X-tendo

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

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
Project Coordinator	Lukas Kranzl Technische Universität Wien (TU Wien) Gusshausstraße 25-29/370-3, A-1040 Vienna E. Lukas.Kranzl@tuwien.ac.at
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
Author(s)	Hummel Marcus (e-think), Campbell David (EST), Weatherall David (EST), Green Caroline (EST)
Co-author(s)	Schmidinger David (e-think)
Reviewed by	Jerzy Kwiatkowski (NAPE) Editing: Roberta D'Angiolella
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.

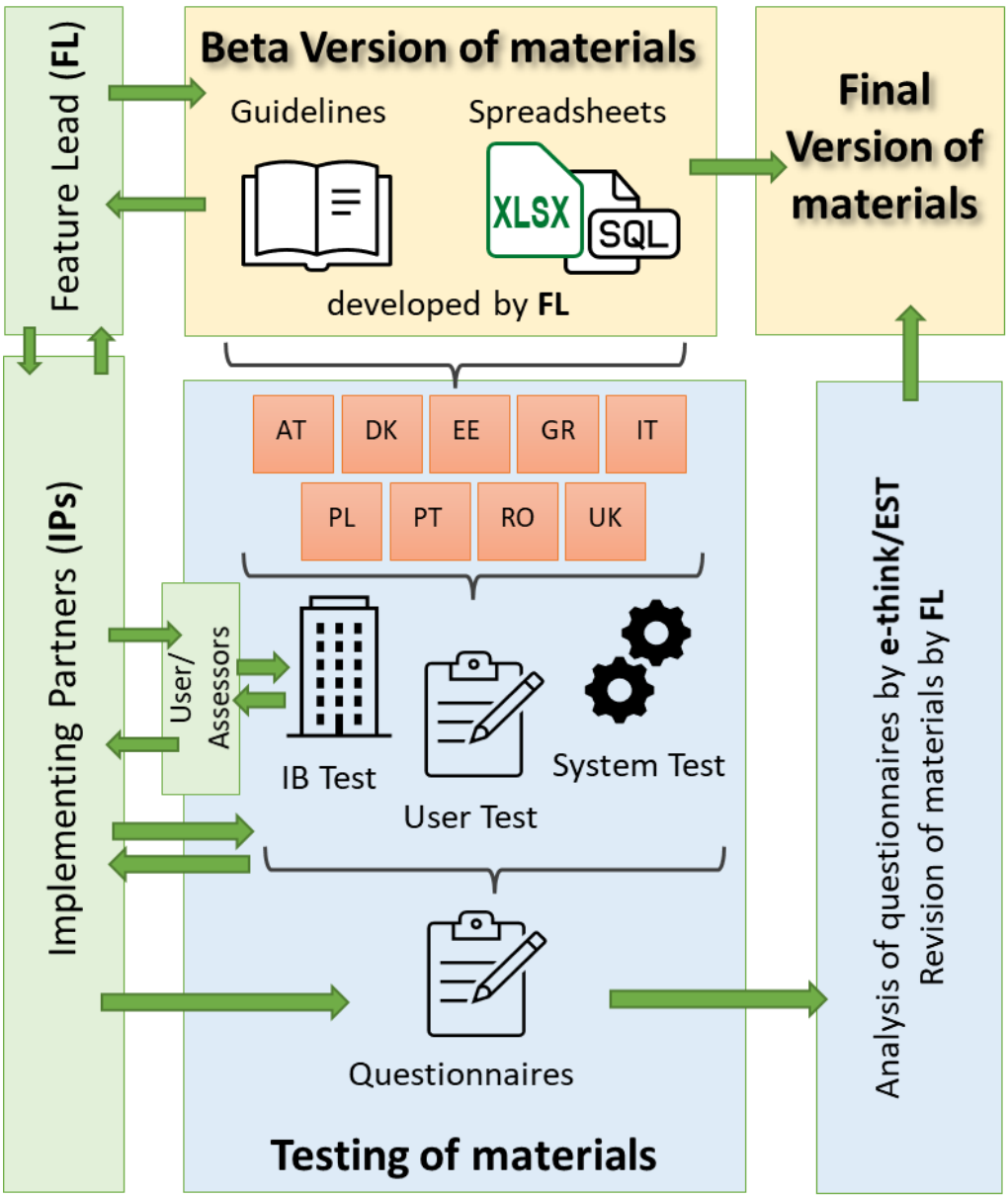

Figure 1: Approach for testing feature materials in the X-tendo project

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 4: REAL ENERGY CONSUMPTION

2.1 Introduction

The gap between real energy performance and EPC-calculated performance can be significant and is a source of confusion for EPC users. Methodologies that integrate on-board monitoring data and diagnose the difference between measured and calculated energy use (e.g. to adjust for real weather or occupant conditions) aim to explain the difference between the measured and calculated energy use to increase trust in the EPCs. The inclusion of real energy use data also enables automation of procedures and simplification of on-site inspections. The improved accuracy and better link with meter readings and billing information enhance user acceptance. Energy performance improvement measures can be better tailored to the specific building, augmenting the quality of renovation advice.

In course of X-tendo a methodology was developed for a measured energy performance indicator that reflects the actual energy performance of the building at standard conditions of climate and use. The calculation tool is complemented by a report with options to process real energy use data to represent part or global energy performance that may be used in cases with limited amount or detail of information or in very complex buildings (e.g., malls, hospitals) where the theoretical approach would be time consuming and costly.

It is anticipated that this will lead to increased market trust and trigger more investments in building energy renovations. Furthermore, a better link with measured energy use will improve policy instruments and targeted policy measures for monitoring and improving the energy performance of the building stock.

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

This feature was tested in Austria (EASt), Estonia (TREA), Italy (ENEA) and Romania (AAECR).

All tests of this feature were in-building tests. The following table gives an overview of the types of buildings in which the tests have been implemented in the different countries.

Table 2 – In-building test objects for F4 – Real Energy Consumption indicator

