X-tendo

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

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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.

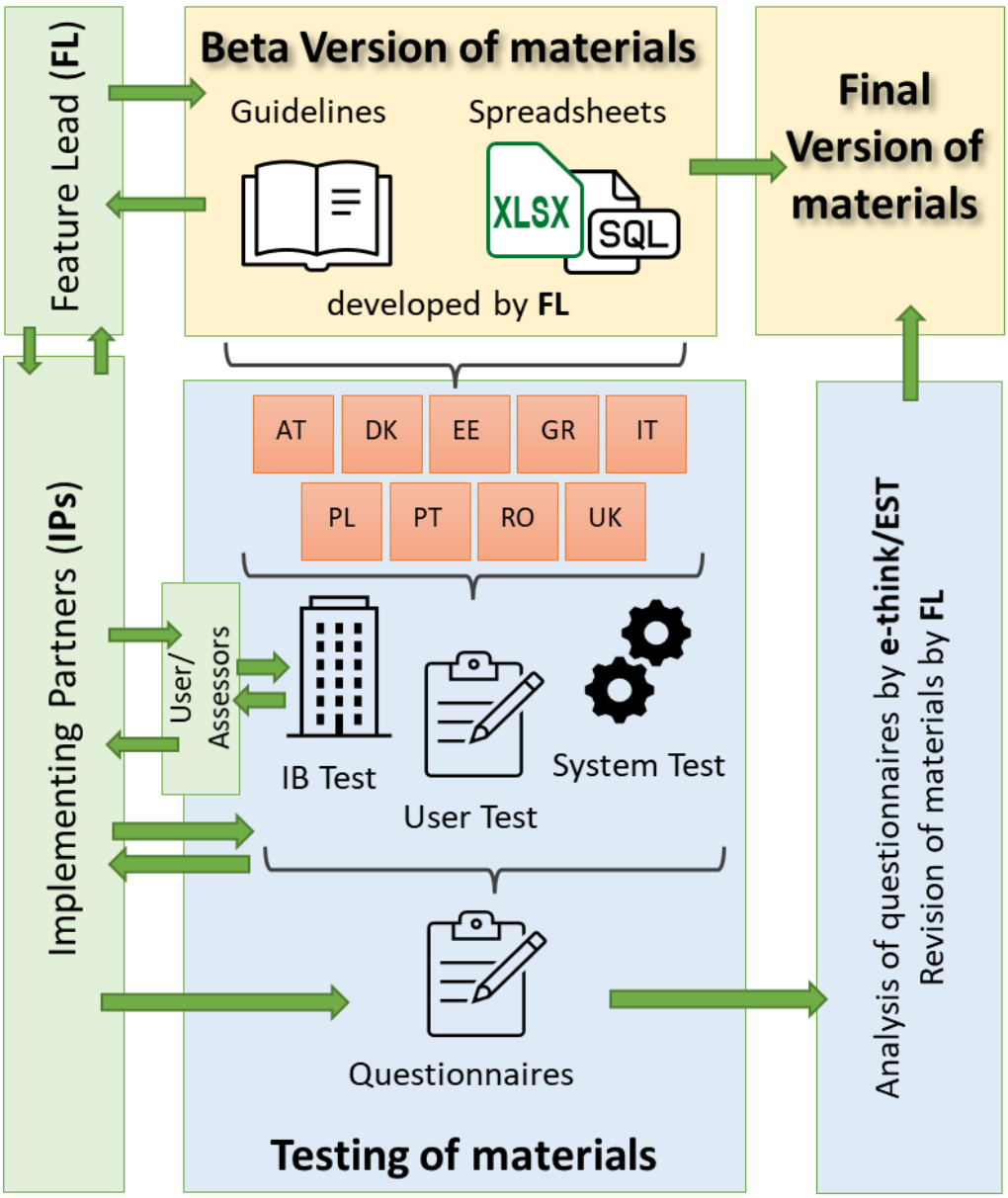

Figure 1: Approach for testing feature materials in the X-tendo project

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 1: SMART READINESS

2.1 Introduction

The Smart Readiness Indicator (SRI) is intended to raise awareness about the benefits of smart buildings, including energy efficiency, optimised mix of various energy sources, user occupancy experience and grid flexibility. In addition, its implementation is expected to stimulate investments in smart building technologies and support the uptake of technology innovation in the building sector.

