

EPC RECAST

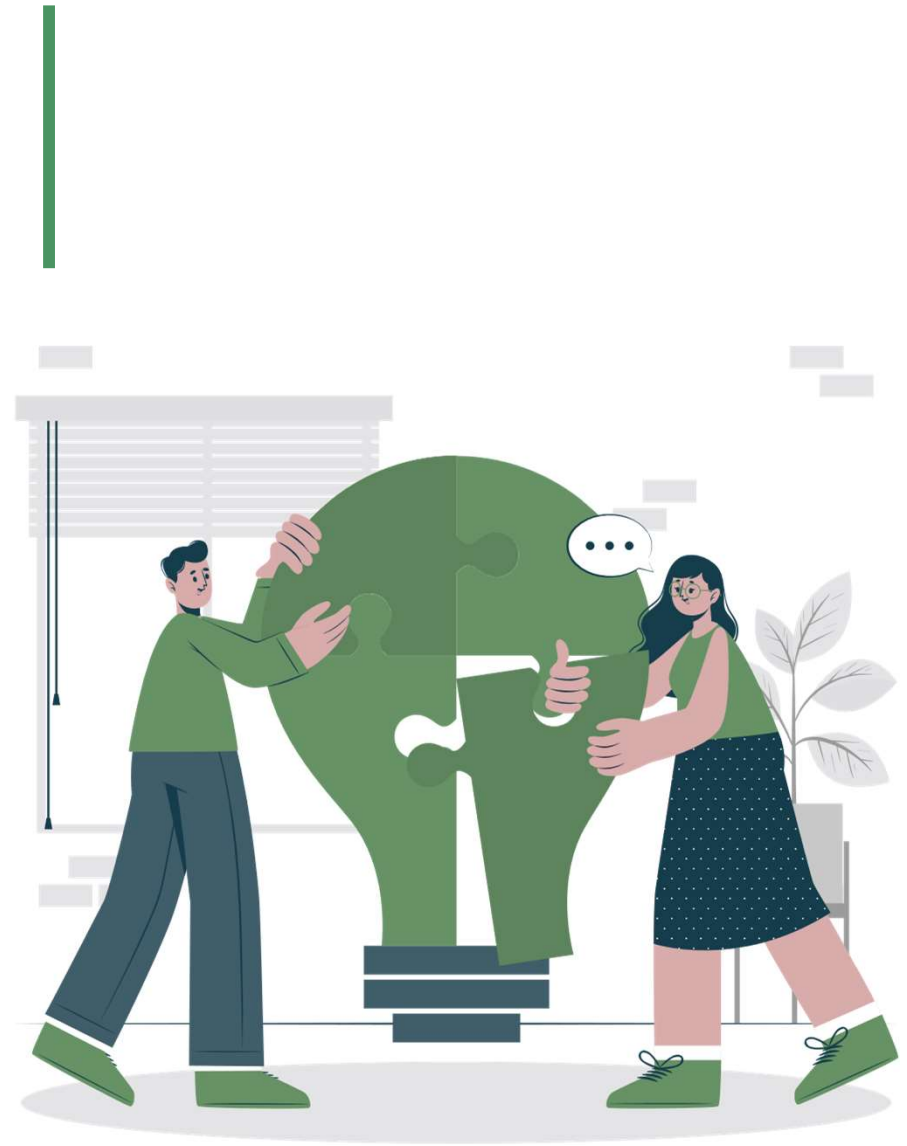
ENERGY PERFORMANCE
CERTIFICATE RECAST



Next Gen. EPC Conference – May 23rd 2024 – Olivier GRESLOU (CSTB)

EPC RECAST : Innovative workflow and digital toolbox to support the implementation of new generation of EPCs for residential buildings

The overall EPC RECAST process





EPC RECAST in a nutshell

*Innovative **process** and **digital toolbox** to develop and validate
a new generation of EPCs for **residential buildings***

- ✓ To facilitate and improve working practices of **EPC assessors** → **quality** and **reliability** of EPCs
- ✓ To tailor renovation recommendations, highlight benefits for **building owners** → **user-centric** approach



Data collection



Quality checks



*Renovation
roadmaps*



Non-energy benefits



OUR TEAM



LUXEMBOURG
INSTITUTE OF SCIENCE
AND TECHNOLOGY



POLITECNICO
MILANO 1863





Project objectives

- Supporting the **work of EPC assessors** to **improve reliability of EPCs** : data collection, quality checks, model calibration
- Developing a prototype of **cloud system toolbox** for EPC assessors and a new generation of EPCs
- Co-designing the EPC assessment process with owners and assessors : interactive **user-centered design approach**
- Improving **renovation recommendations** in EPCs with renovation roadmaps and additional indicators
- Collecting recommendations from public authorities and industrial stakeholders : **advisory board** and **mirror group**



Workload for EPC assessor:
 \leq half a day of on-site work,
off-site work \leq on-site work





The EPC RECAST Steps

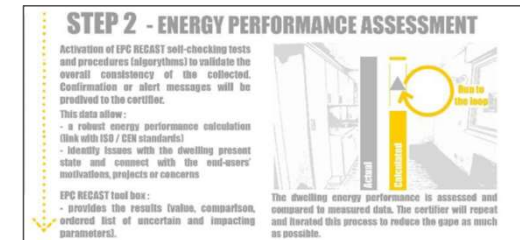
STEP 1 – Data Collection and Inspection Process

TARGET : Duration ≤ 0.5 day, on-site



STEP 2 – Energy Performance Assessment

TARGET : Step 2 + Step 3 ≤ 0.5 day, back at the office



STEP 3 – Certification & Renovation Roadmap

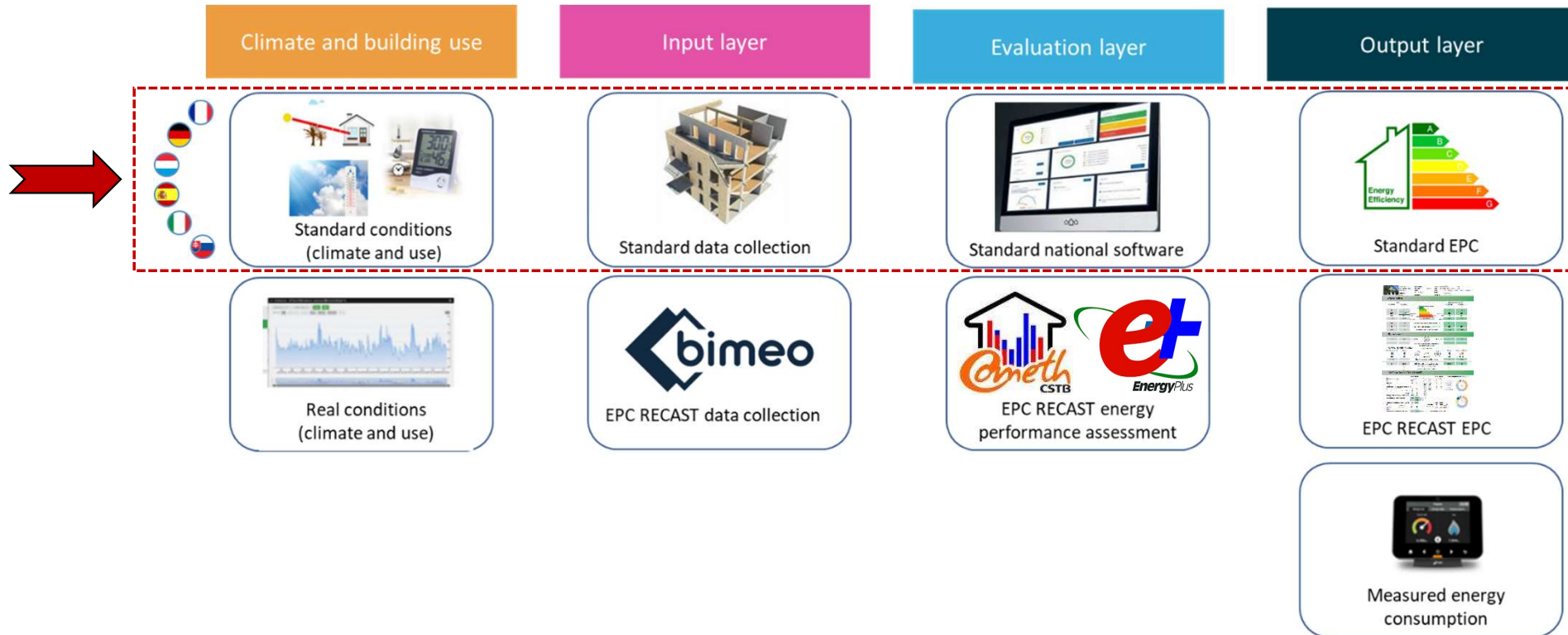
TARGET : Step 2 + Step 3 ≤ 0.5 day, back at the office



