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

X-tendo Feature 1: Smart Readiness Indicator (SRI)

Insights from testing of the Smart Readiness Indicator methodology for integration in EPC schemes

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FOREWORD

The X-tendo project "eXTENDing the energy performance assessment and certification schemes via a mOdular approach", funded under the Horizon 2020 program, aims to support public authorities in the transition to next-generation energy performance certification (EPC) schemes, including improved compliance, reliability, usability and convergence. The key output of the project is a free online knowledge hub including 10 innovative EPC features. One of the innovative features is the Smart Readiness Indicator (SRI). In X-tendo the SRI is tested for inclusion in EPC frameworks.

The calculation spreadsheet and accompanying guidelines for the SRI are based on the simplified method A of the SRI methodology at the status which was developed for the European Commission at the time of initiation of the X-tendo work. It must be noted that in the meantime, this methodology has - partly in parallel to the X-tendo work - evolved into the version that is currently officially endorsed in European regulation. During the X-tendo project the SRI methodology was adapted and tested to gather insights for future improvements.

Due to slight differences between the X-tendo SRI-method and the method endorsed and proposed by the European Commission, it was decided to not provide the X-tendo calculation spreadsheet and accompanying guidelines that have been further developed as a part of the envisioned toolbox as public available information. Instead, it was chosen to redirect interested stakeholders to the official SRI resources on the website of the European Commission in order to assure consistency of the provided materials with the currently ongoing SRI initiative.

As an alternative of the toolbox calculation spreadsheet and accompanying guidelines files, the experiences with SRI from the testing within X-tendo are reported on and published in this report as part of the X-tendo toolbox.

1 INTRODUCTION

1.1 Context

To achieve the EU long-term objectives of net-zero greenhouse gas emissions by 2050, the renovation rates in the building sector need to be significantly increased. Therefore, the EU has set the ambition to at least double the annual renovation rate and to foster deep renovation as part of the Renovation Wave initiative within the Green Deal. Energy performance of buildings certification is an important tool to raise awareness regarding the building energy performance and the need for renovation. The Energy Performance Certificate (EPC) was introduced in the Energy Performance of Buildings Directive (EPBD) in 2002 (2002/91/EC) for this purpose (European Union; 2003) and has received specific attention in the current revision of the EPBD.

Next generation EPCs can support the transition to a low carbon building sector, given that they are revised to meet end-user needs and expectations. New EPCs consider new indicators and more detailed information on the existing buildings, the energy performance and related aspects, and combine it with effective mechanisms to ensure compliance and high-quality certifications. Such aspects are important for reliability, augmenting user acceptance and increasing trust in the market, which in turn may lever renovation rates.

Smart technologies in buildings have the potential to increase the energy efficiency of the building stock, enhance the flexibility in smart energy grids, and improve comfort and health of building occupants. This potential was heavily emphasized in the 2018 revision of the European Energy Performance of Buildings Directive (EPBD) (EU) 2018/844 (European Union; 2018) and the concept of a Smart Readiness Indicator (SRI) was introduced in order to increase the visibility and uptake of smart technologies in the European building stock. The Smart Readiness Indicator would allow to assess the level of smartness of a given building in a reliable and meaningful way for building owners, tenants, and users.

In a technical study, led by VITO and concluded in June 2020, the scope, definition, and calculation of the SRI were investigated, and a more detailed assessment of its potential impacts was performed. More information on the SRI methodology development can be found on the official SRI webpage of the European Commission, the part dedicated to the SRI methodology.

The SRI was officially adopted by Delegated Regulation (EU) 2020/2155 (European Union; 2020a) and Implementing Regulation (EU) 2020/2156 (European Union; 2020b). The SRI is an optional EU scheme; EU Member States can choose whether to implement or not and also how they want to implement it (e.g. apply to all categories of buildings or only for certain categories). However, in contrast to the EPC scheme, assessment rules and criteria are shared among the MS, although adapted to the different climate zones. A follow-up SRI service contract[1] was launched in 2021 installing a support team for a period of two years to provide technical assistance in

- testing and implementing the SRI
- establishing and operating a permanent setup to effectively support the broad roll-out of the SRI in the EU
- the preparation of guidance for the implementation of the SRI

The support team is also to investigate any additional technical support that could effectively support the implementation of the SRI and to promote the SRI.

The support team has initiated the SRI Platform providing a multi-stakeholder forum for discussion and experience sharing on the SRI implementation in the EU. Within the SRI Platform, three Working Groups are initiated focusing on the following specific elements of the SRI;

- Member State SRI test phase
- Maintenance & potential extension of the SRI calculation methodology
- SRI value proposition and supporting measures

Further information can be found on the official SRI webpage of the European Commission.

