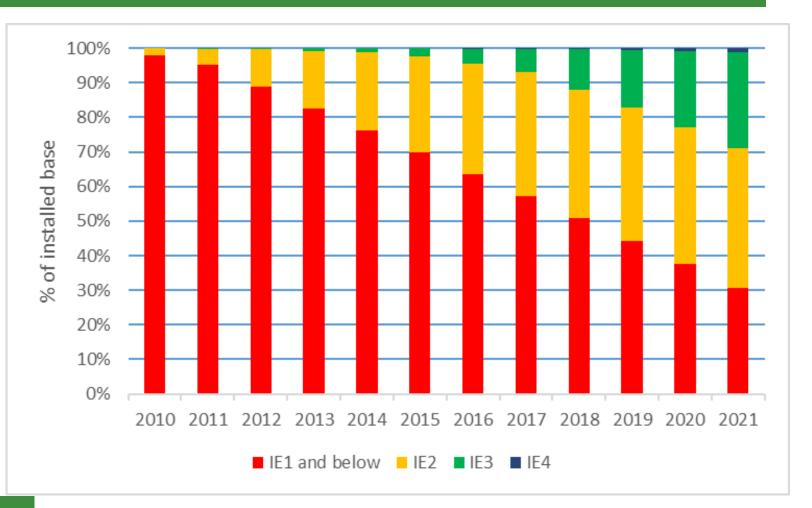
 Motors sold by efficiency class (IE-code), 2005-2021 (CEMEP data)



Electric motor market



 Estimation of EU-27 motor stock by efficiency class



The opportunity: 100 TWh/year





Accelerated motor replacement: replacing old IE0/1/2 motors with new IE3 and above motors + motor system optimisation



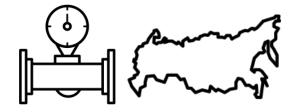
has an estimated **electricity savings** potential of approximately 100 TWh/y in the EU-27, which represents:



55 average gas fired power plants

electricity consumption

of the Netherlands



30% of historic natural gas import from Russia



25 Mton CO2



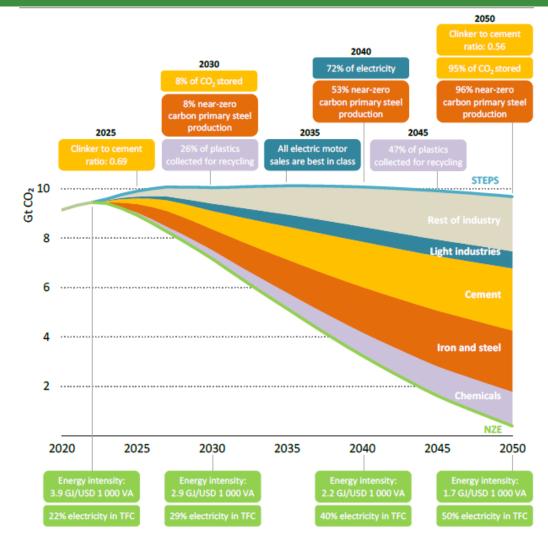
What is the opportunity?



Emissions reductions and key milestones in the industry sector in the NZE scenario relative to the STEPS, 2020-2050

Industry requires a portfolio of technologies and measures to reach net zero emissions, such as energy and material efficiency, electrification, hydrogen and CCUS





Barriers to overcome



PRACTICAL BARRIERS IN INDUSTRY

 A need for quick availability when a motor fails, and many sites have old motors in stock

- Lack of awareness about the co-benefits of energy efficient motors
- Motors are replaced without looking at the system, missing out on the full benefits

ECONOMIC BARRIERS IN INDUSTRY



- Decisions made based on purchase cost instead of life cycle cost, because of split incentives
- Pay-back times of motor replacement are favourable, but not perceived as such because of ignorance or extreme expectations
- Focus on low hanging fruit only following EnEff audits in industry
- Lack of awareness on how to receive funding

BARRIERS AT POLICY LEVEL

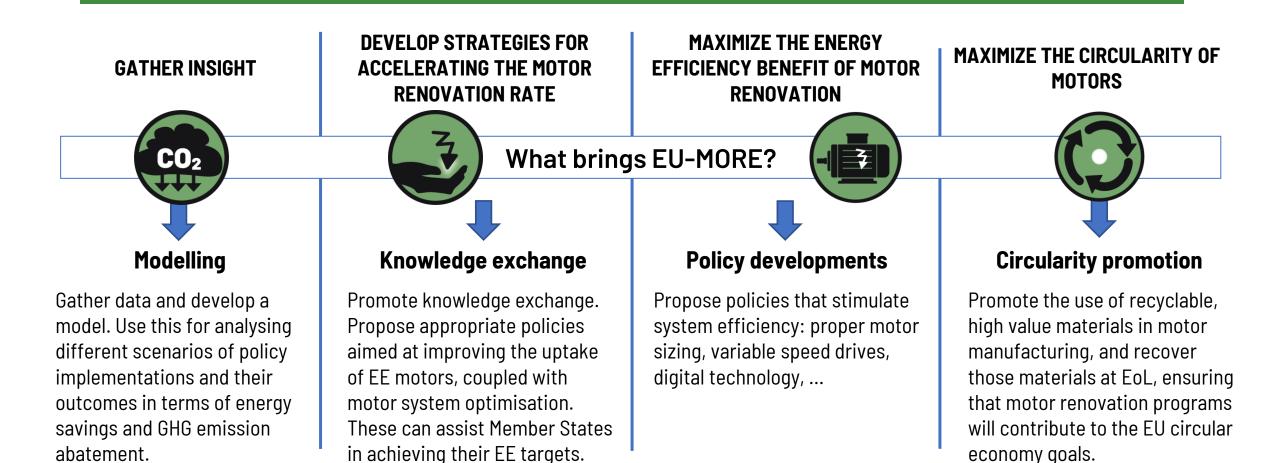


- Mandatory EnEff policies only target new motors and lack a leverage for motor replacement
- A lack of data about motor ages in the EU
- A lack of insight in which policies work for accelerating motor renovation in industry
- False perception that life-times should be extended as long as possible in a circular economy, ignoring the full environmental balance



What needs to be done?





EU-MORE



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Q&A





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Conclusion

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