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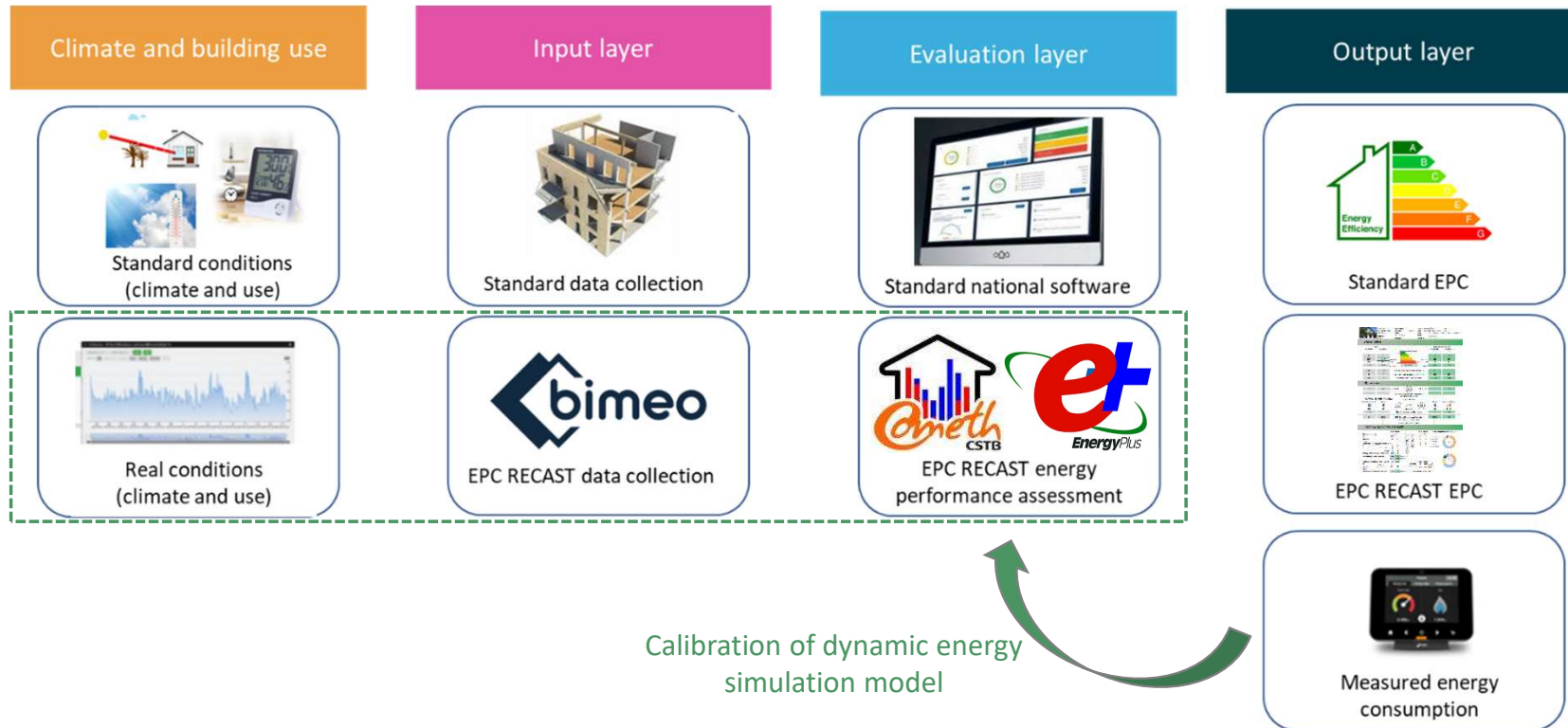


The standard EPC evaluation process : data and layers



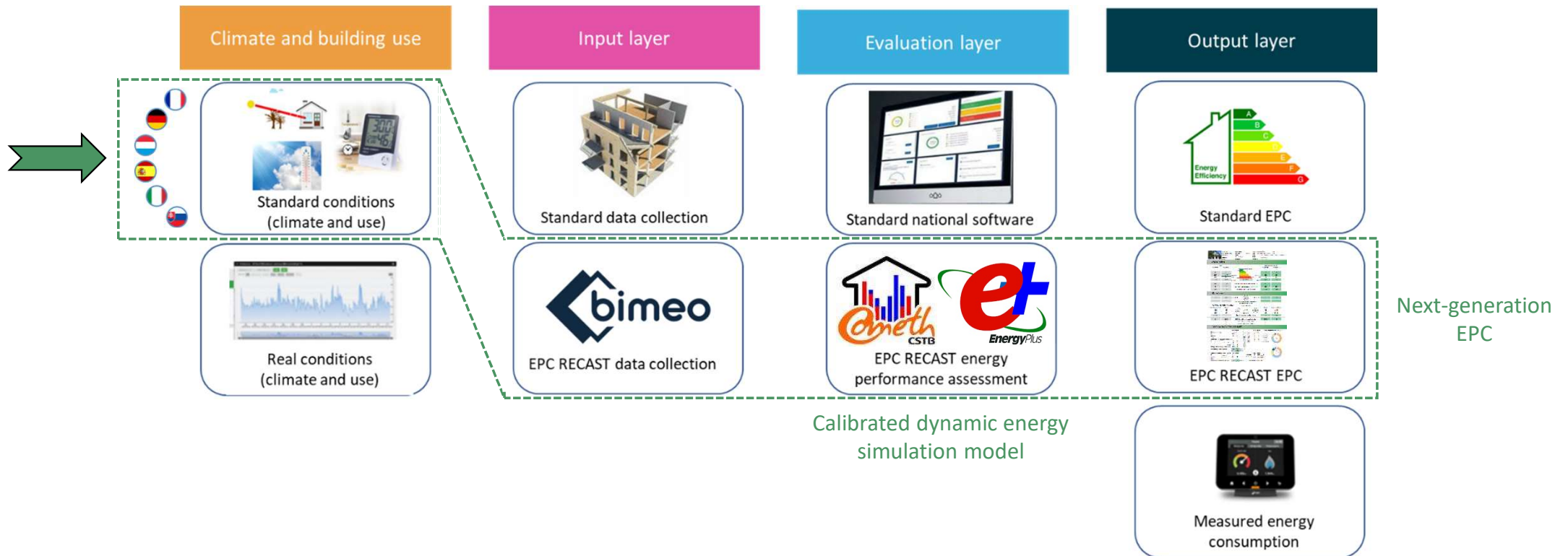


The EPC RECAST evaluation process : step 1



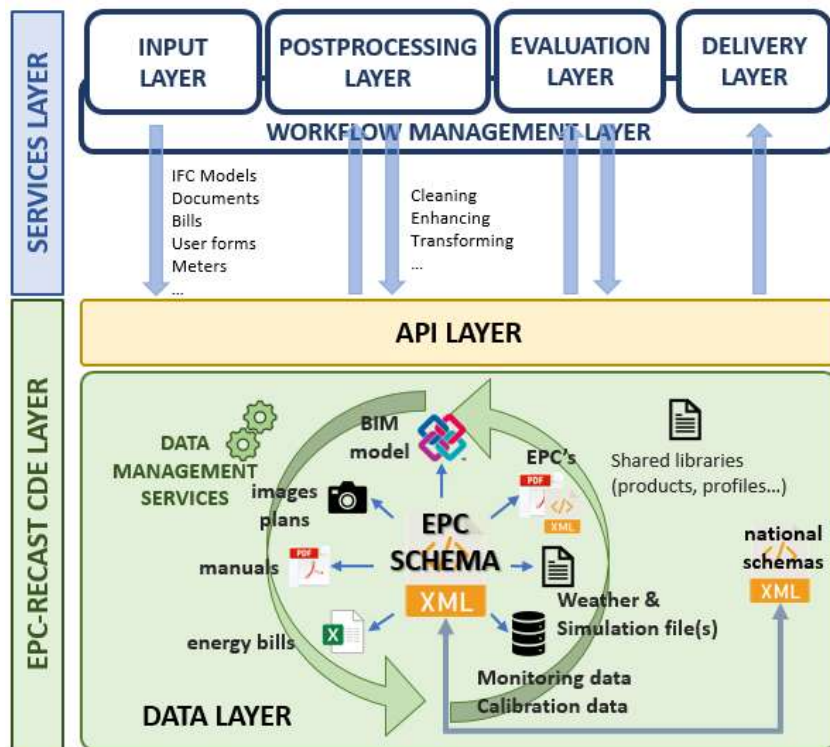


The EPC RECAST evaluation process : step 2



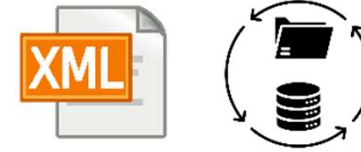
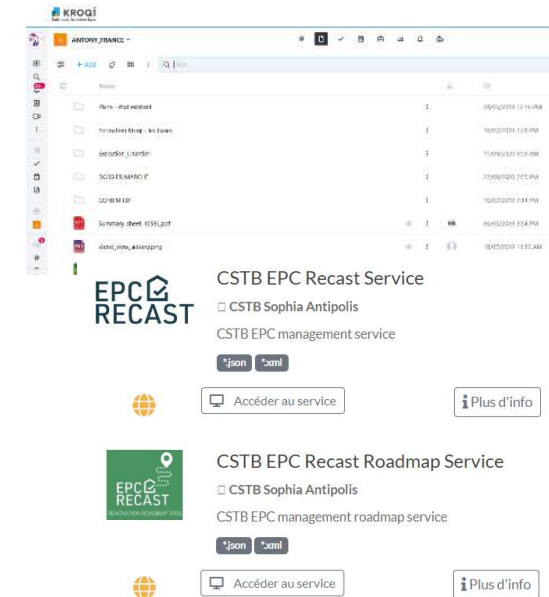