1.2 The X-tendo project

The X-tendo project, "eXTENDing the energy performance assessment and certification schemes via a mOdular approach", funded under the Horizon 2020 programme, aims to support public authorities in the transition to next-generation energy performance certification (EPC) schemes, including improved compliance, reliability, usability and convergence. The key output of the project is a free online knowledge hub including 10 innovative EPC features. The toolbox allows national and regional public authorities and agencies responsible for EPC schemes and their implementation to improve and future-proof their EPC schemes. The 10 innovative features are categorized into two main groups depicted in Figure 1; group one comprises 5 innovative EPC indicators: smart readiness, comfort, outdoor air pollution, real energy consumption and district energy. Group two contains innovative EPC data handling functionalities: EPC databases, building logbooks, enhanced recommendations, financing options, and one-stop-shops.

[1] ENER/2020/OP/0015 – ENER/B3/2020-608/02SI2.846681

Figure 1: 10 innovative features for next generation EPC schemes are developed in the X-tendo project.

The objective of Work Package 3 of the X-tendo project is to investigate innovative EPC indicators - group 1 features, including F1 SRI - that can contribute to a more holistic view for next-generation energy performance assessment and certification schemes.

The more specific aims are to (1) identify existing good practices, clearly outline the scope of the envisioned methodologies and build further on relevant state-of-the-art methodologies; (2) elaborate calculation procedures closely related to current EPC schemes and taking into account end-user expectations (Work Package 2 survey) and (3) test the assessment and calculation procedures using a set of reference buildings and in the field testing within Work Package 5 mainly in the form of in-building testing.

Figure 2 shows the link between Work Package 3 and the other X-tendo Work Packages.

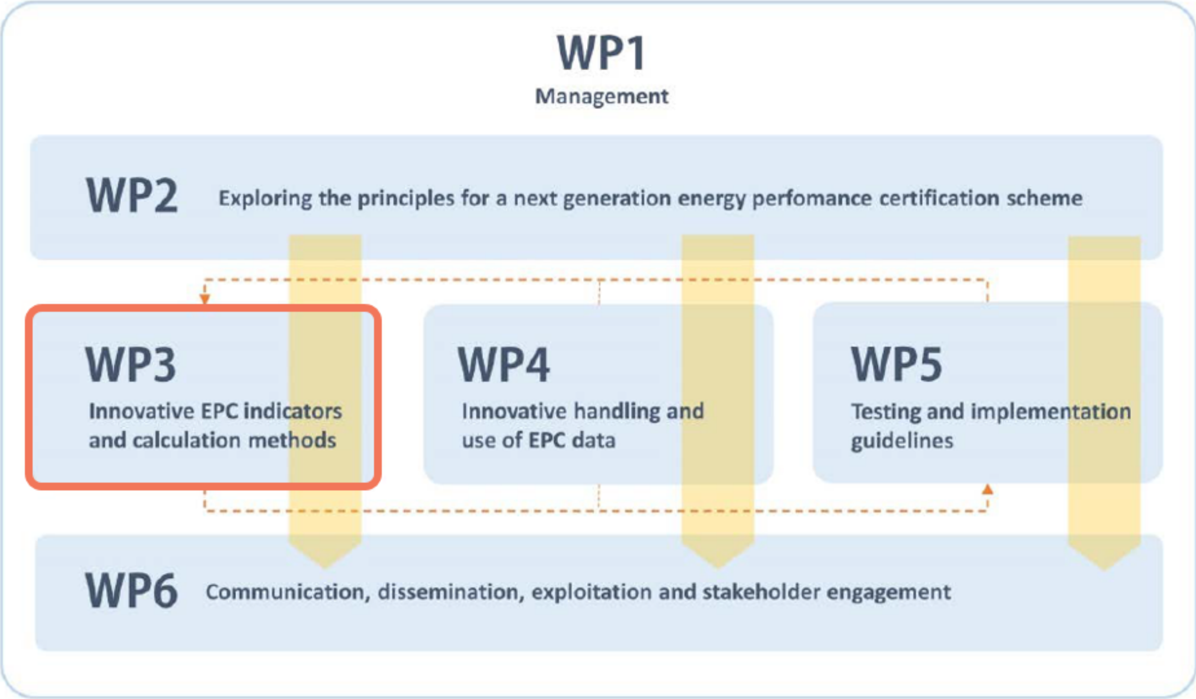


Figure 2: Link between Work Package 3 (development of innovative EPC indicators, including F1 SRI) and the other X-tendo Work Packages.

