X-tendo

CONCRETE IMPLEMENTATION OF NEW ENERGY PERFORMANCE CERTIFICATES FEATURES: TESTINGS AND RESULTS IN NINE COUNTRIES- EPC DATABASES

MARCH 2022

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 845958.

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Project Acronym	X-tendo
Project Name	eXTENDing the energy performance assessment and certification schemes via a mOdular approach
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Project Duration	2019 - 2022
Website	www-x-tendo.eu

Deliverable No.	D5.2
Dissemination Level	Public
Work Package	WP5- Testing and implementation guidelines
Lead beneficiary	e-think energy research
Contributing beneficiary(ies)	TU Wien, VITO, BPIE, ADENE, CRES, TREA, AAECR, DEA, EASt, NAPE, ENEA
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Date	15.3.2022
File Name	X-tendo_Deliverable 5.2

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LIST OF ABBREVIATIONS

ADENE	Portuguese Energy Agency, Department of Buildings
AAECR	Romanian Association of Energy Auditors for Buildings
CDD	Cooling Degree Days
CRES	Centre for Renewable Energy Sources and Saving
DEA	Danish Energy Agency
DH	District Heating
EASt	Energy Agency of Styria
ENEA	Italian National Agency for New Technologies, Energy and Sustainable Economic Development
EST	Energy Saving Trust
HDD	Heating Degree Days
IEQ	Indoor environmental quality
MFH	Multi-family house
NAPE	National Energy Conservation Agency
SFH	Single family house
TREA	Tartu Regional Energy Agency

1 INTRODUCTION

The focus of the Horizon 2020 project X-tendo is the further development of energy performance certificate (EPCs) schemes in EU Member States. This should be done in two dimensions: on the one hand additional indicators are developed that add further relevance to EPCs. On the other hand, EPC handling should be improved to make it easier, more reliable and interconnected with other building related data. 5 features in each of the two dimensions are elaborated throughout the project. This includes the analysis of the theoretical background, the development of materials and methods, the testing of the features in concrete implementation projects, as well as the dissemination on developed ideas and materials.

The goal of the testing of the developed feature materials is to understand the practical viability and the challenges in the practical implementation of the developed ideas and materials in selected countries of the EU. Depending on the feature different types of tests and test projects have been performed. In-building tests apply the feature materials on concrete buildings, user tests consist of understanding the user perception related to the developed materials and ideas, system tests intend to understand the application of feature ideas and materials in related systems like EPC database systems.

The overall approach of testing and further developing feature materials is shown in Figure 1 and consists of the following steps:

- In the first phase of the project the feature leads (FL) developed beta versions of feature materials, hereby taking into account needs and feedback from Implementing Partners (IPs). An overview of FLs and involved IPs per feature can be seen in Table 1. These materials consist of different parts depending on the feature. In most cases these consist of guidelines, spreadsheets or program code in defined languages like sql or python.
- The beta versions of the feature materials have then been provided to the IPs to test their application in their national / regional settings. The IPs have performed different types of tests with or in the context of the developed materials. In some cases, especially for in-building tests of certain features, the tests also involved EPC assessors.
- After finishing the test projects, the IPs reported about their testing results in two different ways: on the one hand they filled previously developed questionnaires (see the annex for exemplary questionnaires). On the other hand, they wrote test result reports providing more details about the context and results of the test projects.
- The filled-out questionnaires as well as the testing results reports have been used as a basis to derive conclusions for the final reshape of the feature materials. They also serve as an input to guiding the implementation of the features in the different countries / regions.