The SRI methodology is applicable to all types of buildings – residential and non-residential, existing, and new – regardless of their size. Two parallel methodologies have been developed and tested so far to speed up SRI evaluation capabilities. These methodologies vary in the amount of information required and the skills needed by the assessor to quantify the level of smartness. Abbreviated method A is composed of a simplified checklist that can be self-assessed online or by an assessor in 15 minutes, making it ideal for assessing single and multi-family dwellings and small commercial and office buildings. Extended method B relies on an on-site inspection and includes more detailed information about the building smartness components. Its specificity makes it suitable for assessing large private (residential, offices) and public (schools, hospitals, etc.) buildings.

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

The Smart readiness feature was tested in Austria (EASt), Estonia (TREA), Greece (CRES) and Romania (AAECR). All tests were in-building tests, the following table shows the buildings / apartments it was tested on.

Table 2 – In-building test objects for F1 – Smart Readiness Indicator (SRI)

Austria (EASt)			Estonia (TREA)			Greece (CRES)			Romania (AAECR)		
building category	const. year	type	building category	const. year	type	building category	const. year	type	building category	const. year	type
SFH detached	1992	B	MFH	1963 2021*	B	MFH	1976	A	SFH	2016	B
SFH	2013	B	MFH	1963 2019*	B	MFH	1976	A	MFH	1974	A
SFH	2012	B	MFH	1961 2019*	B	office	1986 1992*	B	office	2015	B
SFH	2019	B	MFH	1960 2019*	B	office	2001	B	School	1969 2016*	B
MFH	1950	B	MFH	1960 2021*	B						
MFH	2020	B	MFH	1962 2019*	B						
MFH	2019	A	MFH	1960 2020*	B						
MFH	2011	B	MFH	1959 2020*	B						
School	No data	B	MFH	1962 2021*	B						
Public building	1991	B	MFH	1964 2019*	B						

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 – including on-site visits and the evaluation of the assessor
3. Calculation – including the entry of inputs into the calculation sheets and performing the calculation of the SRI score

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

Austria (EASt)

The evaluation examined 10 buildings which consisted of single-family houses and apartments, an office building and two schools. During the tours on the sites, information was collected and acquired. This data was then entered into the Excel tool partly on site but also afterwards.

Estonia (TREA)

In Estonia the SRI feature has been tested on 10 different multi-family houses including on-site visits.

Greece (CRES)

Four buildings were studied: 2 office buildings and 2 apartments. On-site visits and walk through audits were carried out in the four pilot cases combined with F2 (Comfort feature) corresponding activities. The required data of the buildings were gathered and information on the installed technical systems for the assessment of the SRI with the use of the tool was collected.

Romania (AAECR)

The tested buildings were 1 SFH, 1 MFH, 1 office and 1 kindergarten/school. All buildings were visited with walk through technical rooms and access to the technical documents. Valuable information was acquired from building administrators/managers. All collected data was then input to the tool that provided impact and domain scores, as well as the overall SRI score as indicator.

2.2 Results of the testing activities

Overall result of in-building tests

The implementing partners (IP) rate the overall difficulty to implement the feature whether "somewhat easy" (AAECR, CRES) and "neither easy nor difficult" (EASt, TREA). EASt and AAECR found it "neither easy nor difficult" to explain it to assessors or stakeholders, TREA "somewhat easy" and CRES "very easy".

The IPs were able to perform all steps in the testing process in all buildings.

IPs rate the feasibility to include the developed methodology into the standard EPC assessment quite differently. TREA rates it "somewhat unpractical" as the feature might be misunderstood. TREA suggest naming the feature "building automation" instead of smart readiness. CRES rates the implementation into the Greek EPC assessment "somewhat practical" with the explanation that "the tool is easy to use and rather easy to complete. Some knowledge about the systems, technologies, efficiencies is required." AAECR and EASt find the feature "very practical" to be implemented in national EPC assessments in Romania and Austria: data was easily collected; the tool was easy to use and the indicator has sufficient relevance to the users of the EPC.