Austria (EASt)			Estonia (TREA)			Italy (ENEA)			Romania (AAECR)		
building category	const. year	type	building category	const. year	type	building category	const. year	type	building category	const. year	type
SFH detached	1922	B	School	1980 2018*	B	MFH	1966	A	SFH	2016	B
SFH detached	2013	B	Pre school	2017	B	MFH	1980	A	MFH	1974	B
SFH detached	2011	B	Pre school	1972 2018*	B						
SFH detached	1991	B									
SFH detached	2018	B									
MFH	2019	A									
MFH	1950	A									
MFH	2020	A									
MFH	2019	A									
MFH	2012	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
2. Monitoring
3. Assessor evaluation

However, still there were differences in the implementation of the different steps as well as the building settings that are described in the following.

Austria (EASt)

10 pilot buildings were assessed with the provided Excel-Tool. All of them were residential building with half of them being single family buildings and half of them being multifamily buildings. In the latter buildings the tests have been implemented for single apartments, not for the entire building. For each building / apartment the consumption of all energy carriers was collected from the energy bills. In the bills yearly consumption values were stated and used for the test. Hereby it was recognised that the measurement (as well as billing) periods were different in all of the buildings and also partly for different energy carriers.

Estonia (TREA)

Two kindergartens and one school building were selected for testing. Real energy consumption data was monitored/metered for the year 2020. The measured data were directly used in the developed spreadsheets.

Italy (ENEA)

In Italy EPCs need to be issued for each building unit, and 2 residential building units in multifamily houses have been selected for the test. In one of the selected building units an individual heating system is installed, in the other a centralized heating system with an individual heat metering is installed. These two different settings can be considered representative for two widespread heating system configurations for multifamily houses.

For the two building units, the procedure usually adopted for EPC issuing has been carried out. In addition, the following energy consumption data has been collected: 1) Energy consumption for space heating per energy carrier and 2) energy consumption for domestic hot water demand per energy carrier. The source for both types of data were energy bills from the buildings. In case no dedicated energy bills for the specific energy service (space heating or domestic hot water) were available, but only bills for multiple energy services, assumption to assess the share of each energy service have been made. The collected data has been used to perform the calculation with the provided spreadsheet tool.