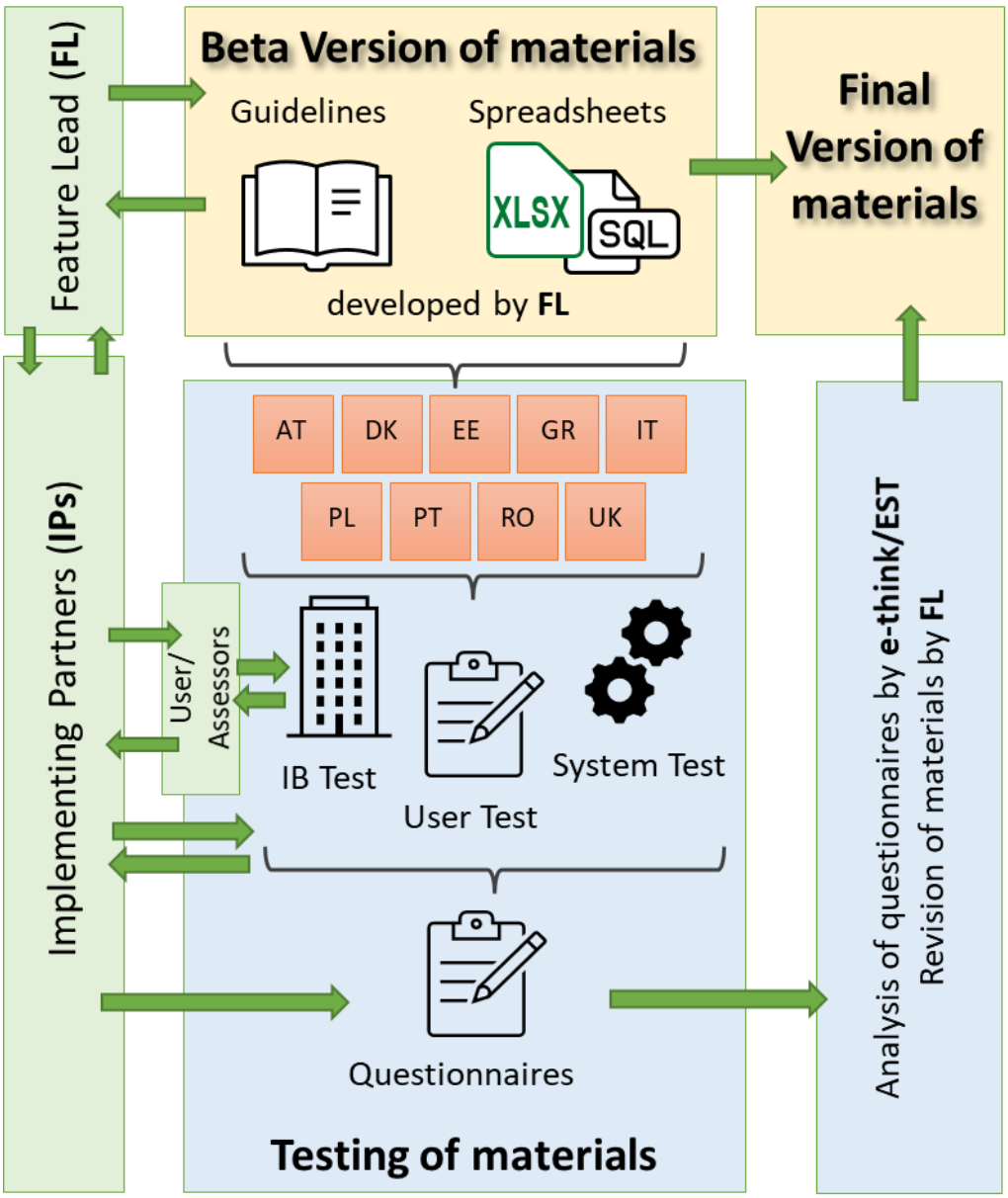

Figure 1: Approach for testing feature materials in the X-tendo project

The following Table 1 gives an overview of the types of tests that have been performed for the different features in the different implementing countries. More details of the characteristics of each test project are described in the feature chapters.

Table 1 – Overview of testing activities by feature and implementing country / partner

		1. Smart readiness	2. Comfort	3. Outdoor air pollution	4. Real energy consumption	5. District energy	6. EPC database	7. Building logbook	8. Enhanced recommendations	9. Financing options	10. One stop shops
		Feature lead partner									
Country	Implementing Partners	VITO	BPIE	NAPE	VITO	e-think	TU Wien	BPIE	TU Wien	ADENE	ADENE
AT	EASt	IB	IB		IB				Expert		
DK	DEA					Expert	S		IB	U/S	U/S*
EE	TREA	IB Expert			IB			U/S			
GR	CRES	IB Expert	IB Expert				S	U/S			
IT	ENEA				IB	IB	S				
PL	NAPE			IB U Expert		IB			IB S	Expert	
PT	ADENE		IB					U/S Expert		U/S	U/S* Expert
RO	AAECR	IB	IB		IB Expert	IB				U/S	U/S*
UK	EST				**		Expert		IB		S
	No of partners testing	4	4	1	4	3	3	3	3	3	1 stand-alone test*