Estimated time and costs per EPC

The time necessary for performing the in-building tests was very similar for the different implementing partners. Overall, around 2.5 hours were needed per building / apartment to perform all the steps (data collection, assessor evaluation and calculation). The estimated extra costs to include the feature into EPC issuing per EPC were then estimated rather differently from the implementing partners. While EASt estimated around 260 EUR for the different steps, CRES and AAECR estimated 60 EUR and 35 EUR, respectively. TREA instead

states that they could not estimate the costs incurred with the feature test as the data were collected for multiple purposes.

Cross cutting criteria

Quality and reliability

It is agreed by all IPs that the used calculation methods are clearly described, and the required input data is clearly asked for in the spreadsheets. Also, most IPs agree that the user is provided fundamental technical knowledge needed to understand the details of the feature through the information in spreadsheet and the guidelines.

There is an agreement that training of assessors is most probably needed. AAECR states that "Assessors with strong technical/engineering background may need less training. The others may need a check list when verifying the presence of specific equipment (sensors, meters, controllers)." CRES agrees that the amount of necessary training depends on expert's knowledge and experience, the knowledge required hereby refers to the technical systems, technologies and efficiencies.

The IPs agree that the results are transparently shown in the spreadsheet tool, they are "presented well, transparently and in a structured way" (EASt). However, TREA states that this transparency will get lost on the way to the EPC user, which then only sees the result of the evaluation, but not the calculation process anymore. IPs hereby also agree that the user of the spreadsheet tool should have access to formulas and weightages, which make the calculation transparent.

The verification of the collected data in terms of completeness and correctness should be done by the assessors. There are no additional measures foreseen (e.g. automatic detection of missing or wrong input data in the spreadsheets) to ensure the verification of collected data at the moment of testing the feature in course of the project. However, training and certification of assessors should minimize the risk of inserting incorrect or incomplete data.

User-friendliness

The IPs confirm the provision of a glossary of technical terms and the stepwise description of the procedure for assessing the SRI. At the time of testing several references to background documents have been missing. AAECR states that "Links to databases are provided. References are missing at paragraphs 3.1.1.1. and 3.2 (if there is any)."

The IPs confirm that the results of the SRI assessment are graphically presented in the spreadsheet. EASt states that "they are easy to understand because of the implemented chart", AAECR reports that "Scores are on a scale 0-100, easy to understand."

All implementing partners agree that the prepared spreadsheets and guidelines for the SRI assessment provide good flexibility to adapt the methodology to different building types. AAECR and CRES also mention that multiple-benefits (health, energy, cost saving etc.) of the

feature were studied. They "are well included in paragraph. 3.2. and in "Weightings" sheet of the tool" (AAECR).

Economic feasibility

All IPs agree that the implementation of the SRI into the EPC framework of their country would increase the costs for EPCs. An estimation of additional costs per EPC has been provided in the previous chapter.

For the assessment of the SRI in all countries included in the testing activities additional data to the data already collected for EPCs are needed. AAECR state that not much additional data is needed, it includes "Conditions for health/wellbeing and electric vehicle charging", CRES state that additional data on the technical building system (Electric Vehicle Charging) and additional data for the other building systems are required, e.g. for cooling. Apart from CRES all IPs state that they needed more than 1 hour to collect the additional data. TREA states that the time needed for collecting the additional information depends on the building, "the more smart features are available, the more time" is needed. All IPs agree that although additional data is needed, no additional on-site visit is required.

Consistency with ISO/CEN standards

All implementing partners that tested the SRI feature agree that national regulations from their countries have not been used in the methodology of the feature.

2.3 Conclusions and discussion

The testing of the Smart Readiness Indicator (SRI) developed within X-tendo by the implementing partners in Austria, Estonia, Greece and Romania showed that the assessment procedure is straight forward and that it can easily be implemented into an energy audit / the standard EPC assessment in most cases. The guidelines and the calculation spreadsheets are clearly explained.

The time required for preparation, gathering of additional data and calculating the SRI was estimated very similarly in all countries to around 2.5 hours per EPC. However, the related cost estimates vary significantly between the countries, potentially due to remarkable differences in salary levels. These estimated extra costs also raised concerns regarding the potential for implementation in the EPC regulations. Thus, a reduction of time needed, and costs incurred for the assessment of the SRI seems the most important next step in the feature development.

Furthermore, the following ideas for improving the feature have been identified: A slider could be added to the calculation spreadsheet for selecting the share of the functionality level, this would improve the user-friendliness of the feature. The term "climate zone" might be renamed to "Location", as no climate related information is processed.

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

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