The Work Package 3 outcomes include a modular toolbox with feature methodologies that can be used to extend current EPC schemes with assessment of one or more of the innovative (group 1) features 1-5. Each feature tool consists of one or more Excel calculation spreadsheets and accompanying guidelines documents. The toolbox final versions of the features – including spreadsheets and accompanying guidelines - can be downloaded from the X-tendo webpage part dedicated to the toolbox, except for feature 1 Smart readiness indicator (SRI).

1.3 The SRI and the X-tendo toolbox

In the X-tendo project, the inclusion of the SRI assessment as an integral part of the EPC has been evaluated via the following actions:

- Verification calculations have been done using the SRI calculation spreadsheet on theoretical reference buildings
- The synergies between SRI, EPC and other X-tendo features are explored.
- The SRI methodology has been tested in 12 real buildings according to the following criteria:
    - 3 European Climates: Southern Europe, Central Europe and Northern Europe represented respectively by the cities of Palermo, Bratislava and Helsinki
    - 4 Reference buildings: single family house (SFH) new, SFH old, apartment (APT) new, APT old where newer buildings are expected to have better heating and cooling efficiencies overall

For feature 1 Smart Readiness Indicator, no calculation spreadsheet and guidelines are included in the toolbox for publication. The calculation spreadsheet and accompanying guidelines for feature 1 as tested and further developed within the X-tendo project are not publicly available.

Instead, a reference is made to the official SRI resources on the website of the European Commission in order to assure consistency of the provided materials with the currently ongoing SRI initiative.

As an alternative of the toolbox calculation spreadsheet and accompanying guidelines files, the experiences with SRI within X-tendo are reported on and published as part of the X-tendo toolbox. The following subsection provides the outline of content included in this report.

1.4 Outline of the report

In this report, the following aspects are included in relation to the SRI and the testing of the SRI methodology in the X-tendo project:

- Description of the SRI, both the final X-tendo version of the calculation spreadsheet and the EU officially endorsed version of the SRI calculation spreadsheet with a description of the main differences between both versions.
- Results of an analysis on the input data required for the X-tendo SRI compared to EPC input data and that of other X-tendo features
- Results obtained from verification calculation
- Summary of the main outcomes obtained from in-building testing

In the current report, only a summary of the main outcomes of in-building testing is included. The reader is referred to the deliverable reports of Work Package 5 on testing of the SRI (D5.2 and D5.3) that can be downloaded on the X-tendo website to consult the detailed outcomes from in-building testing of F1 SRI.

1.5 The SRI as currently adopted in EU regulation

The SRI is officially adopted by Delegated Regulation (EU) 2020/2155 (European Union; 2020a) and Implementing Regulation (EU) 2020/2156 (European Union; 2020b) and is an optional common EU scheme. The first regulatory document established the definition of the SRI and a common methodology, by which it should be calculated. The second regulatory document detailed the technical modalities for effective implementation of the SRI.

The SRI rating depends on a building's capacity to accommodate smart-ready services. These services are categorized in 9 technical domains - including space heating, cooling etc. - and are assessed for a given building against 7 desired impacts in 3 main functionalities of building smartness; 1) Optimize energy efficiency and overall in-use performance; 2) Adopt their operation to the needs of the occupant and 3) Adopt to signals from the grid (energy flexibility).

Figure 3 depicts the SRI scores calculated at different levels.

	Overall SRI score (%) + SRI class							
	%		%				%	
	Optimise energy efficiency and overall in-use performance		Adapt its operation to the needs of the occupant				Adapt to signals from the grid (energy flexibility)	
	%	%	%	%	%	%	%	
	Energy efficiency	Maintenance and fault prediction	Comfort	Convenience	Health, well-being and accessibility	Information to occupants	Energy flexibility and storage	
Heating	%	%	%	%	%	%	%	%
Cooling	%	%	%	%	%	%	%	%
Domestic hot water	%	%	%	%	%	%	%	%
Ventilation	%	%	%	%	%	%	%	%
Lighting	%	%	%	%	%	%	%	%
Dynamic building envelope	%	%	%	%	%	%	%	%
Electricity	%	%				%	%	%
Electric vehicle charging		%		%		%	%	%
Monitoring and control	%	%	%	%	%	%	%	%

Figure 3 – SRI scores calculated at different levels

The result of the smart-ready services assessment is translated into one overall SRI score and 3 sub-scores for the main functionality domains.

1.6 The SRI in X-tendo

In this testing, X-tendo assessors were invited to test the draft SRI assessment process in pilot buildings and provide feedback to the technical study team.

Although the extended SRI methodology includes different assessment options, the following parameters have been set for X-tendo:

- Simplified calculation method A
- Default weighting factors
- Default ordinal scores

The SRI calculation implements a **triage process** to identify which services should be considered for the final score. It is very likely that due to local and site-specific context some domains and services are not relevant, not applicable, or not desirable.