*Feature 10 tests in DK/PT/RO are delivered alongside testing of feature 9 **Note UK test under feature 10 also relevant here

This report provides the summary of the outcomes of the testing activities for each of the 10 features in one or several implementing countries. This is mainly based on the analysis of the evaluation questionnaires filled out by the implementing partners, but also on the content of the testing results reports where these have already been available at the time of writing the document. The questionnaires hereby consist of general questions along the testing steps, questions on testing time and related costs, an evaluation against defined cross-cutting criteria (Quality and Reliability, User-friendliness, Economic feasibility, and Consistency with ISO/CEN standards) and final thoughts. The questionnaires slightly differ for the different types of test projects (in-building, system, user tests) and for the different features (composition of detailed questions for the cross-cutting criteria). Exemplary evaluation questionnaires for each of the three types of test projects can be found in the Annex of this report.

With this the report should provide a summary of the outcomes of the testing activities on the different features in the different countries, provide conclusions for further development of the developed ideas and materials towards the end of the project and beyond, explain the practicability and challenges in the implementation of the features in practice, and give guidance for organising similar test projects in the future.

The report first provides an introduction to the topic of the feature, the developed methodologies and materials and the performed testing activities. This is followed by the description of the testing results structured by the types of test projects. This includes a description of overall results, estimated time and costs and the different cross-cutting criteria. Finally, conclusions out of the testing activities are presented.

2 FEATURE 6: EPC DATABASE

2.1 Introduction

Energy performance certificate (EPC) databases store all EPCs and underlying data in many EU countries. They are an important tool for public authorities to source building stock information and check compliance with the national assessment methodology. Improving EPC databases includes how to set them up, how to gather the data, how to establish the interoperability of different databases, and how to use data and extract relevant insights. Finally, quality assurance processes and data verification are key to ensure the reliability and accuracy of the information stored in the database.

Because quality assurance of the EPC databases can contribute significantly to improving trust in EPCs, the X-tendo project has developed a methodology for implementing quality assurance routines.

More information about the feature can be found in the introductory report or on the X-tendo website.

F6 was tested in Denmark (DEA), Greece (CRES) and Italy (ENEA).

All the tests were system tests.

Table 2 – Description of F6 tests – EPC databases

Denmark (DEA)			Greece (CRES)			Italy (ENEA)		
System test name	System test type	Description	System test name	System test type	Description	System test name	System test type	Description
F6.ST.01.DK Outcome from Risk-Based control in Denmark.	Analysis/ recommendations	An analysis of the outcome from the risk-based control performed in Denmark. The analysis will focus on the outcomes from a learning perspective. This will then result in action recommendations regarding learning material or new validations on input parameters.	F6.ST.01 Outliers identification	Software code test	Software 'runs' on the database to identify outliers, i.e. EPC input data points or EPC key result points that differ significantly from the bulk of the EPCs stored in the database	F6.ST.IT01 Riskiness identification	Software code test	Software code "run" on the database to assign to each EPC a riskiness evaluation, identifying possible missing data and/or a significant difference from the bulk of the EPCs stored in the database

2.2 Results of the testing activities

Overall results of system tests

System tests summary

Greece (CRES)

Greece ran software on the EPC database to identify outliers, i.e. EPC input data points or EPC key result points, that differed significantly from the bulk of the EPCs stored in the database.

Denmark (DEA)

The Danish control of EPC's is based on a risk-based approach combined with validations on the input parameters, which corresponds to the developed methodology from the project. Therefore, the test was an analysis of the results from the risk-based control in Denmark in 2019. As far as possible, the analysis was designed to learn from the control, provided by a user feedback-loop, so the new knowledge could be implemented in educational programs for EPC consultants or in the development of new validations of input parameters.

Italy (ENEA)

For the EPC database, developed and operated by ENEA in a "test environment", ENEA tested a software code, developed by TUWIEN specifically for the Italian EPC database.

All implementing partners (IPs) reported that overall, it was somewhat difficult to implement the feature.