Integrated data and services : Common Data Environment



KROQI
Bâtir avec le numérique

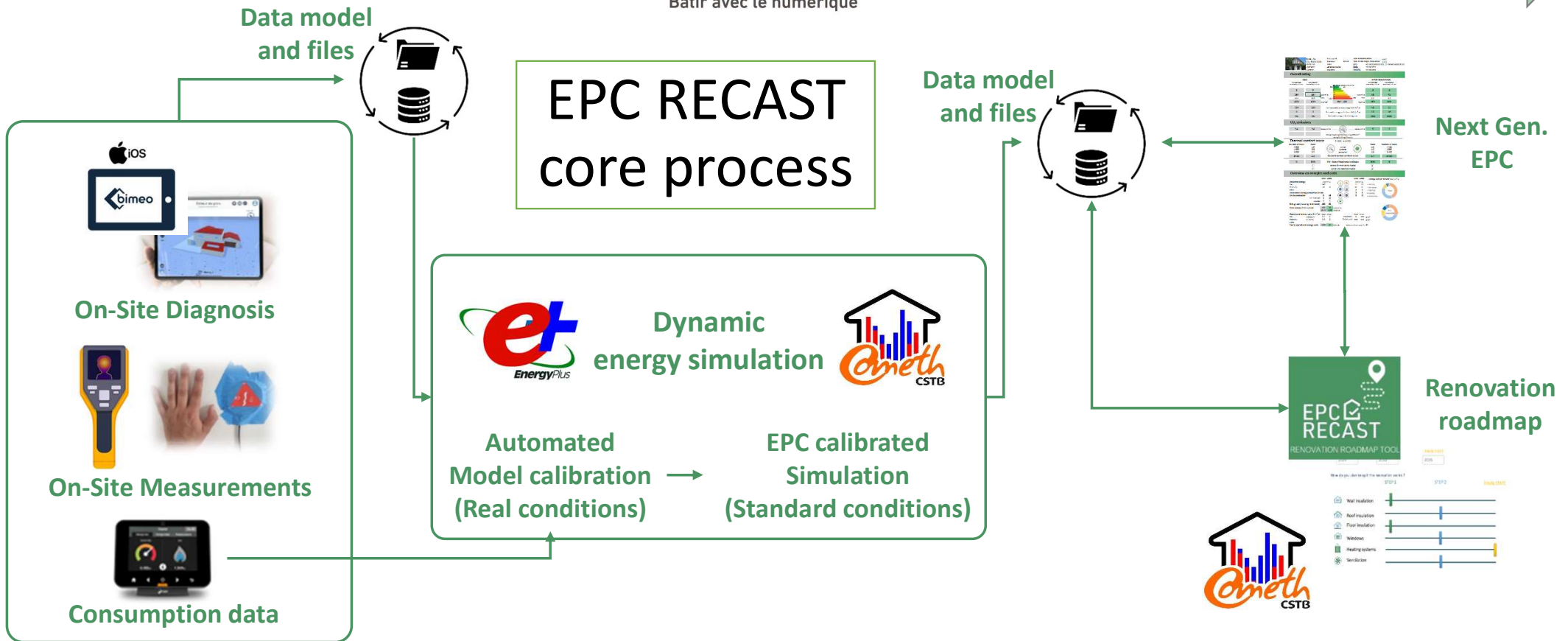
Cloud-based platform :
files management
and web services



Central data model and
complementary data files



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EPC RECAST supporting the EPBD RECAST

- ✓ **Article 4.** Methodology for calculating the EP
 - **Computing cores for dynamic EP calculation**
 - **Model calibration and operational rating**



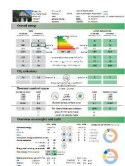
- ✓ **Article 9.** Trajectories for progressive renovation
- ✓ **Article 12.** Renovation passport
 - **Quick renovation roadmap tool**



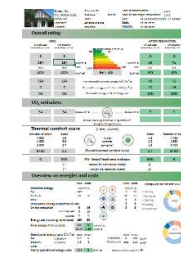
- ✓ **Article 16.** Data exchange
 - **Common data environment**



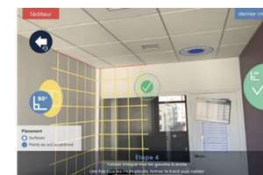
- ✓ **Article 17.** Financial incentives
 - **KPIs before and after renovation on the EPC**



- ✓ **Article 19.** EPCs
 - **EPBD RECAST compliant template**
 - **Digital tool for on-site visits**



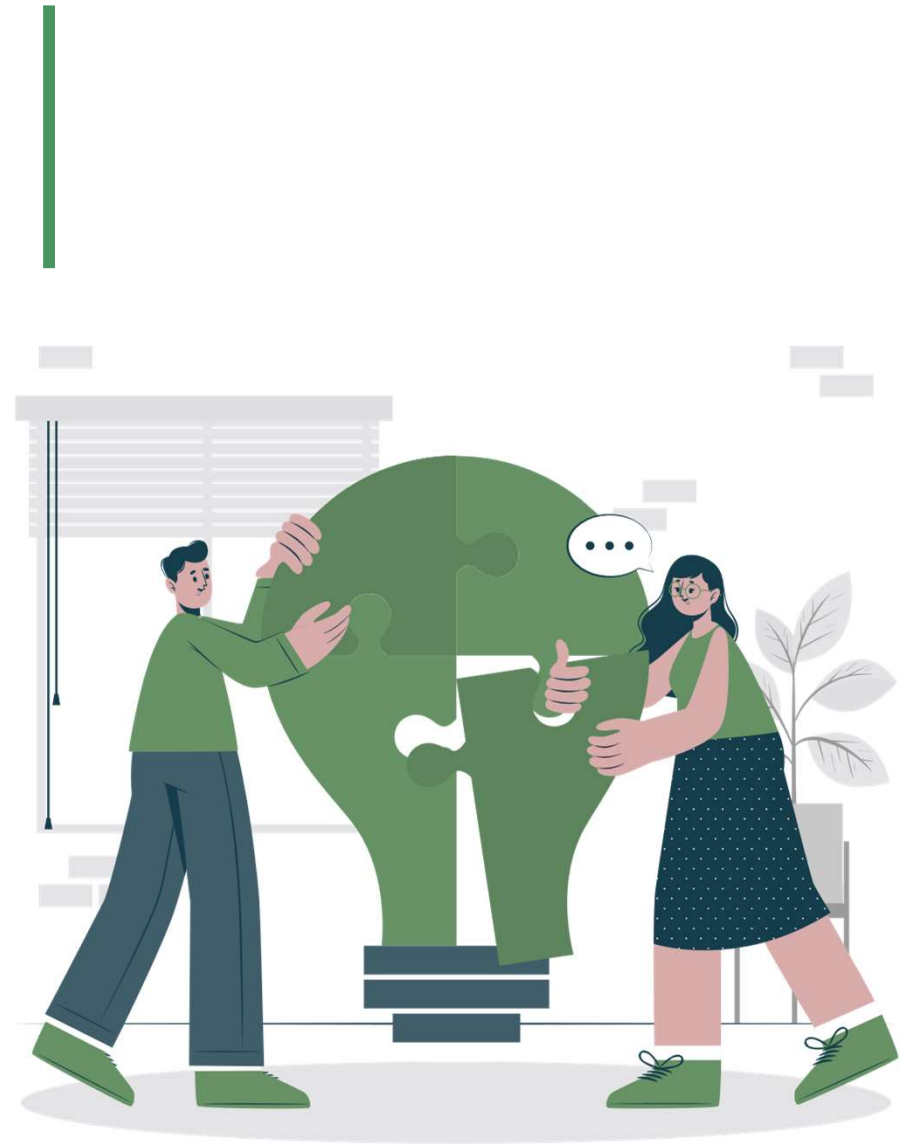
- ✓ **Article 20.** Issue of EPCs
 - **Simulation data model and report**



- ✓ **Article 22.** Databases for the EP
 - **Common data model of the building**



STEP 1 – On-Site data collection





Technologies for data collection

Main difficulties for real data collection about the dwelling:



- Often inaccurate evaluation of the building dimensions
- High variability of data collection practices and results
- High uncertainties in the assessment of the envelope thermal characteristics & energy systems



What are EPC RECAST's major contributions?

New tools and technologies to facilitate and enrich the on-site data collection



EPC RECAST
ENERGY PERFORMANCE CERTIFICATE RECAST

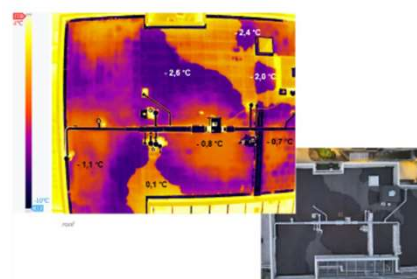
Questionnaire for the EPC ASSESSOR during the on-site visit

Informazioni valide in Francia per un tecnico iscritto professionalmente nel settore edile

Indicare le coordinate esatte

Indirizzo e-mail *

Vostro indirizzo e-mail



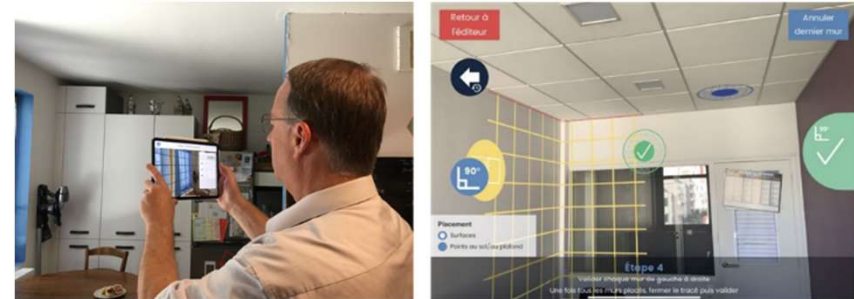
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On-site inspection of the building

The BIMEO technology for the digitization of the dwelling

- Augmented-reality technology based on Ipad + Lidar sensor
- Fast geometrical scan to generate a reliable BIM-model of the dwelling with precise dimensions
- Integrated questionnaires to facilitate observations of the envelope and energy systems and centralize information
- ✓ Fast data collection
- ✓ Automated connection with energy simulation software