In summary, the following approach has been implemented:

- for some services, an evaluation is only relevant in cases where the technical building systems it relates to are present (hence "smart ready"); this approach is appropriate when assessors cannot unambiguously determine the relevance of a domain. The service is excluded from the assessment

- some services may be mutually exclusive; if such services are not present, they can be excluded from the assessment
- some services might be absent but nonetheless desirable to consider in the methodology from a policy perspective (hence "smart possible"); this approach may provide stimuli for upgrading existing buildings with additional (smart) services. These services are included in the assessment. As a guiding principle, it could be considered that all services that are mandatory in a Member State's building code are mandatory in the SRI.

Based on the triage process, the services that are not applicable to a particular building and for which no assessment is required are identified.

For each service to be assessed, information is to be inserted on the main functionality level, the share of the functionality level, the additional functionality level (optional), the estimated assessment time and the assessor comments (optional).

The theoretical maximum concept: For each impact criterion, a total impact score is calculated as the weighted sum of the domain impact scores. In this calculation, the weight of a given domain will depend on its relative importance for the considered impact. The maximum nominal impact score is not simply the sum of the impacts of the services listed in the streamlined SRI catalogue. It is highly likely that due to local and site-specific context some domains and services are either not relevant, not applicable, or not desirable. The SRI methodology accommodates this by performing a triage process to identify the relevant services for a specific building.

An assessor evaluation tab was added to the SRI calculation spreadsheet including a few questions addressed to the assessors involved in the in-building testing regarding the quality and perceived value of the assessment. The aspects questioned include:

- Testing Time
- Feasibility of the assessment experience
- Perceived reliability of the outcome
- Relation with other assessment schemes part of X-tendo

1.7 Difference between the X-tendo SRI version and the EU officially endorsed SRI version

At the start of the X-tendo project, the official SRI calculation spreadsheet of method A - in the status as it was at that moment developed for the European Commission - was adopted as a starting basis for the development of a smart readiness indicator for the X-tendo toolbox.

In the period after that, both versions have evolved in parallel and not entirely in a synchronized manner, which means that the two versions are slightly different. The main core of the final version of the X-tendo feature 1 SRI calculation spreadsheet and that of the

EU officially endorsed SRI spreadsheet as part of the SRI assessment package however are the same.

The main differences are briefly described hereafter:

- The X-tendo SRI version was extended with additional input fields to capture experiences and insights gained by the building assessors while performing the in-building testing and to facilitate evaluation of the in-building testing. A brief description is provided in the subsection 1.6.
- The presentation of results in the X-tendo SRI version does not reflect the final intended presentation/format of the SRI but is merely provided for testing purposes. Research on the proper format was ongoing at the time of testing SRI in X-tendo.
- The format and lay-out was adapted to the X-tendo template format and accompanying guidelines were established similarly as was done for the other X-tendo indicator tools.

2 DATA INPUT ANALYSIS OF SRI AND EPC

2.1 Introduction

In order to gain insights in the implementation potential in combination with other EPC indicators, such as the EPC indicators currently in use in practice in the Member States and potentially also other innovative feature developed within X-tendo, an analysis of the data inputs that are required for the methodologies to determine the various indicators was done. This analysis is in this report referred to as "data input analysis".

The purpose of such analysis is to identify opportunities to economise in feature introduction in existing EPC practices. Synergies in input data between the indicator determination methods are considered beneficial from an economic viewpoint for the implementation of the SRI (and potentially also one or more of the other X-tendo indicators) in a specific existing context of a Member State as they represent a reduction in the efforts and costs associated with execution of the assessments.

More information (including insights from a similar exercise) on linking SRI to national EPC schemes can be found in a report delivered in the ePANACEA project (Borragán G., Legon A.-C.; 2021), with in it an exploration of synergies between national EPC schemes and SRI, implementation opportunities and challenges and guidelines for maximizing common implementation.

2.2 Analysis programme

Given the large differences between the EPC methodologies currently implemented in practice in the various EU Member States, it was deemed appropriate to include a representative number of countries with different climate and building characteristic in the analysis programme.

Nine EPC country experts were consulted to provide information on input data of EPC determination methods in use in their country; the United Kingdom (UK), Portugal (PT), Poland (PL), Italy (IT), Greece (GR), Estonia (EST), Denmark (DK), Romania (RO and Austria (AT)..

