X-tendo

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

MARCH 2022

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

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.

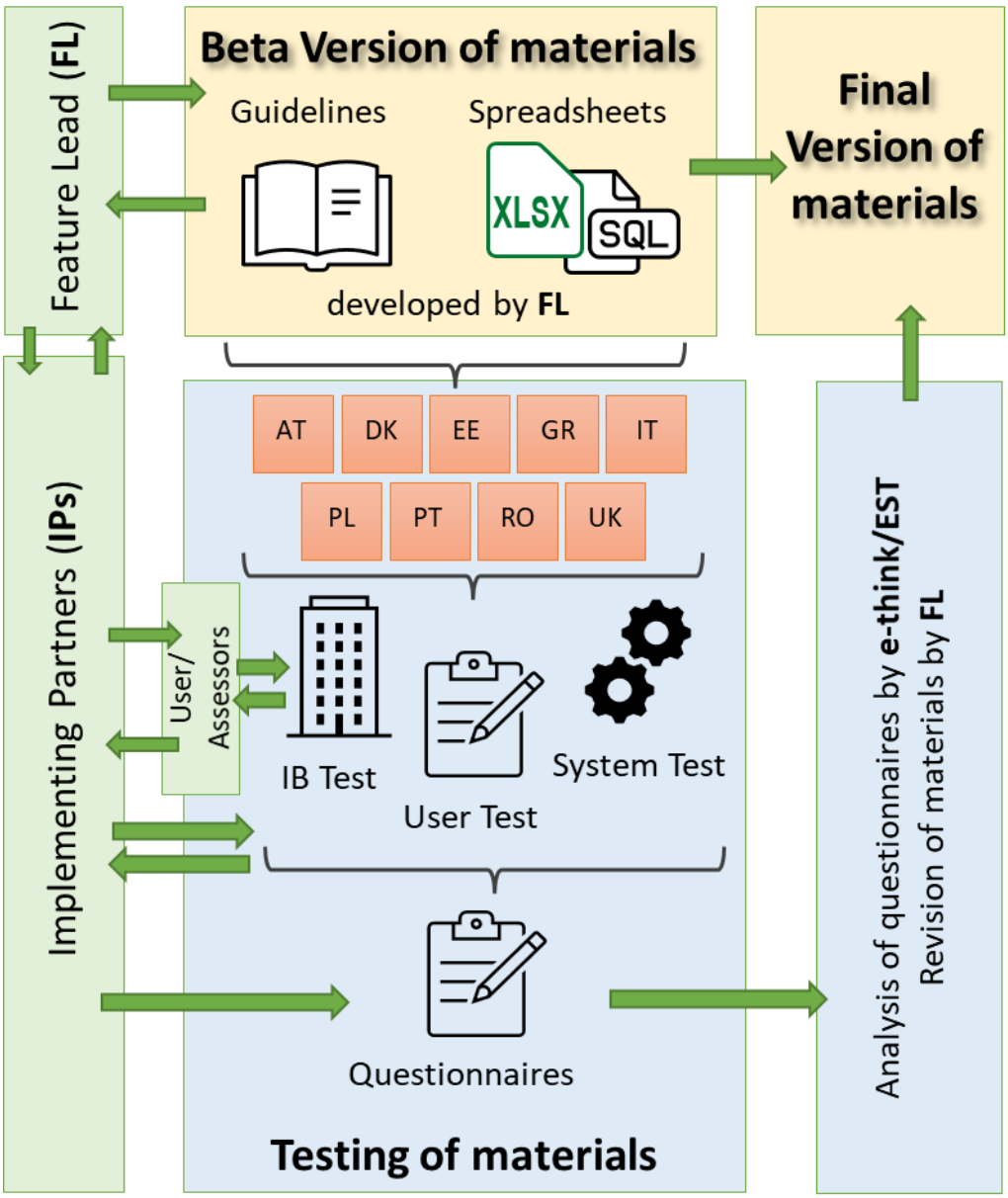

Figure 1: Approach for testing feature materials in the X-tendo project

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 5: DISTRICT ENERGY

2.1 Introduction

District heating and cooling networks are an important pillar for low-carbon future heating (and cooling). Industrial waste heat, the heat from combined heat and power (CHP) plants or deep geothermal energy can often only be used in district heating networks. At the same time, the technical and economic suitability of district heating and cooling depends on properties of the buildings like overall heat / cold demand or the needed supply line temperatures. To provide such information and thus ease the planning of district heating and cooling, within X-tendo two sets of parameters in the context of district heating and related building properties has been developed.