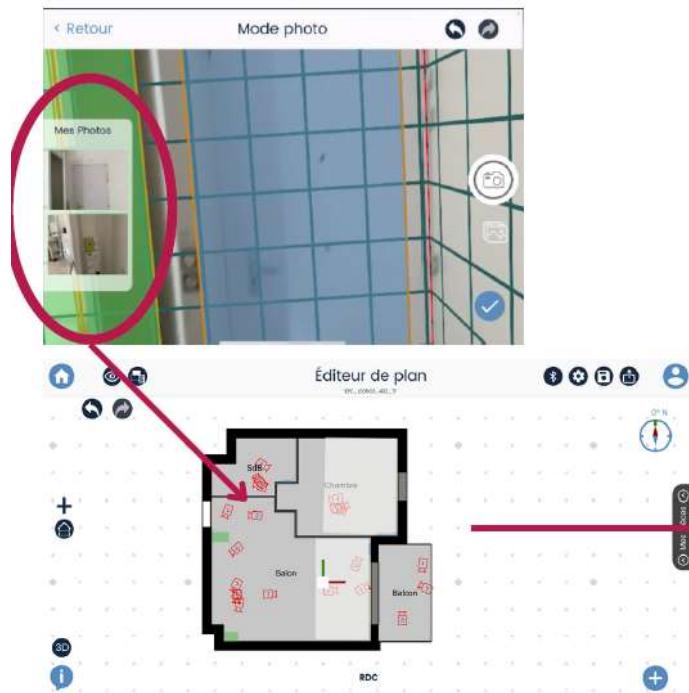
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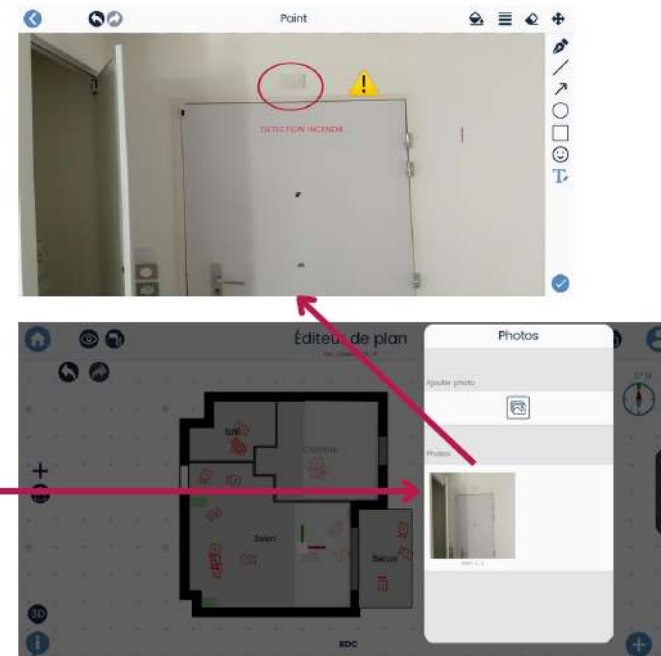
On-site inspection of the building

The BIMEO technology for the digitization of the dwelling

Adding georeferenced photos to the building plan



Annotation of photos



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Specific measurements : thermal characteristics of the envelope

Difficult assessments for EPC assessors :

- Lack of technical documentation dating back to construction or previous renovations
- Visual observations : insufficient to characterize wall materials and thermal bridges
- EPC assessors cannot take samples of wall materials


 Default values in national EPC methods strongly decrease the simulated energy performance



 Reference values based on typical walls and materials



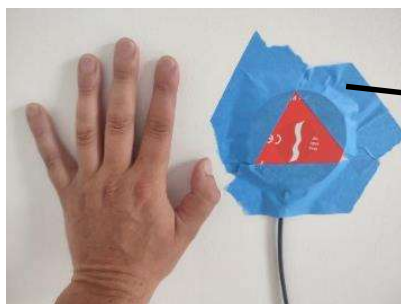
Measuring the performance of the building envelope

 Additional measurements could be used to evaluate infiltration rates and heat losses through walls to get heat transfer coefficients (« U values »)





Thermal characteristics of the envelope : using heat-flux meters



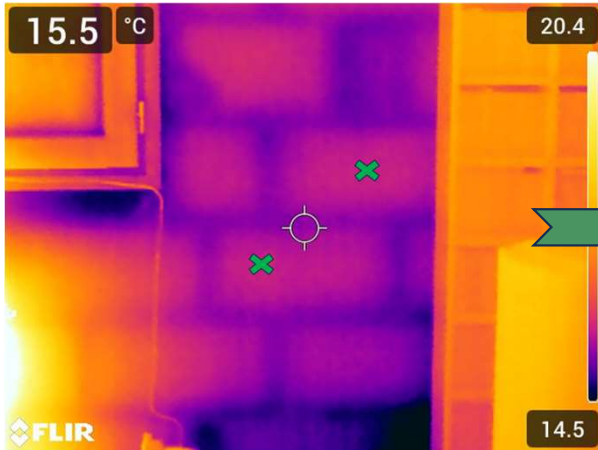
Sampled dwellings in
multifamily building

- Heat-flux meters + sensors to measure indoor and outdoor temperatures
- Analysis based on **ISO 9869**
- Duration of measurements : 7 days with low impact on households
- Temperature difference between outside and inside $> 10^{\circ}\text{C}$
- Use of a thermal camera to position heat-flux meters at the right place





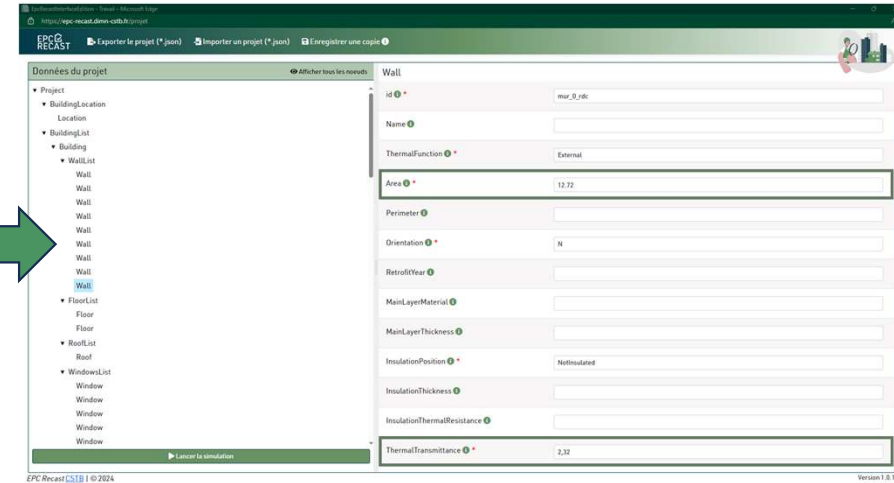
Getting the U-Value of the wall : Example on a pilot house