Also, X-tendo consortium members leading the development of six innovative features selected for their relevance in view of the purpose of the analysis were involved to provide information on the required input data of these feature determination methods. The following features were considered in the analysis;

- F1: Smart Readiness Indicator
- F2: Comfort
- F3: Outdoor Air Pollution
- F4: Real Energy Consumption (indicated in the current analysis as F4a)
- F5: District Energy
- F8: Enhanced recommendations

This has led to data acquisition of 174 inputs provided by six feature leads and nine country experts. Figure 4 contains an excerpt of the analysis input table.

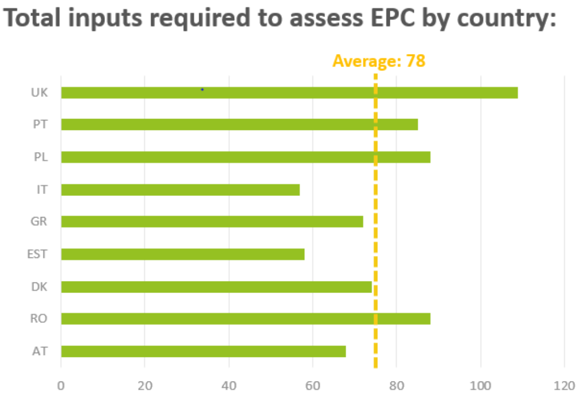
No.	Input data (Level 1)	Input data (Level 2)	EPC Input data (Level 3)	Unit	Data type (input/default)	OBS - EPC information	AT	RO	DK	EST	GR	IT	PL	PT
36	Building	Technical Energy System	Space cooling service exists		Default		1	1	1	1	1	1	1	1
37	Building	Technical Energy System	Space heating service exists		Default		1	1	1	1	1	1	1	1
38	Building	Ventilation system	Fan power	kW	Default		1	1	0	1	1	1	1	1
39	Building	Energy performance indicato	Cooling primary energy demand (not renewable)	kWh	Input		0	1	0	0	1	1	1	1
40	Building	Energy performance indicato	Cooling primary energy demand (renewable)	kWh	Input		0	1	0	0	0	1	0	1
41	Building	Energy performance indicato	Global CO2 emission (heating, cooling, dhw, etc.)	kCO	Default		1	1	1	0	1	1	1	1
42	Building	Energy performance indicato	Global primary energy demand (not renewable)	kWh	Default		1	0	1	0	1	1	1	1
43	Building	Energy performance indicato	Global primary energy demand (renewable)	kWh	Default		1	0	1	0	0	1	0	1
44	Building	Energy performance indicato	Heating primary energy demand (not renewable)	kWh	Default		0	0	1	1	1	1	1	1

Figure 4 – Excerpt of the data acquisition table of the synergies analysis

Similarity of the required data input of the feature methods and the EPC assessment methods is quantified using the Jaccard index or similarity coefficient, which represents the ratio of the size of the intersection over the size of the union, resulting in a value between zero and one; zero representing no overlap or similarity and one representing full overlap or maximum similarity.

2.3 Synergy analysis results and main outcomes

The bar charts in Figure 5 depict the number of all the input parameters required to assess EPC in the nine different countries and for the six features considered in the analysis.



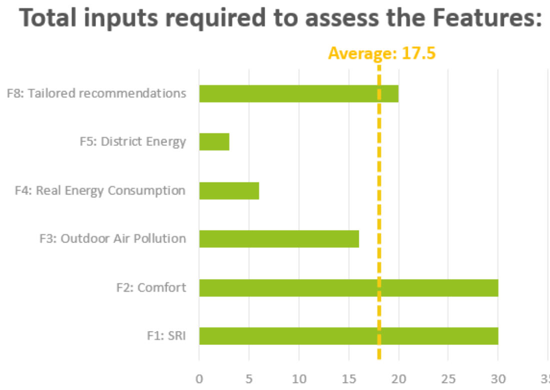


Figure 5 – Total number of inputs required to assess EPC (left) and X-tendo features (right)

The assessment methods of the features require a smaller number of input parameters compared to the number required for EPC assessment.

Variation is high, both for the number of input parameters required for the EPC assessment methods in the different countries and for the number of inputs required for the feature assessment methods.

There is very little overlap in input data required for the various features.

The overlap between features and country EPC input parameters is quantified by means of the Jaccard index (0: different, 1: identical). The results are graphically depicted in Figure 6.