The first parameter set indicates the efficiency, the carbon content and the share of renewable energy of the nearest district heating grid. It should be included into EPCs to illustrate these values to end-users. The three parameters should also be presented for a future point in time, thus illustrating the ambition of the district heating grid operator to decarbonise to the end-users.

The second set of parameters consists of two temperatures related to the building's heat distribution system: supply and return flow temperatures. These indicate the feasibility of the building being connected to a (low-temperature) network, and therefore to provide important information for potential future construction of efficient heat networks.

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

The testing activities described in this report only relate to the second parameter set, the building related parameters. This testing was done via in-building tests in three implementing countries: Italy (ENEA), Poland (NAPE) and Romania (AAECR). The following table shows the buildings / apartments it was tested on.

Table 2 – In-building test objects for F5 – District Energy indicators

Italy (ENEA)			Poland (NAPE)			Romania (AAECR)		
building category	const. year	type	building category	const. year	type	building category	const. year	type
MFH	1966	A	SFH	2012	A	MFH	1974	A
MFH	1980	A	SFH	2016	A	Kinder-garten	1969 2016*	A
			MFH	1956	A			
			MFH	1950	A			
			MFH	1990	A			
			MFH	2020	A			
			Dormitory	1973	A			
			Cultural center	No data	A			
			Health-care	1963	A			
			Office	1981	A			
			Office	1982	A			
			Technical building	1983	A			
			Technical building	1979	A			

A … apartment or unit in building B … whole building * … year of renovation

The steps for the in-building tests of this feature were generally the same in all countries:

1. Administration / data collection – including gathering of building data, distribution of tasks and establish a testing strategy
2. Assessor evaluation – on-site visits, evaluation by the assessor and use of the provided calculation spreadsheets

Particularities in the implementation of these different testing steps in the different tests are described in the following.

Italy (ENEA)

In Italy EPCs need to be issued for each building unit. This feature therefore has been on two residential building units / apartments in two different multifamily houses. For the assessment a representative room was considered for each building unit. The method adopted is based on the evaluation of the energy demand for both apartments and representative rooms, and on the collection of information and data on the heating elements present in the representative room of each apartment.

Poland (NAPE)

This feature was tested on 13 buildings of different types: 7 residential buildings (4 multi-family houses, two single-family houses, one dormitory), one health-care building, two offices, one cultural centre and two technical buildings (workshop). First, the building documentation has been collected. If the heating designs were not available, a site visit has been performed. The tests were done for one selected representative room in each building.

In most of the cases the characteristics of the thermal transfer elements (radiators) had to be found, as the radiator types were different than default types provided in the spreadsheet tool. Beside that the tools were easy to use.

Romania (AAECR)

This feature was tested on two buildings connected to the local district heating (DH) system: a MFH and a kindergarten/school. In this case not only the building related indicators have been tested in these buildings, but also the calculation of the DH indicators for the local DH system has been tested. For this information from the local company was requested to calculate the required parameters. For testing the building related parameters, the calculation in the spreadsheet tool had to be adapted: the radiator types were different compared to those provided in the spreadsheet tool. For this, the national methodology to calculate the thermal power for the radiator size and hot water temperatures in the selected room was used.

2.2 Results of the testing activities

Overall result of in-building tests

The implementing partners (IPs) rate the overall difficulty to implement the feature as "somewhat easy" (NAPE, ENEA) or "somewhat difficult" (AAECR). To explain the feature to the assessors IPs rated "neither easy nor difficult" (AAECR) or "somewhat easy" (NAPE, ENEA).

All IPs were able to perform all steps in the testing process in all buildings. However, challenges have been identified in using the provided spreadsheet tool for the circumstances in their countries. In nearly all tested buildings the installed radiators differed to the radiators for which data was provided in the spreadsheet tool. Therefore, the IPs had to search for data on thermal transfer characteristics for the radiators in the tested buildings.

Overall, IPs rate the feasibility to include the developed methodology into the standard EPC assessment as "somewhat practical" (NAPE) or "somewhat unpractical" (AAECR, ENEA). The spreadsheet tool would also need to provide data on thermal characteristic of all widely installed radiators in a country to be practical.