Romania (AAECR)

AAECR performed the test on a multi-family- and a single family building. In case of the multi-family building, the test was performed on the entire building, not a single apartment. Assessors recorded the consumptions of gas and electricity with their corresponding energy bills. These were provided by the building users/owners based on already installed meters. Where technologies using renewable energy sources were installed, its specific data was provided by the residents. The metering of energy data per utility was not always available and therefore the separation of the metered values was not always possible (e.g. gas for heating, DHW or cooking, electricity for lighting, DHW or other consumers).

2.2 Results of the testing activities

Overall results of in building tests

The perception of how easy or difficult it was to implement feature 4 varies remarkably between the different implementing partners (IPs). While AAECR found it “very difficult”, EASt and TREA “somewhat easy” and ENEA “neither easy nor difficult”. This is similar for the question of how easy or difficult it was to explain the feature to the EPC assessors. Here, the answers even vary between “very difficult” (AAECR) and “very easy” (TREA).

The implementation of the different steps in the testing procedure (Administration / data collection, monitoring, assessor evaluation) was mostly possible for all IPs. It was mentioned by the Austrian IP (EASt) that detailed measurement for complex heating systems (like a pellet boiler combined with solar thermal collectors) would require detailed measurement, which was not possible to do in course of the X-tendo project and the related testing activities.

The challenges in implementing the test cases that were reported concern the gathering of the necessary data and were similar in the different countries: metering of energy consumption for different purposes within the buildings or apartments was not available. Thus, the allocation of the energy consumption values found in the energy carrier bills to the different purposes had to be done based on information from users and assumptions / assessor experience. For the Italian cases for example the split between energy consumption for space heating and domestic hot water consumption was done based on the summer baseline method.

The IPs in Romania (AAECR), Austria (EASt) and Italy (ENEA) rate the overall feasibility of implementing the feature in the national EPC schemes as "somewhat unpractical". This is mainly argued with the above mentioned challenges related to gathering of the data needed in the spreadsheets. Measuring of energy (carrier) consumption for different purposes within the buildings or apartments is rarely done today, for which the allocation of the data found in energy (carrier) bills is estimated to be complex and time consuming. This estimation is still easier in case only a split between space heating and domestic hot water must be found, e.g. in the case of district heating or natural gas. In case that electricity is used for space heating and / or hot water generation the complexity is remarkably higher.

ENEA further mentions that official data for heating degree days (HDD), cooling degree days (CDD) and solar radiation is not available for each location in Italy. For the test these data had to be collected and for an implementation of this feature into the national EPC schemes official data need to be generated and provided.

Estimated time and costs per EPC

For the first step in the testing procedure (administration and data collection) between 20 minutes (EASt, TREA), 60 minutes (ENEA) and 120 minutes (AAECR) per building were reported. It was mentioned that the gathering of local measured weather data as an input for the tool took a large part of this time. In the current version of the tool default data is provided at national level. When providing this data at regional / local level the time for data gathering by assessors and the related costs could remarkably decrease. The second step (collection of energy data and allocation to different use purposes) was reported to take equal time per building for all IPs: 20 minutes (EASt, TREA), 60 minutes (ENEA) and 120 minutes (AAECR). The last step of calculation with the tool was reported to take between 10 minutes (EASt), 15 minutes (TREA), 30 minutes (ENEA) and 240 minutes (AAECR) per building. This sums up to between 50 and 480 minutes per building.

Deviations between the reported numbers could be an indication that there might be potentials to reduce the necessary time for assessing the real energy consumption: in Estonia, where integrating real energy consumption into EPC assessment is a standard procedure, 55 minutes have been needed in total per building. EASt needed around 50 minutes per building, hereby testing 10 buildings, the highest number of all IPs. ENEA needed 150 minutes in total, but states that this might decrease to 90 in case that local weather data are centrally provided.

The estimated costs per EPC for each of the steps in the testing range between 28 EUR (TREA), 71 EUR (EASt), 90 EUR (AAECR) and 100 EUR (ENEA).