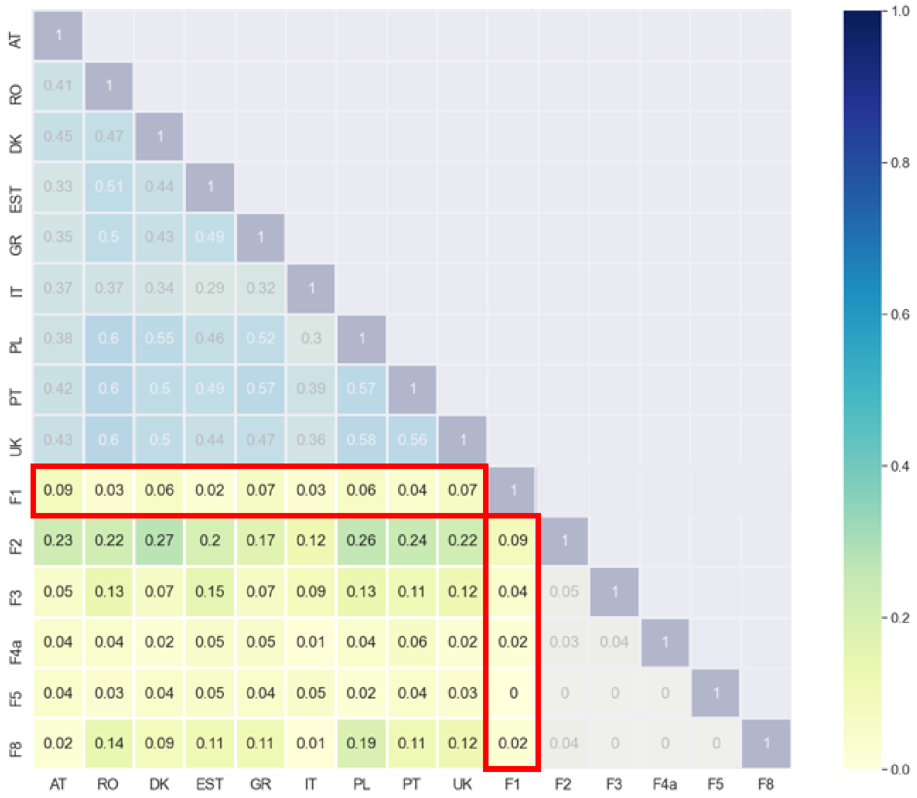


Figure 6 Distance between countries and features (Jaccard index; 0=different; 1=identical)

The horizontal rectangle in line colour red highlights the results for F1 SRI showing very low overlap in required input data between F1 SRI method and country EPC methods hinting at a very low opportunity to reduce efforts and costs for data acquisition when implementing F1 SRI in any one of the countries considered in the analysis. Similarly, very low overlap in required input data between feature methods can be seen when analysing potential synergies between the features considered in the analysis, which is shown in the results highlighted by the vertical rectangle in line colour in Figure 1Figure 6.

It should be noted that in case of a joint implementation of two or more different indicator assessments, a reduction in efforts and associated costs is even so to be expected because of a reduction in the amount of common activities part of the assessment procedures of the various indicators other than the actual input data acquisition activity, such as for instance transport to and from the building unit site or other cost reductions associated with bulk activities. Such benefits of a joint implementation are not reflected in the results described in this chapter.

3 VERIFICATION CALCULATIONS

3.1 Introduction

Calculations with the methodologies of F1, 2, 3, 4 and 5 were executed on (composed) theoretical reference buildings taking into account the variety in terms of location and climatic conditions (Northern, Central and Southern Europe).

The objective of the calculations is to verify the procedures of the calculation method of F1 in terms of

- the functionality; the calculation tools work for inputs of specific cases; (inputs; available input selection options, calculation and output generation);
- the sensitivity (impact of combination of extreme input parameters on calculation results);
- the usability (clear definition of inputs, avoidance of unnecessary input complexity, clear procedure for the executioner to obtain the results and clear interpretation of the output).

In this section only the verification calculations executed with X-tendo F1 SRI calculation spreadsheet is reported on.

3.2 Analysis programme

Two residential reference building units are defined with two levels of input parameters;

- one single family house with energy performance characteristics referred to as new, representing the high level of energy performance, described in tab "SFH_new";
- one single family house with energy performance characteristics referred to as old, representing the low level of energy performance, described in tab "SFH_old";
- one apartment unit with energy performance characteristics referred to as new, representing the high level of energy performance, described in tab "APT_new";
- one apartment unit with energy performance characteristics referred to as old, representing the low level of energy performance, described in tab "APT_old";

Feature 1 specific input parameters have been defined with two levels of input for each of the input parameters of feature 1; one corresponding with a high level of performance and one corresponding with low level of performance.

Climatic zone definitions are adopted from the Aldren project for 3 zones; "Warm", "Moderate" and "Cold" climate for use in X-Tendo task on verification calculation.

The following table contains a summary of the classification criteria and the locations representing the climatic zones.