Thermal Camera Scan



Installed Heat-Flux Meters and remote measurements toolkit

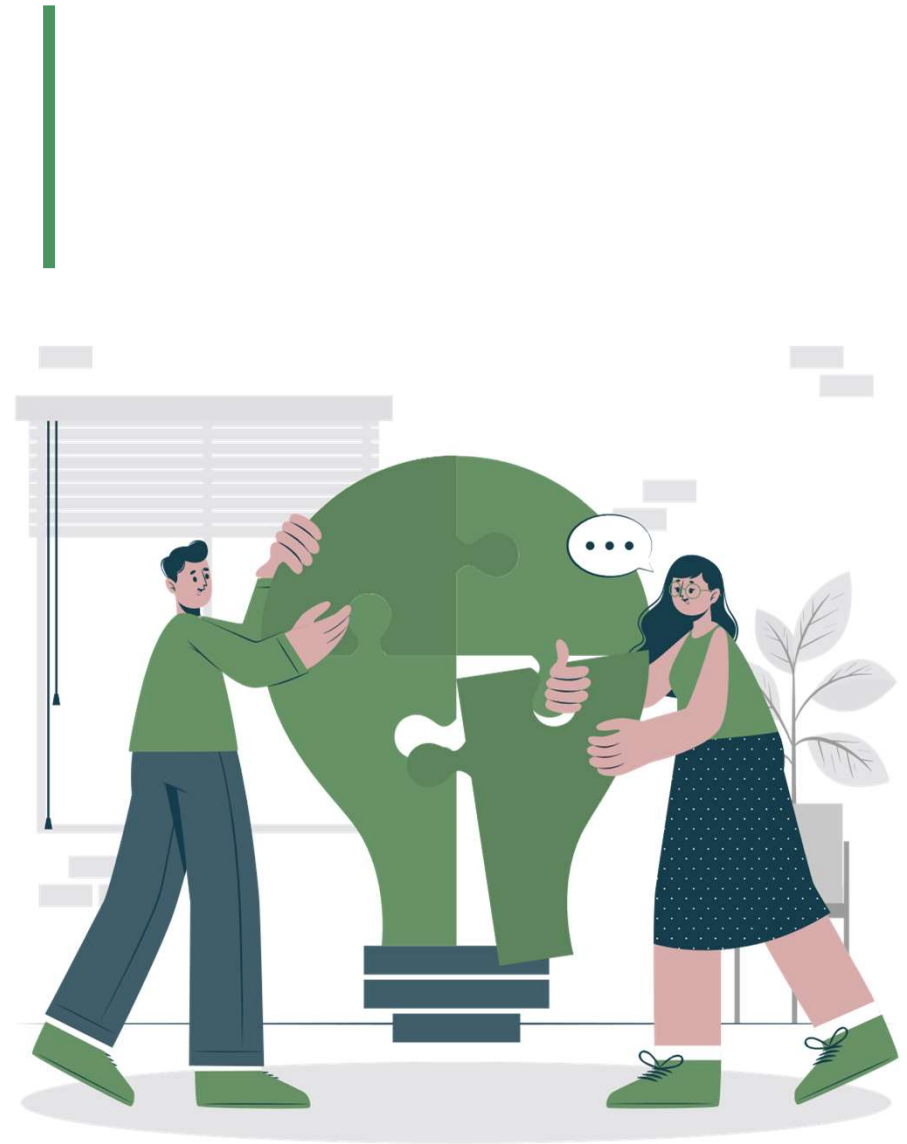


Thermal Transmittance (U-value) in EPC RECAST simulation tool



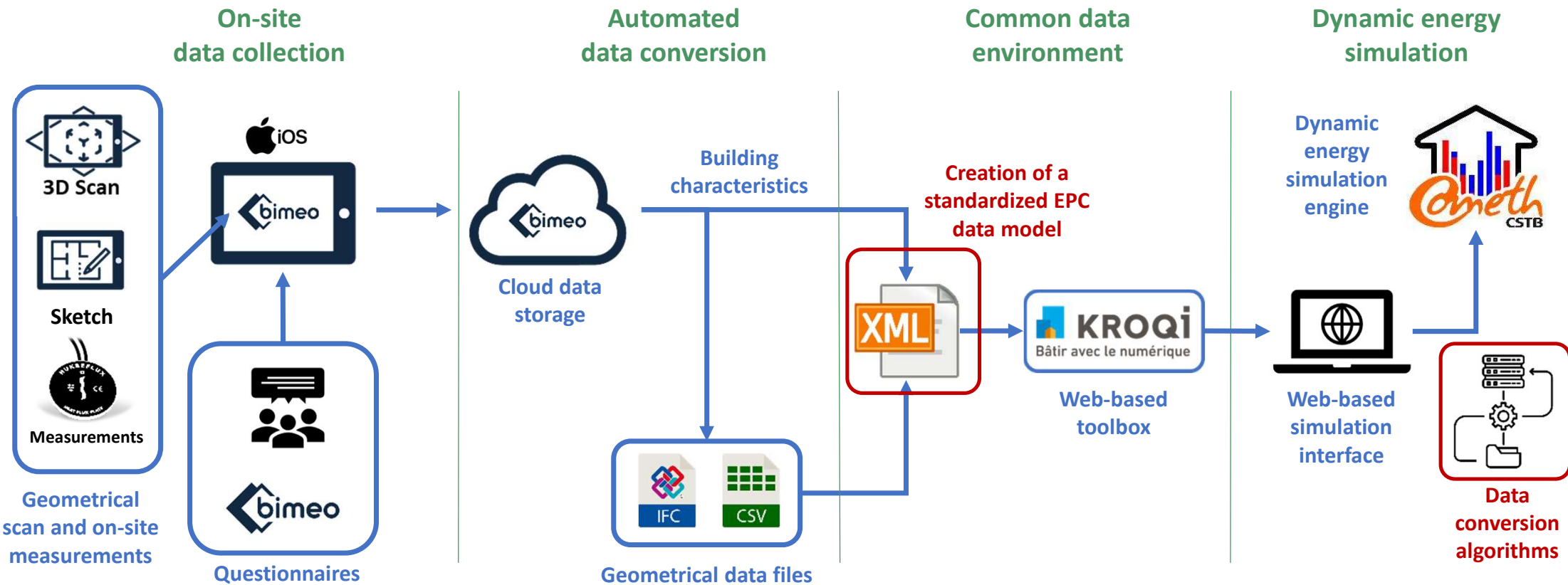
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STEP 2 – Energy performance assessment





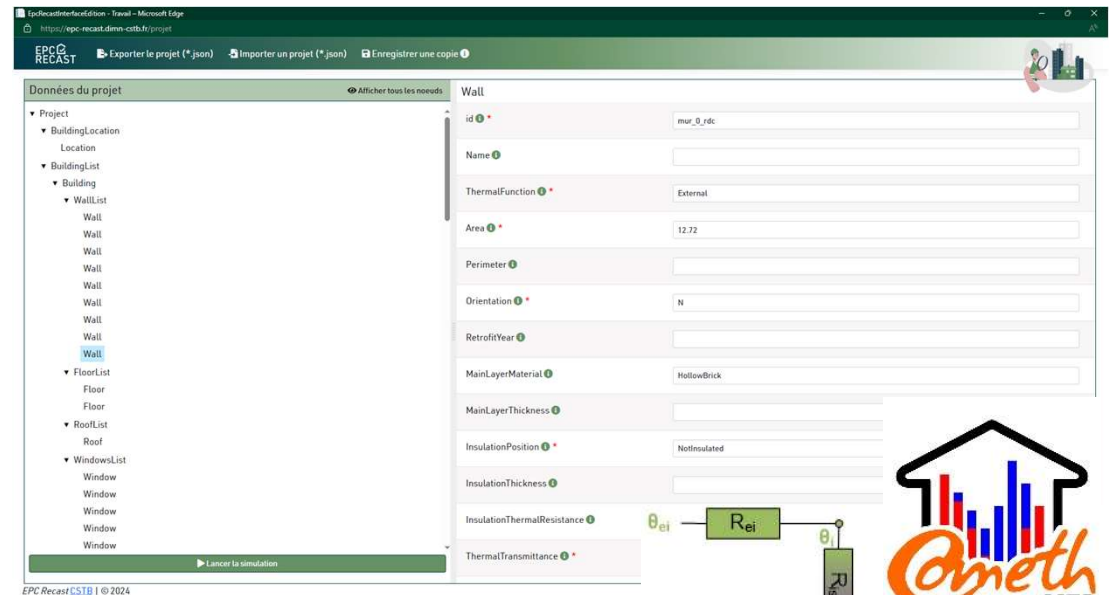
From data collection to dynamic energy simulation



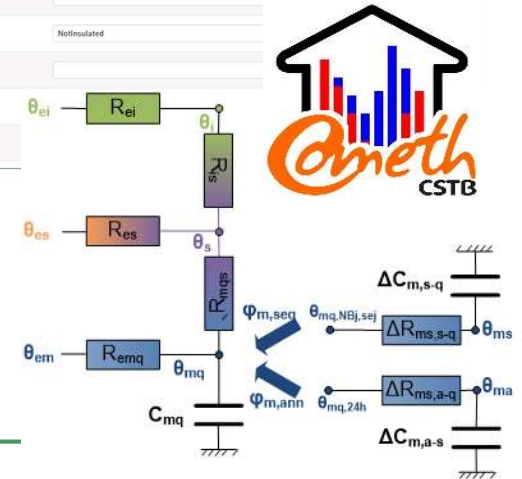


EPC RECAST tool for dynamic energy simulation

- Online interface with simple set of input data
→ *equivalent to datasets in national EPC software (simplified simulations, monthly or annual time steps)*
- Automated connexion with detailed computing core for dynamic EP assessment, hourly time step
- Reads and updates the EPC RECAST XML data model
- ✓ Easy-to-use, quick setup
- ✓ Takes into account thermal inertia of the envelope
- ✓ Allows detailed simulations of HVAC systems from very little information (eg : heat pumps)



Web-based simulation interface



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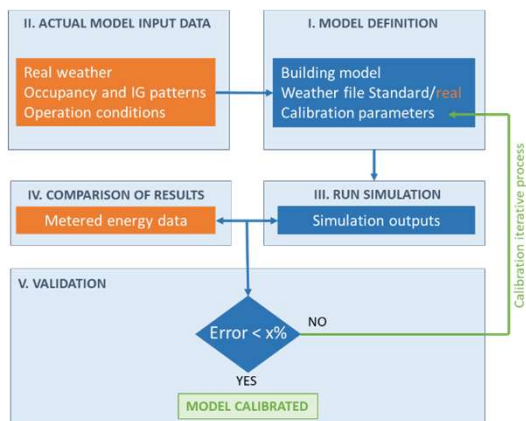


Mitigating the gap between calculated and measured energy

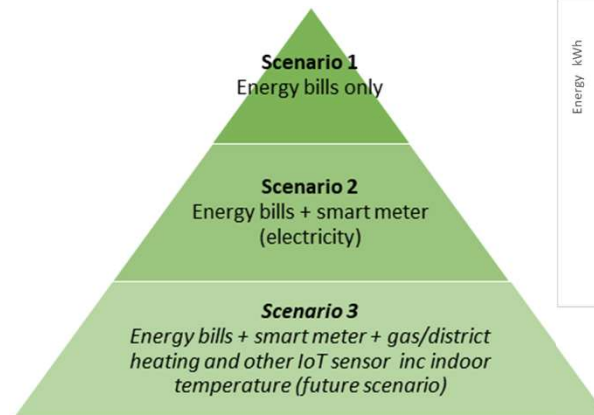
Two approaches have been developed and tested:

1. Calibration procedure

Iterative process for asset rating – actual input data – model definition – run simulation – comparison of results with metered data



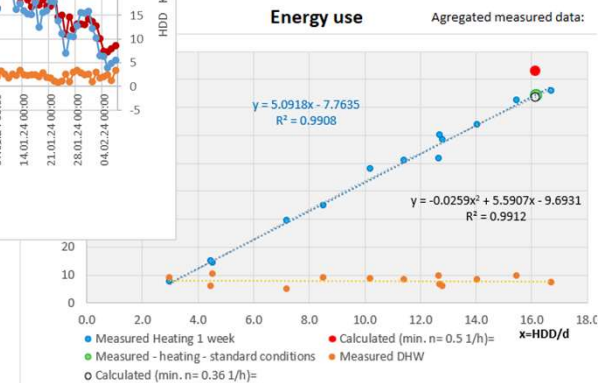
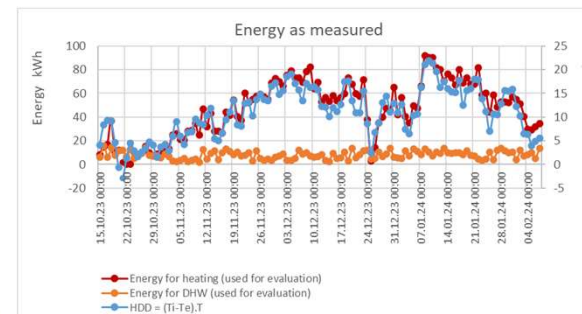
Steps of proposed calibration procedure



The measured data availability.