All IPs stated that they were able to implement all of the key changes they had planned to make to the existing 'back-end' EPC systems, in order to enable the feature.

Challenges encountered

Greece (CRES)

Defining building clusters that: (i) contain enough buildings to give statistically significant results and (ii) have a detailed enough definition for the buildings in each cluster to be similar from an energy performance point of view.

Denmark (DEA)

Denmark had already implemented a risk-based control scheme which means that the digitization strategy was already at a state which meant that it did not make sense to implement database quality checks in the project. Therefore, a new scope for testing in Denmark was to test the feedback loop and provide lessons learned from the risk-based control in Denmark.

Italy (ENEA)

The major challenge is the duration of the execution time of the code. Due to the long code execution time, it is only viable to run the code on the whole database very few times in a year.

Main advantages of the feature

Greece (CRES)

Providing the user (building owner, energy expert, EPC assessor) with information comparing the building to similar buildings could be useful for data quality control and preventing mistakes, as well as informing the building owner about the performance of specific building components.

Denmark (DEA)

Digitization of control has great potential, making it possible to identify potentially faulty EPCs for investigation and improvement. This method reduces time wasted in manually checking correct EPCs. It also has the potential to indicate the worst mistakes in an EPC, meaning that the faults with the greatest impact can be reduced or even eliminated entirely.

Italy (ENEA)

The main advantages of the testing were to identify errors and inconsistencies in the DB data. To assign two risk identifiers to each EPC: one identifying possible missing data, the latter identifying possible significant differences from the bulk of the EPCs stored in the database.

The major areas of monetary cost in implementing the new feature

Greece (CRES)

Moderate cost of developing the database analysis software.

Denmark (DEA)

First, it is important to have a working database, where data is organised into tables, so that a data extraction is possible. Then it is important to have a combination of two skills: EPC knowledge and Data Statistics knowledge. A database can have many other benefits, so if there is already a working database, the monetary benefits will outweigh the costs.

What can be done to minimise the monetary cost in each area?

Denmark (DEA)

The greatest monetary cost is the establishment of a full functioning database.

Implementing the risk-based control scheme and validations on input parameters was not a high cost in Denmark since there was no need for external expertise.

Cross cutting criteria

Quality and reliability

Both CRES and ENEA stated that the calculation methods were clearly described (ENEA stated that 'The theoretical method has been agreed upon and is well described. A clear readme file has been provided.') and that the required input data was asked clearly (ENEA stated that 'A clear readme file has been provided in which the inputs are clearly explained.').

CRES stated that the results were shown transparently. However, ENEA responded 'Partly', stating 'The results are written to two DB tables. Some of the information in those tables is very verbose and difficult to read.'.

CRES and ENEA responded positively that the user has access to formulas/application interface (CRES: 'Not needed. Fairly simple (from an analysis point of view) calculations.', and ENEA: 'The user can choose the type of control to be performed and on which EPCs to perform the control.').

ENEA responded positively that the user has access to weightings for the calculation of final results ('Thresholds and percentile values have been defined by the implementing partner. The code is fully available and editable.'), and CRES stated that this wasn't required ('Not needed.').

Both CRES and ENEA responded not applicable to the question 'Are the specific requirements to carry out the assessment outlined for assessors?', with CRES stating, 'Not needed. The results are fairly straightforward to understand and use.'.

Both CRES and ENEA responded that no training of experts/assessors was needed for the feature, with ENEA stating, 'IT technicians possess the skills to use the code.'.

All of the IPs responded 'NA' to the question 'Are the qualification requirements clearly outlined for experts/assessors?).

User-friendliness

CRES and DEA responded 'NA' to the question 'Is the stepwise description for feature assessment provided?', but ENEA responded 'Yes' ('A clear readme file has been provided.').

CRES responded 'Partly' to the question 'Are reporting templates used?', stating that 'Some modifications might be needed.', while ENEA responded 'No', that 'The results are written to two DB tables.'.

There is a discrepancy between CRES and ENEA's responses to the question 'Is the calculation/process description provided in guidelines?', with CRES responding 'Yes', but ENEA responding 'No', and stating 'No guidelines have been written.'.