Table 1 – Aldren project climatic zones definition

Climate zone definition		Represented by				
Name	HDD*ref [K.day]	Name	Latitude [decimal value]	Longitude [decimal value]	HDD** ref [K.day]	CDD** ref [K.day]
Warm	≤1200	Palermo	38,122	13,361	871	271
Moderate	1201-4000	Bratislava	48,149	17,107	2873	39
Cold	>4000	Helsinki	60,171	24,933	4215	0

*HDD: Calculation according to the rules by Eurostat (JRC); ** Difference with values in original Aldren publication are due to other reference period.

The climatic data of TMY are derived from data of the period 2007-2016 from JRC TMY generator tool (JRC; 2022). HDD and CDD are calculated according to the Eurostat rules (Eurostat; 2022);

- HDD is calculated according to following formula;

  for mean air temperature of day: If Tm ≤ 15°C Then [HDD = ∑i(18°C - Tim)] Else [HDD = 0] where Tim is the mean air temperature of day i.

- CDD is calculated according to following formula;

  for mean air temperature of day: If Tm ≥ 24°C Then [CDD = ∑iTim - 21°C)] Else [CDD = 0] where Tim is the mean air temperature of day i.

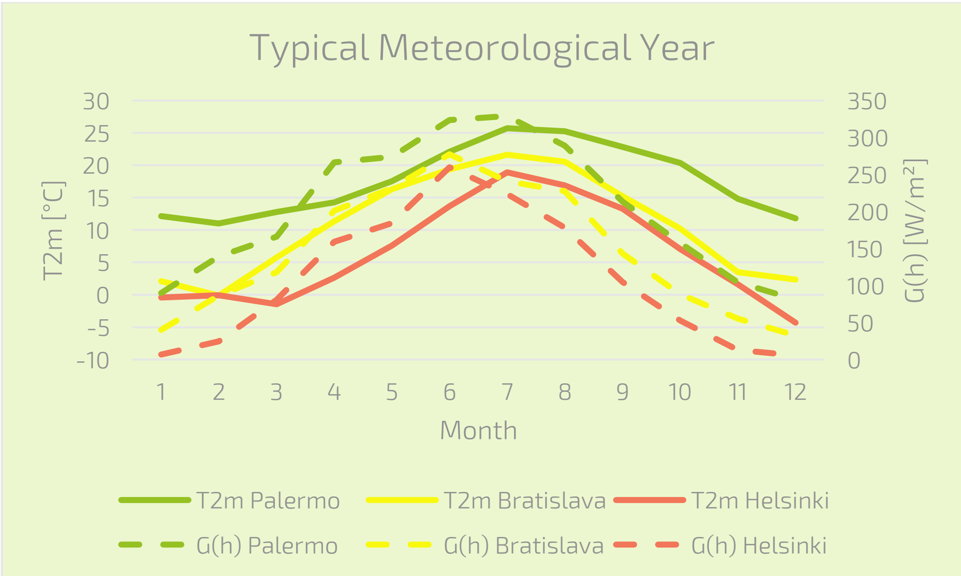


Figure 7: Typical Meteorological Year monthly average 2m air temperatures and global horizontal irradiation for 3 locations representing Warm, Moderate and Cold climate in Europe.

For each location, Palermo, Bratislava and Helsinki, representing respectively Warm, Moderate and Cold zone climate, a file is constructed containing climate data for a typical meteorological year on the basis of JRC TMY generator tool and translated to monthly and year TMY values.

Source data can be obtained from JRC TMY generator tool (JRC; 2022).

Calculations are executed for all reference building cases (SFH and APT) combining the SFH_new or APT_new with the feature specific inputs corresponding with high performance level and combining the SFH_old and APT_old with the feature specific inputs corresponding with low performance level. This results in 4 analysis cases for which calculations need to be done in 3 climatic zones each, rendering a total of 12 calculations.

3.3 Verification calculation results and main outcomes

The F1 SRI verification calculation output is included in annex 1.

Revision of the Feature tool files has been processed based on the findings from verification calculations; the process and the calculation outcomes; difficulties encountered during execution of the process in terms of input options, execution procedure and expected outcomes. Some minor bugs had been detected in the calculation spreadsheet during the process of executing the verification calculations. These minor bugs were all fixed and communicated to the developers of the official SRI calculation spreadsheet.

Apart from these minor bugs, the verification outcomes did not reveal errors, anomalies, or unexpected score values. In that sense the results of the F1 SRI verification calculations confirm correct implementation of the SRI calculation method in the calculation tool for the given cases. The results of the findings on aspects of functionalities, usability and clarity of the calculation tool from the verification calculations were used to improve the calculation and guideline tool files in preparation the beta version of the X-tendo F1 SRI tool.