2. Operational rating for heating and DHW

Normalisation of measured energy to standard conditions
Test on measured data in WP3 (SK pilot buildings),
Link to EN 15378-3:2017





Guided automated calibration of parameters

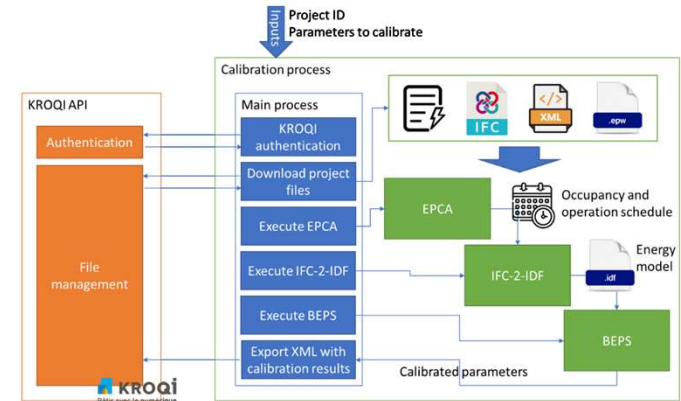
Performance gap between calculated and measured data

- EPC energy models are not reliable enough
→ conclusions are not valid
- Reliable predictions through simulations to evaluate improvement measures and define **best-value renovation roadmap**



Necessary to reduce the performance gap to ensure reliable results

Online toolbox with step-by-step process



Calibration of main uncertain parameters

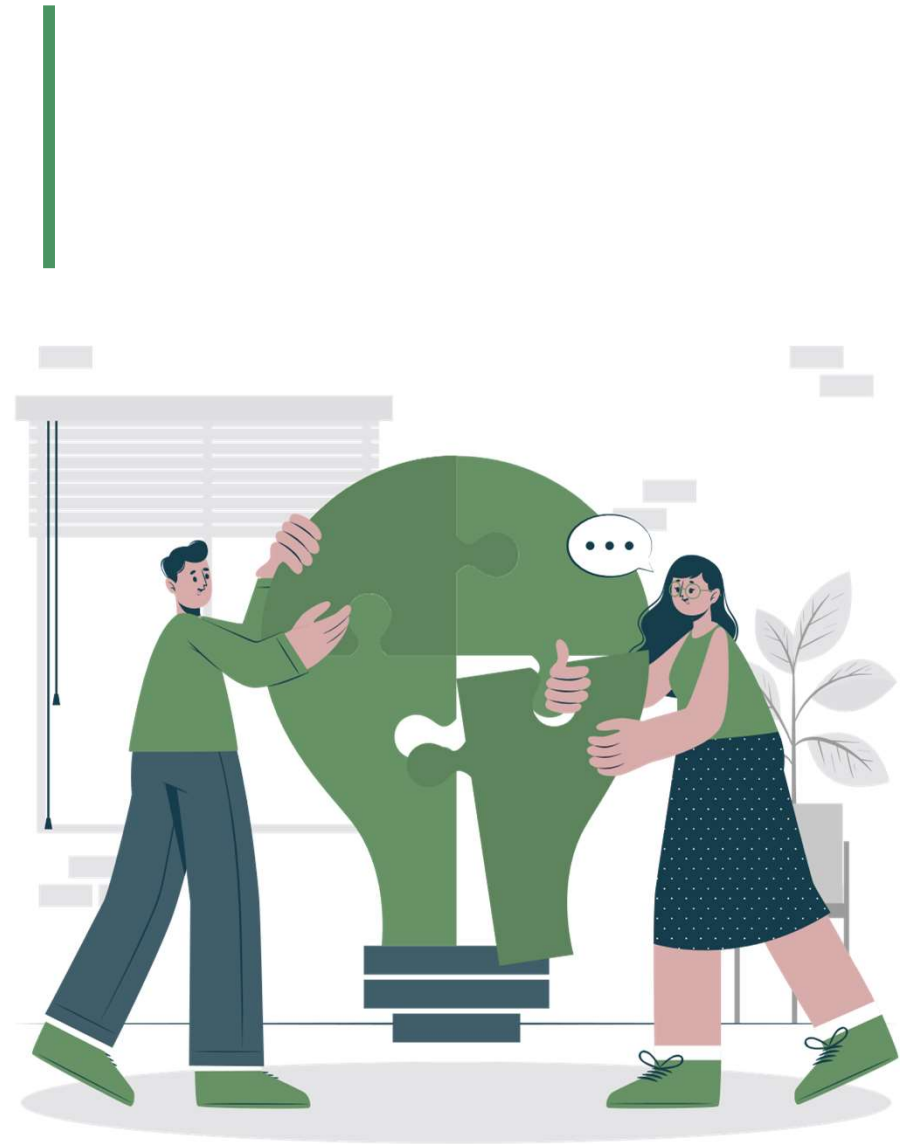


Parameter	Value before	Value after
Walls U-value	0.6	0.75
Windows U-value	4	3.5
Window solar control	0.5	0.65
Infiltration rate	0.5	0.6

Navigation buttons: <<Previous, Next >>



STEP 3 – Certification and Roadmap





Next Gen EPC Template

The 2024 EPBD recast:
IAQ, new performance indicators

New performance indicators :

- Thermal comfort score
- Smart readiness indicator (SRI)
- Metered energy, energy signature, operational rating
- Costs reporting taking into account the **owner-tenant dilemma**.

ENERGY PERFORMANCE CERTIFICATE

Building category: Rodinný dom
Street, No: Lomnická 8
City, Postal Code: Bratislava Devín 841 10
Parcel No: 1174/7
Cadastre: Devín
Climate: Bratislava

Reference floor area (m²): 215.98
Year of construction: 1999
Year of last major renovation: 2023
GPS: 48.17280324277542, 16.988709256417586
Date: 8.3.2024
Validity until: 8.3.2034

Overall rating

with respect of renewable produced	NOW with self-used renewable produced	AFTER RENOVATION with self-used renewable produced	with respect of renewable produced
C	C	C	C
106	106 kWh/(m ² .a)	98 kWh/(m ² .a)	95
22.9	22.9 kWh	21.1	20.4
57%	57% % of Ref	53% % of Ref	52%
106	106 kWh/(m ² .a)	97 kWh/(m ² .a)	92
0	0 kWh/(m ² .a)	1 kWh/(m ² .a)	3
0%	0% % of Ref	2% % of Ref	3%

Total primary energy kWh/(m².a) **ZEB < 65**

D = REF = 186

CO2 emissions

21.1	21.1 kg CO ₂ /(m ² .a)	19.4 kg CO ₂ /(m ² .a)	18.6
21.1%	21.1%	19.4%	18.6%

Global Warming Potential in kg CO₂e/m² for the whole lifecycle (50 years)

Thermal comfort and SRI

Number of hours	Score	(1=best, 4=worst)	Score	Number of hours
4935	2.8	Winter	1.8	4 435
1820	3	Summer	1.5	1 920
2005	2.7	Spring/Fall	1.9	2 405
8760	2.8	Overall thermal comfort score	1.8	8760

SRI - Smart Readiness Indicator

G	30%	SRI - Smart Readiness Indicator	60%	B
----------	------------	--	------------	----------

Building has a capacity to react to external signals and adjust the energy consumption

Overview on energies and costs

Delivered energy kWh/(m ² .a)	NOW	RENOVATED
Gas	94.71	88.26
Grid electricity	0.65	0.07
Light oil		
Ambient heat		
Renewable energy production on-site:		
Photovoltaic:	0	2.648
From heat:	0	0.96
From wind:	0	2.09
Energy use (including renewable)	95.36	88.88
Final energy (from outside)	95.36	88.32
	20.6	19.1

Energy use per service kWh/(m ² .a)	NOW	RENOVATED
Heating	81.9	75.0
Hot water	13.4	13.4
Lighting		
Cooling		
Ventilation		

Yearly energy costs	NOW	RENOVATED
Gas	5.68	5.30
Grid electricity	0.18	0.01
Light oil	0.0	0
Yearly energy costs	5.8	5.3

Investment	NOW	RENOVATED
Global costs	174	319.22

Floor area m² = 215.98

Building envelope and technical systems

Envelope average U-values	REQUIRED	NOW	RENOVATED
Walls	0.22	0.20	0.20
Roof/ceiling to loft	0.15	0.29	0.15
Windows	0.80	0.75	0.75
Ground floor/basement ceiling	0.25	0.38	0.38

Technical systems

System	NOW	RENOVATED
Heating	low efficiency boiler	low efficiency boiler
Cooling/Air-condition		low efficiency boiler
Hot water		low efficiency boiler
Lighting		

Renewable energy production on-site:

System	NOW	RENOVATED
Thermal solar		
Heat pump		
Other		

Energy needs: Heating kWh/(m².a) 120, Cooling kWh/(m².a) 0

Technical details: The heat distribution system inside the building is capable to work at low temperature levels. Sensors for monitoring (installed heating). Number of charging points for car (Storage (Open, slow))

Measured energy consumption

Standard calculated power: Heating, Hot water

Actual measured power: Heating, Hot water

Measurement period: 2020-2021

Average winter external temperature: 1.85 °C

Installed boiler size: 5 kW

Normalised measured energy for heating

Calculated energy use for heating	81.4 kWh/(m ² .a)
Calculated energy use for DHW	13.4 kWh/(m ² .a)
Standard degree-days for calculation	3422 K.day
Real degree-days during measurement	3136 K.day
Normalised measured energy (heating)	73.1 kWh/(m ² .a)
Normalised measured energy (hot water)	13.4 kWh/(m ² .a)
Difference between measured (calculated) result of comparison (measured/calculated)	< 10% compared to calculated

What is the problem?

The difference between calculated and normalised measured energy is due to lower actual air exchange rate during measurement than hygienic minimums. For calculation, the minimum hygienic value used is n=0.3 1/h. The actual air exchange rate calculated from the length of windows gaps and permeability is n=0.36 1/h. With actual air exchange rate the gap between calculated and measured value is only 3%.

What has to be done?

Description - actual building	Recommendation for achievement of NZEB/ZEB
Steny s keramičnou izoláciou Porotherm 38 P1 D s tepelnou izoláciou hr. 100 mm. Sbitná strecha s T1 hr. 140 mm medzi lokami. Masivná obkladná izolácia v trojčlennom.	Prídanie tepelnej izolácie hr. 340 mm do strešnej konštrukcie.
Vyhľadanie prípravy tepelnej izolácie podlahy.	inštalácia fotovoltických panelov.