When asked 'Does the tool have stepwise description of the assessment?', both CRES and DEA responded 'NA', and ENEA responded 'No', stating 'The assessment has been performed based on the tool results, but no description of this process is present in the tool.'.

Economic feasibility

Both CRES and ENEA responded that no additional infrastructure was required for implementation, with ENEA stating, 'At the moment no additional infrastructure is foreseen.'.

CRES and ENEA both thought that high skills e.g. IT and programming knowledge, are required to implement and handle the feature.

Consistency with ISO/CEN standards

CRES and ENEA both responded that no national regulations were used in the methodology of this feature, with ENEA responding, 'No specific national regulation exists at the moment for EPC data consistency methods.'.

All IPs responded that the data used for the feature is already covered by their current EPCs, with ENEA stating, 'The data checked by the feature is already part of the current EPC.'.

2.3 Conclusions and discussion

Greece (CRES)

The main barrier was in identifying sufficient numbers of suitable buildings for testing. Suggestions for improvement include: 'Harmonization of the EPC input and output data across Europe would be very useful to get comparable results.' And also 'Compatibility of the selected data (Product Data Exchange) format with building related software (CAD, CAE, BIM) is very important.'.

Denmark (DEA)

No barriers were identified. Suggestions for improvements include 'More inputs on the input parameters. Instead of checking the EPC's after it is received in the database it should be checked way before, so that EPC's that are faulty with certainty should not be allowed in the database. That will also save resources within the quality check of the EPC.'.

Italy (ENEA)

The main limitation encountered is related to the high execution time of the code when processing each EPC record. Long processing times were apparent when running very large datasets, with ENEA stating that it would be possible 'to run the code on the whole database only very few times in a year.'. A possible suggestion is to use a programming language "faster" than Python.

ENEA suggested that a possible feature improvement would be the implementation of the threshold and percentile values calculation in the code.

Full responses from participating IPs can be found in the D5.2 collated responses template.xlsx.

3 ANNEX

3.1 Questionnaires

Table 3: Exemplary questionnaire for in-building tests

General questions and testing steps		
	Provide a short summary of the test you are carrying out. Please describe in your words.	
	Overall, how easy or difficult was the feature to implement? Please select an option.	
	How easy or difficult was it to explain the feature to the assessor and/or other stakeholders involved in delivering the test? Please select an option.	
	List all of the planned steps for implementing the feature. Please list performed tasks in each step	
	Were you able to perform each step? Please select an option for each step	
	[Only answer this question for options you selected "No" or "In part" in previous question] Why were you not able to perform or complete these steps? Please describe in your words.	
	[Only answer this question if you were able to perform the step and you faced any challenges] Did you face any challenges in steps that you were able to complete (for those you answered "Yes")? Please describe in your words.	
	Overall, how feasible is it to include the feature as part of a standard EPC assessment? Please select an option.	
	Explain your answer to the above question. Please describe in your words.	
Testing time & costs		
	How much time (in minutes) did it take to perform each step	
	What are the approximate costs incurred in each step? Please specify the positions as well as an approximate estimate. (Costs per EPC)	
Cross Cutting Criteria		
	Quality and Reliability	
		Are the calculation methods clearly described?
		Is the required input data clearly asked?
		Is the user provided fundamental technical knowledge needed to understand the details of the feature?
		Is training of experts/assessors needed for the feature?
		Are the results shown transparently?
		Does the user have access to formulas/application interface?
		Does the user have access to weightages for the calculation of results?
		Are measures foreseen to ensure that data collected is verified (e.g. completeness, accuracy timelines etc.)?
		Is training of experts/assessors needed for the feature?
	User-friendliness	
		Are the technical terms used provided in a glossary?
		Are the references to documents provided?
		Is the stepwise description for feature assessment provided?
		Are the results presented in graphical way?
		Did you consider the impact of graphical results on the user?

		Does the evaluation of the feature consider flexibility to adapt the methodology to different building types?
		Are the multiple-benefits (health, energy, cost saving etc.) of the feature studied?
	Economic feasibility	
		Does this feature increase EPC costs?
		Does the methodology require additional data to the one already included in current EPC derivation?
		If additional data is required, does it take longer than 1 hour to gather them?
		Is an additional on-site visit or measurement needed?
	Consistency with ISO/CEN standards	
		Have any national regulations been used in the methodology of this feature? If yes, which one?
		Is the data used for the feature already covered by the current EPC?
Final thoughts		
	Do you have any suggestions for improving this feature? For example, the description, recommendations, modules, or calculation methodology. Please describe in your words. Do you have any other comments? Please describe in your words.	