Cross cutting criteria

Quality and reliability

The guidelines are clearly described for most of the testers (ENEA, EASt and TREA). AAECR instead would find it practical to have a more detailed description of the calculation procedure directly in the guidelines instead of referencing to the standards for further information.

The required input data is clearly asked for in the spreadsheets. In case that a heat pump is (part of) the supply system, it was not clear how to define this in the tool. A clarification on that could be included in the guidelines.

Overall, the transparency of the results is perceived differently between the testers. ENEA, EASt and TREA find the results shown transparently, ENEA stating that the summary sheet is clear, AAECR argues that the results are not transparent due to the calculation not being transparent. EASt as well states that the calculation is contained in protected cells, which do not allow for seeing the formulas. This also makes it difficult to find errors in the calculation.

Training for assessors might be needed for this feature. This is especially relevant in case that an allocation of the overall consumption of energy carriers to different use purposes (e.g. space heating and hot water preparation) is required. In contrast, in Estonia additional training might not be needed, as the experts are already certified, and the procedure is already part of the EPC scheme.

User-friendliness

Overall, the feature is explained in a straightforward language. Some formulations that are not fully clear have been identified and communicated to the feature developers. A glossary of terms is provided, AAECR found some parameters that are missing and should be added.

A stepwise description of the calculation process is provided in the guidelines. As mentioned above in the quality and reliability section, AAECR mentions that the description is brief and frequently refers to the standards. All references to literature and standards are clearly given.

Economic feasibility

While in Austria, Romania and Italy the implementation of this feature would increase the EPC costs relevantly, in Estonia this is already a standard procedure and would not increase costs nor need additional data to be collected. EASt state that the needed effort depends remarkably on the complexity of the heat supply system. ENEA mentions that even in case

no measurement is needed additional time for allocating data from the energy bills will increase time and costs in EPC issuing.

Thus, the additional costs for EPCs when implementing this feature will depend relevantly on the concrete way of implementation: is measurement equipment needed, and (how) does the consumption need to be allocated to use purposes?

Consistency with ISO/CEN standards

Testers state that climatic conditions need to be adapted to the local test case. ENEA used UNI 10349 series for standard weather data, TREA usually use Estonian degree days, but in this case used EU issued data, and AAECR also used the national methodology to calculate HDD and CDD. For allocating energy consumption to different use purposes AAECR used the national assessment methodology Mc001/2007 for domestic hot water use, surface area per person etc.

2.3 Conclusions and discussion

The "Real energy consumption" feature developed in X-tendo was tested in 4 implementing countries: Austria, Estonia, Italy and Romania. In Estonia a similar procedure for assessing real energy consumption is already part of the EPC scheme. Therefore, the implementation of the feature is perceived somewhat easy by the Estonian IP (TREA). In contrast, for the other three IPs the testing of the implementation of the feature was more challenging.

The main challenge in implementing this feature into a building assessment was identified to be related to data gathering and allocation. Metering of energy consumption for different use purposes was not available in none of the tested buildings in AT, IT and RO. Thus, consumption data had to be estimated based on energy bills, which was perceived complex, time consuming and uncertain. As meters for consumption of space heating and hot water preparation are very likely not present in most buildings in the three stated countries, it is seen very relevant for the implementation of the feature to have a simple method for allocation of consumption values from energy bills.

Additionally, for the implementation of the feature it is relevant to provide data on HDD, CDD and radiation for all locations in a country by an official body, so that assessors do not need to search for them on their own but can refer to standardised official values.

The testing also showed that some open questions remain in case that more complex heat supply technologies are installed in the buildings, like solar thermal or ventilation systems with heat recovery. Buildings with one or several of these technologies can be assessed with the current version of the tool. The description of how to perform this within the guidelines document could be made clearer.

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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AAECR Asociația Auditorilor Energetici pentru Clădiri din România

adene Agência para a Energia

BPIE

КАПЕ CRES

Danish Energy Agency

ENEA

ENERGIE AGENTUR Steiermark

energy saving trust

think ENERGY RESEARCH

NAPE NATIONAL ENERGY CONSERVATION AGENCY

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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.