Digital Building Logbook is available for the building

Building Renovation Passport is available



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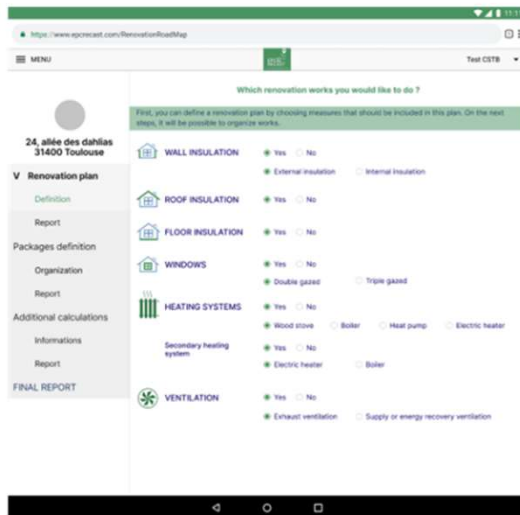
Renovation Roadmap : fast evaluation based on the EPC data



1. Import data from the EPC data model



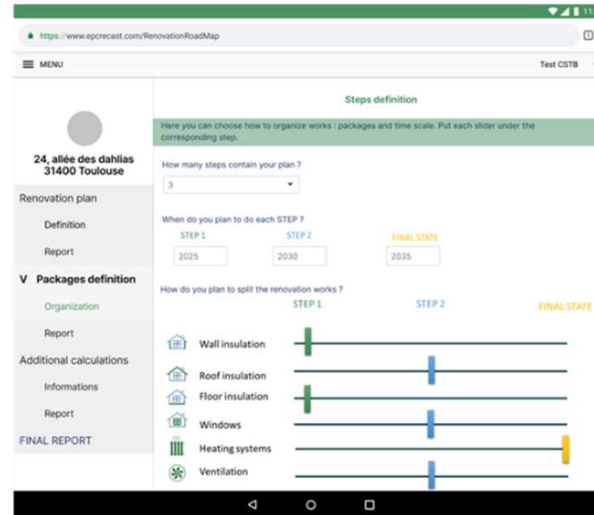
2. Select your renovation works



... get feedbacks and warnings



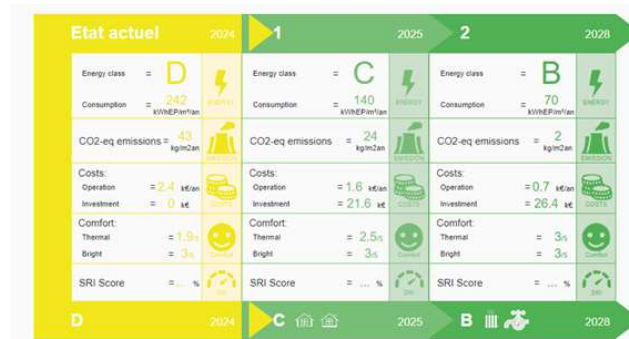
3. Split your works into steps



... and simulation results

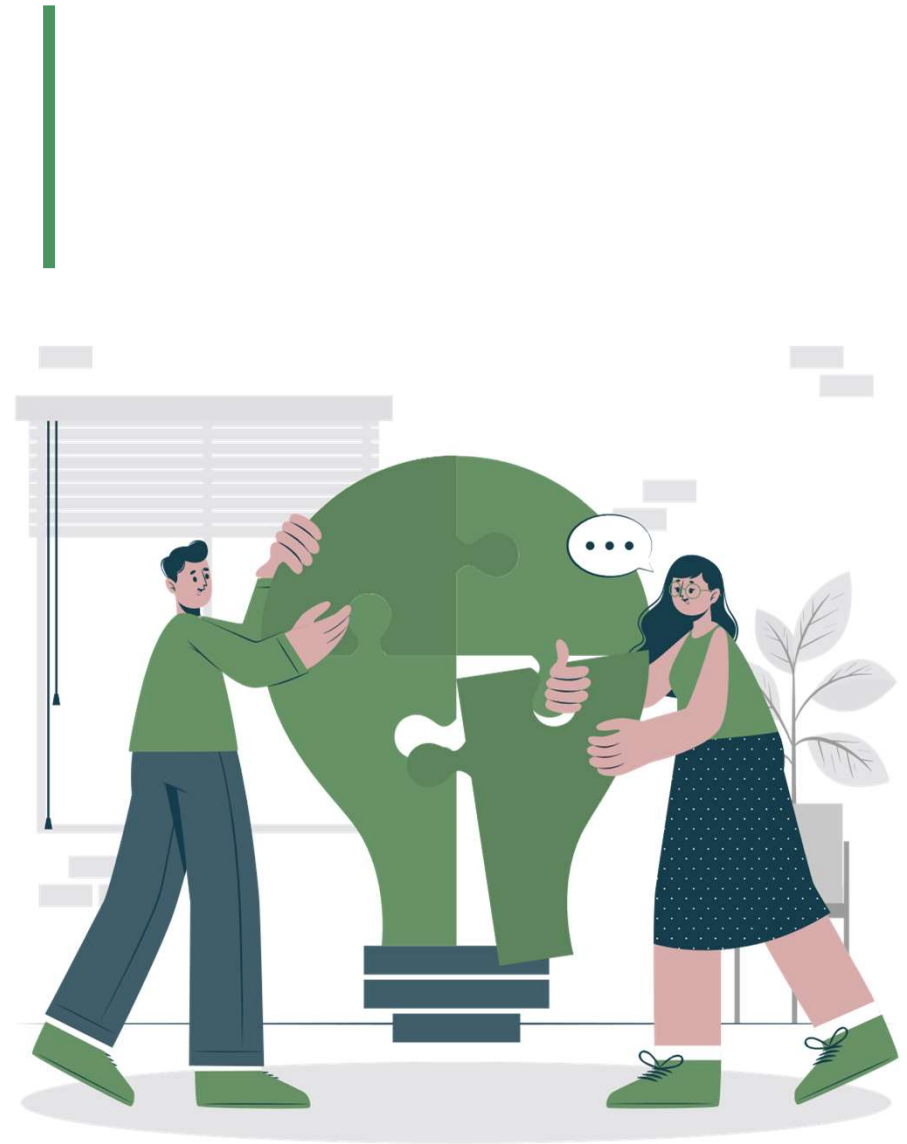


4. Get your final Renovation Roadmap



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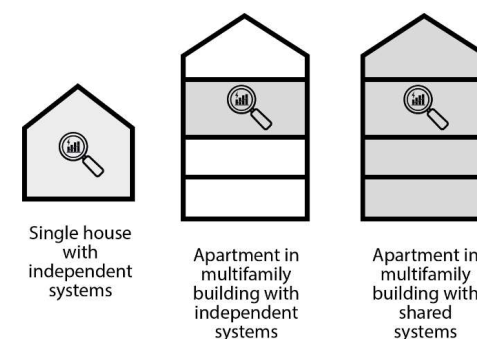
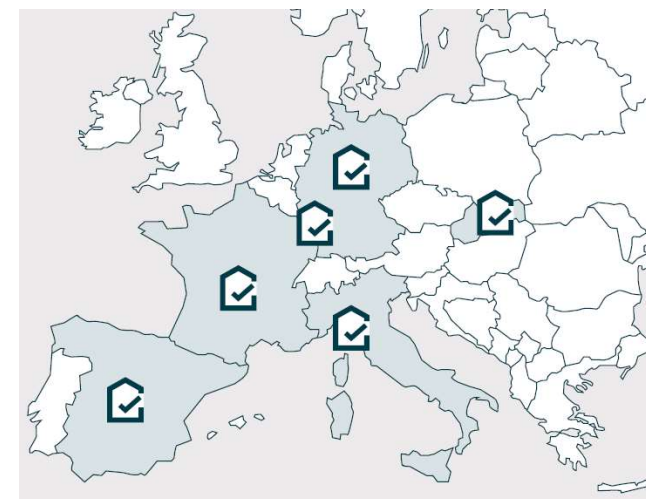
Applying EPC RECAST on pilot buildings





Pilot activities

- The EPC RECAST toolbox and process has been tested on more than **55 pilot sites : 3 multi-family buildings, 40 apartments and 12 single-family houses** spread over the 6 participating countries
- By **sucontracted EPC assessors and project partners** (2022-2024)
- **Next-generation EPCs** are delivered at dwelling or building scale
- **Long-term monitoring** has been implemented in 50% of the pilot dwellings (2021-2023)

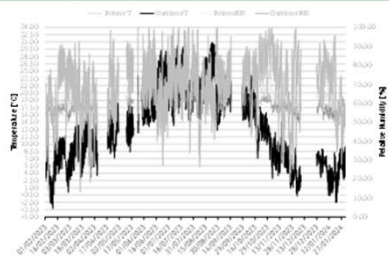


Long Term Monitoring



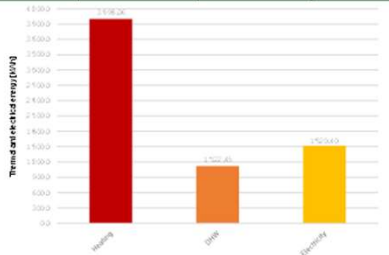
IT07 - INDOOR AND OUTDOOR TEMPERATURE AND HUMIDITY

Data source	Sensors	LTM period
		03/2023 - 01/2024



IT07 - MEASURED ENERGY CONSUMPTION

Data source	Bills	LTM period
		01/2022 - 12/2022



Standard EPC

ATTESTATO DI PRESTAZIONE ENERGETICA DEGLI EDIFICI
CODICE IDENTIFICATIVO: VALIDO FINO AL:

DATI GENERALI

Destinazione d'uso
 Residenziale
 Non residenziale

Oggetto dell'attestato
 Intero edificio
 Unità immobiliare
 Gruppo di unità immobiliari

Nuova costruzione
 Passaggio di proprietà
 Locazione
 Ristrutturazione importante
 Riqualificazione energetica
 Altro: APE volontario

Classificazione D.P.R. 412/93: **E.1 (1)**
 Numero di unità immobiliari di cui è composto l'edificio: **3**

Dati identificativi

Regione: Lombardia
 Comune: ZONE
 Indirizzo: Via Panoramica 27
 Piano:
 Interno:
 Coordinate GIS:

Zona climatica: F
 Anno di costruzione: 1946-1960
 Superficie utile riscaldata (m²): 101,29
 Superficie utile raffrescata (m²): 0,00
 Volume lordo riscaldato (m³): 374,51
 Volume lordo raffrescato (m³): 0,00

Comune catastale	Subalterni	da	7	7	da	a	7	7	da	a	9	9	da	a	2683
Altri subalterni															

Servizi energetici presenti

Climatizzazione invernale
 Climatizzazione estiva

Ventilazione meccanica
 Prod. acqua calda sanitaria

Illuminazione
 Trasporto di persone o cose

PRESTAZIONE ENERGETICA GLOBALE E DEL FABBRICATO

La sezione riporta l'indice di prestazione energetica globale non rinnovabile in funzione del fabbricato e dei servizi energetici presenti, nonché la prestazione energetica del fabbricato, al netto del rendimento degli impianti presenti.