Estimated time and costs per EPC

For the first step in the testing procedure (Administration and data gathering) NAPE reported 60 minutes per building and AAECR 40 minutes per building. ENEA mentioned that this step is already part the existing EPC assessment, for which it does not increase assessment time of EPCs. For the second step (Assessor evaluation including site visits and calculation with the spreadsheet tool) all IPs reported (up to) 60 minutes per building. In total EPC costs per building are estimated to increase between 40 EUR (ENEA), 50 EUR (NAPE) and 60 EUR (AAECR).

Cross cutting criteria

Quality and reliability

NAPE and ENEA state that the calculation methods are clearly described. AAECR reports that default values are given without reference and assume that they are referring to national values in Austria. All IPs agree that the required input data are clearly asked for in the spreadsheet tool. Also, the IPs state that the results are shown transparently. ENEA although suggests finding a more readable way to present the minimum supply temperature.

IPs agree that users have access to formulas and weighting factors. ENEA states that in the sheet of "heating element size" the user can select several parameters. NAPE states that this number of parameters being able to be changed by the user makes it a bit confusing to be used.

On the question "is the user provided fundamental technical knowledge needed to understand the details of the feature?" all IPs answer with "partly". In the current form of implementation, the general technical knowledge of an assessor might not be sufficient when the radiators in use are different to the ones currently documented in the spreadsheet tool.

User-friendliness

AAECR, NAPE and ENEA agree that the feature is explained in a straightforward language and that the technical terms are provided in a glossary. ENEA states that there is not one single glossary, but one glossary in each spreadsheet. IPs found only one reference to documents, namely to the DIN EN 442.

The IPs agree that the stepwise description of the feature assessment is provided. NAPE and ENEA found the process / calculation procedure described in the guidelines, AAECR didn't.

Economic feasibility

The IPs agree that the implementation of the feature will increase costs for EPCs. NAPE states that "However, the additional cost is not so high (approx. 10% of EPC cost)". Additional data to those already included in current EPC derivation are needed in all testing countries. This refers especially to the geometrical data of the heat transfer system in the representative room. To gather the additional data ENEA needed less than an hour, NAPE in some cases more in some less and AAECR more than an hour.

ENEA reports that no additional on-site visit would be required in Italy, as the additional data can be collected during the on-site visit usually performed when issuing an EPC. NAPE in some cases reports that an additional site visit was needed. IPs find that the implementation of the feature cost more than 10 EUR per EPC (see also cost estimation in the previous chapter). However, ENEA states that in case of simple heat transfer systems for which reference data is given in the provided spreadsheet tool it might be cheaper. IPs agree that

no further infrastructure like servers or programs are needed to implement the feature. NAPE and ENEA agree that no high skills are needed to implement the feature. AAECR, however, states that they had to perform a regression analysis to determine the power of radiators for a given radiators size, as installed in the test buildings.

Consistency with ISO/CEN standards

The IPs state that the feature methodology is based on a relation of power and size for specific types of radiators under different temperature conditions (flow, return, room). These are usually determined according to national regulations for heat transfer systems. Therefore, these power to size relations must be provided for each radiator type installed calculated under the respective national standards.

2.3 Conclusions and discussion

The method for calculating building related indicators within the district energy feature developed in course of X-tendo was tested in three implementing countries: Italy, Poland and Romania. The overall implementation of the feature was perceived "somewhat easy" or "somewhat difficult" by the different implementing partners.

The developed tool and guidelines were felt easy to use and the information on possible temperatures within heating installations in the building might show the possibility to change the heating source to a low-temperature source (even heat pump). However, to be practical for implementation into EPC schemes the spreadsheet tool must provide default data for all potentially installed radiator types. Assessors will not have the knowledge nor the time to adapt the tool to the local circumstances.

NAPE also suggests considering definition of the representative room based on the room with the highest specific heat load [W/m^2], not as currently defined based on the highest nominal heat load [W]. Furthermore, to decrease the complexity of the sheet "Heating element size" NAPE suggests redesigning the sheet so that the goal is to find the heating element size to fit the room and meet the required heat load. NAPE also suggested that the information may be useful input to building renovation decisions, and the information regarding the building might influence decisions on the district heat provision level.

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

TU WIEN TECHNISCHE UNIVERSITÄT WIEN Vienna | Austria

AAECR Asociația Auditorilor Energetici pentru Clădiri din România

adene Agência para a Energia

BPIE

КАПЕ CRES

Danish Energy Agency

ENEA

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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.