Table 4: Exemplary questionnaire for system test

Questions		
	Provide a short summary of the test you are carrying out. Please describe in your words.	
	Overall, how easy or difficult was the feature to implement? Please select an option.	
	List all of the key changes you planned to make to the existing 'back-end' EPC systems to enable the feature. Include all changes, whether they were successfully implemented or not. Please put a small description (5 words or less) for each change in a cell.	
	Were you able to perform each planned change? Please select an option for each change.	
	[Only answer this question for options you selected "No" or "In part" in previous question] Why were you not able to perform or complete these steps? Please describe in your words.	
	What are the major challenges in implementing the new feature? Please describe in your words.	
	What are the main advantages of the feature? Please describe in your words.	
	Explain the major areas of monetary cost in implementing the new feature. Please describe in your words.	
	What can be done to minimise the monetary cost in each area? Please describe in your words.	
Cross Cutting Criteria		
	Quality and Reliability	
		Are the calculation methods clearly described?
		Is the required input data clearly asked?
		Are the results shown transparently?
		Does the user have access to formulas/application interface?
		Does the user have access to weightages for the calculation of final results?
		Are the specific requirements to carry out the assessment outlined for assessors?
		Is training of experts/assessors needed for the feature?
		Are the qualification requirements clearly outlined for experts/assessors?
	User-friendliness	
		Is the stepwise description for feature assessment provided?
		Are reporting templates used?
		Is the calculation/process description provided in guidelines?
		Does the tool have stepwise description of the assessment?
	Economic feasibility	
		Does the implementing need additional infrastructure in the form of servers, programs, ...? If so, are these costs higher than €1000 to purchase, according to a rough estimation?
		Are there high skills (for example: IT and programming knowledge) required to implement and handle the feature?
	Consistency with ISO/CEN standards	
		Have any national regulations been used in the methodology of this feature? If yes, which one?
		Is the data used for the feature already covered by the current EPC?
Final thoughts		
	Do you have any suggestions for improving this feature? For example, the description, recommendations, modules, or calculation methodology. Please describe in your words.	
	Do you have any other comments? Please describe in your words.	

Table 5: Exemplary questionnaire for user tests

Questions	
	Provide a short summary of the test you are carrying out. Please describe in your words.
	List all of the planned steps for delivering the test. Please put a small description (5 words or less) for each step in a cell.
	Were you able to perform each planned step? Please select an option for each step.
	[Only answer this question for options you selected "No" or "In part" in previous question] Why were you not able to perform or complete these steps? Please describe in your words.
	[Only answer this question if you were able to perform the step and you faced any challenges] Did you face any challenges in steps that you were able to complete (for those you answered "Yes")? Please describe in your words.
	How well did the users understand the feature? Please select an option. (Only answer if a question regarding perception was in the questionnaire)
	What did the test tell you about how much users find the feature useful? Please select an option.
	What did the test tell you about how much users liked or disliked the feature? Please select an option.
	What did the test tell you about how users would use the information provided in the new feature? Please describe in your words.
	List the headline quantified results from your test, for example, the percentage of users who found the feature useful. Please describe in your words. (Please provide at least the top 3 findings)
	Did users make any suggestions for changing the feature? Please describe in your words.
New questions	
	Please describe the participation in the survey (number of participants, potentially split to different target groups; share of returned questionnaires)
	Please describe the objective of the survey
	Please describe the main questions asked
	Please describe the main findings of the survey
	Please provide us with quantitative results in the form of additional xls file as much as possible (e.g. anonymised filled questions or aggregated results of the survey questionnaires)
Testing time	
	How much time (in minutes) did it take to perform each step
Final thoughts	
	Do you have any suggestions for improving this feature? For example, the description, recommendations, modules, or calculation methodology. Please describe in your words.
	Do you have any other comments? Please describe in your words.

X-tendo

eXTENDing the energy performance assessment and certification schemes via a mOdular approach

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BPIE

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845958.