Prestazione energetica del fabbricato

INVERNO	ESTATE
 101,29 kWh/m ² anno	 101,29 kWh/m ² anno

Prestazione energetica globale

EDIFICIO A ENERGIA QUASI ZERO
CLASSE ENERGETICA F
EP_{gl,nren} 239,64 kWh/m²anno

Riferimenti
 Gli immobili simili avrebbero in media la seguente classificazione:

Se nuovi:

 (0,01.659)

Se esistenti:

EPC Recast EPC

CERTIFICATO DI PRESTAZIONE ENERGETICA

Tipologia di edificio:	Apartment house	Superficie utile (m ²):	84
Via, N°:	Putnicka 18	Anno di costruzione:	2004
Città, CAP:	Bratislava	Anno di riqualificazione:	2013
Particella No:	1234	GPS:	48.24255606335, 17.043401669839
Comune catastale:	Zahorska Bystrica	Data:	17/09/2022
Clima:	Bratislava	Valido fino al:	17/09/2022

Prestazione energetica globale

ATTUALE		DOPO RIQUALIFICAZIONE	
con esportazione da fonti rinnovabili		solo autoconsumo da fonti rinnovabili	
E	E	A	A
192	192 kWh/(m ² ·a)	54	36
16.1	16.1 MWh	4.5	3.0
103%	% of Ref	29%	19%
189	189 kWh/(m ² ·a)	46	18
0	0	4	16
0%	0%	17%	67%

ZEB < 65

D = REF = 186

Energia primaria non rinnovabile kWh/(m²·a)

Produzione di energia rinnovabile kWh/(m²·a)

Energia rinnovabile in % del consumo

Emissioni di CO2

37.1	37.1	kg CO ₂ /(m ² ·a)	ZEB (A0) = 10	kg CO ₂ /(m ² ·a)	8.4	3.4
371%	371%			84%		34%

Potenziale di riciclaggio globale in kg CO₂/m² per l'intero ciclo di vita (50 anni)

Comfort termico e SRI

Numero di ore	Punteggio	(1-migliore, 4-peggior)	Punteggio	Numero di ore
4935	2.8	Inverno	1.8	4435
1920	3	Estate	1.5	1920
2005	2.7	Primavera/Autunno	1.9	2405
8760	2.8	Punteggio totale di comfort termico	1.8	8760

SRI - Smart Readiness Indicator

L'edificio è in grado di reagire agli stimoli esterni e di adattare il consumo energetico

G	30%	60%	B
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Panoramica di energia e costi

Energia distribuita kWh/(m ² ·a)	ATTUALE	RIQUALIFICATO
Gas naturale	140	20
Elettricità da rete	15	4
Oilio combustibile	0	0
Calore ambientale	0	0
Produzione di energia rinnovabile in-situ:		
Solare fotovoltaico	0	16 kWh/(m ² ·a)
di cui FV autoconsumo	0	4
FV esportata	0	12
Energia utilizzata (include rinnovabili)	155	24 kWh/(m ² ·a)
Energia finale (dalla rete)	155	20 kWh/(m ² ·a)
	13.0	1.7 MWh/a

Energia utilizzata per servizio

ATTUALE		RIQUALIFICATO	
Riscaldamento	127	18	
ACS	13	7	
Illuminazione			
Raffrescamento			
Ventilazione			

Costo annuale dell'energia €/a

Investimento	0	160 €/m ²
Costi globali	390	232 €/m ²

Superficie utile m² = 84

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Examples of pilot results (Italy)



Energy use	Long-Term Monitoring primary energy [kWh/m ² y]	KROQI simulation primary energy [kWh/m ² y]	Standard EPC primary energy [kWh/m ² y]	Variation between KROQI simulation and Standard EPC (Standard EPC as baseline)
Total	427.06	396.17	344.64	+ 15%
Heating	393.15	310.28	316.86	- 2%
Cooling	-	55.38	1.16	-
DHW	33.91	27.20	26.62	+ 2%

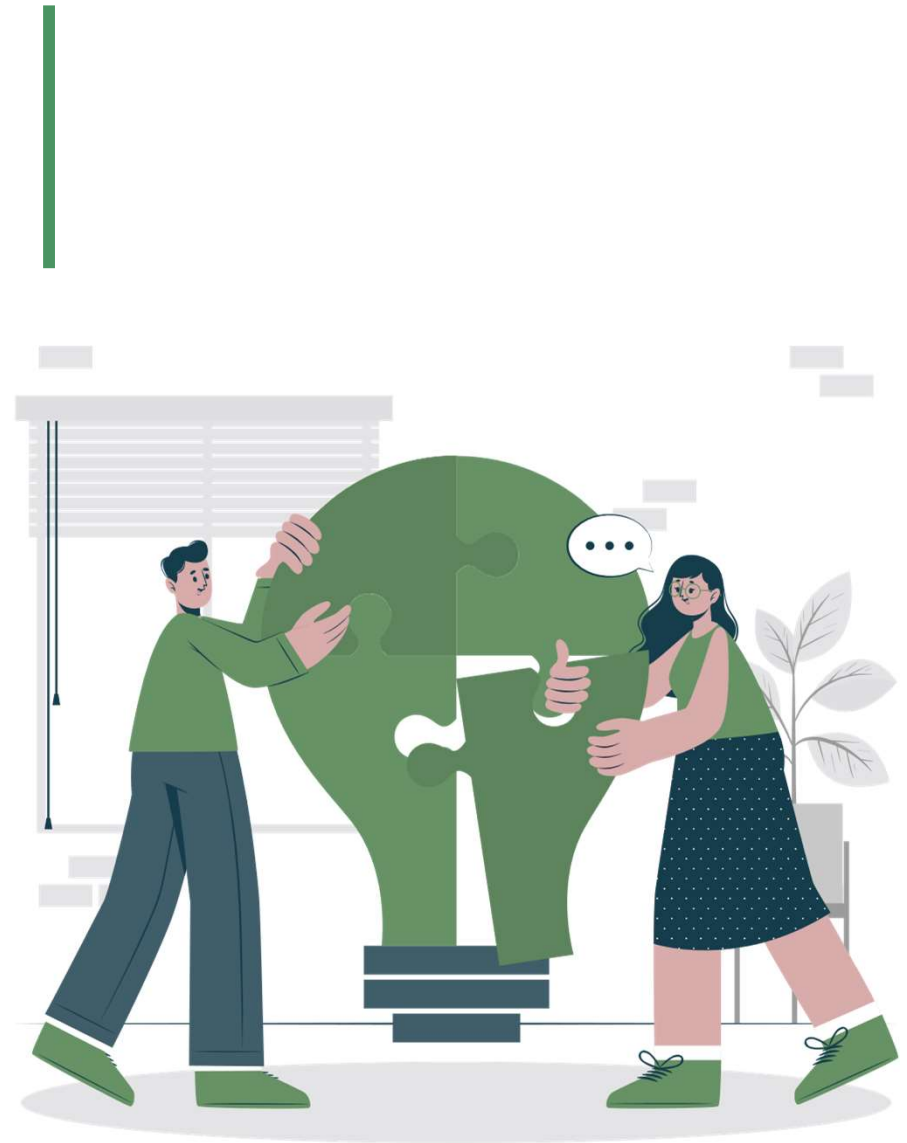


Energy use	Long-Term Monitoring primary energy [kWh/m ² y]	KROQI simulation primary energy [kWh/m ² y]	Standard EPC primary energy [kWh/m ² y]	Variation between KROQI simulation and Standard EPC (Standard EPC as baseline)
Total	142.61	252.26	315.75	- 20%
Heating	124.17	229.01	298.00	- 23%
Cooling	-	-	-	-
DHW	18.44	19.74	17.75	+ 11%



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Key Conclusions





EPC RECAST proves that:

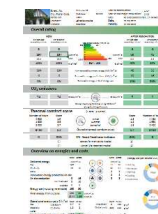
✓ **Integrated workflows to improve the daily work of EPC assessors** are already feasible:

- ✓ a **common data model** of the building
- ✓ a set of digital services and measurement protocols



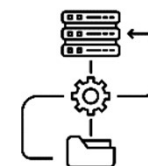
✓ **Reporting tools** from the EPBD can be made **interoperable** and delivered jointly:

- ✓ improved EPCs, simplified Renovation Roadmaps, automated simulation reports
- ✓ based on a **common data model** of the building

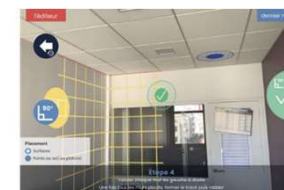


✓ Detailed hourly simulations can be made accessible to assessors :

- ✓ **without** requesting the evaluation of **more parameters**
- ✓ through **data conversion algorithms**



✓ Innovative digital tools can already **facilitate on-site visits and data collection**



✓ Implementation on national markets : **IT development strategies** and **data standardization** are now needed



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R

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E

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A

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S

STANDARDS & SMART-READINESS

T

TRANSPARENCY

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CERTIFICATE RECAST