4 IN BUILDING TESTING

4.1 Introduction

The Smart Readiness Indicator methodology - including revisions for improvement to the tool as a result of the advisory board meeting discussions, the internal review feedback and the verification exercises - has been tested by EPC assessors in practice in different building types in four European Member States: Austria, Estonia, Greece and Romania. Table 2 includes the number of buildings and the building categories included in the in-building testing.

Table 2: buildings included in the in-building testing of feature 1: SRI

Country	Number of buildings	Building category
AT-Austria	10	SFH, MFH, Schools, public buildings
EE-Estonia	10	MFH
GR-Greece	4	Office buildings
RO-Romania	4	School/kindergarten, SFH, MFH, Office

The experiences and insights gained from the in-building testing, guidelines for implementation and the analysis of the replicability potential are reported on in the deliverable reports of WP5.

Within the X-tendo process of testing the X-tendo SRI version of the calculation spreadsheet, several suggestions for improvements were captured of which the most important ones were processed in the SRI X-tendo final version of the tool. The main findings and most important suggestions for improvements resulted from the in-building testing are summarized in this section.

The reader is referred to the publications from Work Package 5; D5.2 and D5.3 for further and more detailed information on the in-building testing of F1 SRI, more specifically in the following X-tendo publications:

- D5.2: Summary documents from test cases
- D5.3: Report on the implementation guidelines and replicability potential

4.2 Main outcomes of the in-building testing

After evaluation of the in-building testing, the following outcomes were reported as the most important ones:

- The SRI assessment procedure was found to be straight forward and easily to be implemented into an energy audit or a standard EPC assessment in most cases.
- The X-tendo SRI guidelines and calculation spreadsheets were judged to be clearly explained.
- The time required for preparation, gathering of additional data and applying the X-tendo SRI calculation spreadsheet was on average around 2,5 hours per EPC. It

concerns the time of performing all tasks required to determine the SRI (independent of EPC assessment).
- The estimated extra costs raised concerns regarding the potential for implementation in the EPC regulations of the Member States. This was judged to be the most important potential improvement of the feature. It is suggested to consider modification to the SRI methodology with the aim of reducing the time and costs required for the completion of an SRI assessment.

The following suggestions for improvement of more specific aspects were selected as most important ones to take into consideration for improvement upgrades of the SRI methodology:

- Introduction of a slider in the calculation spreadsheet for selection of the share of the functionality level to improve the user-friendliness of the calculation spreadsheet.
- Rename the term "Climate zone" to "Location" for the reason that no climate related information is processed.

5 CONCLUSION

In the X-tendo project, the inclusion of the SRI assessment in EPC frameworks has been evaluated by looking into several specific aspects.

A data input analysis exploring synergies between SRI, EPC and five other X-tendo features revealed very low overlap in input parameters between the SRI and the EPC assessment methods of the 9 countries considered as well as with the other features. These insights hint at a very low additional potential to reduce efforts and costs for data acquisition in case of a joint implementation on top of the reductions in other cost associated with a joint implementation.

The findings from verification calculations on theoretical reference buildings analysing aspects of functionalities, usability and clarity of the calculation tool were used to improve the calculation and guideline tool files of the X-tendo F1 SRI tool, consecutively tested in buildings in 4 countries.

From the evaluation of in-building testing in 4 countries including various building types it was concluded that the X-tendo SRI assessment procedure is clearly explained and easily to be implemented in standard EPC assessment methods in most cases.

Adapting the SRI assessment methodology to lower the time required (on average 2,5 hours) and the costs associated with it was judged to be the most important potential for improvement of the feature.

Based on the findings from testing the SRI in X-tendo, it is concluded that the X-tendo version of the SRI assessment methodology - which in its essence is almost entirely the same as the simplified method A of the SRI assessment methodology as currently endorsed in EU regulation – is well suited for integration in existing EPC frameworks.

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ANNEXES

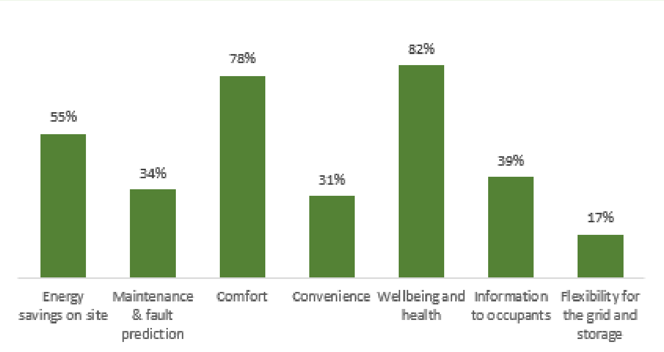
ANNEX 1: RESULT TABLES OF SRI ASSESSMENT OBTAINED IN THE VERIFICATION CALCULATION EXERCISE

1. SFH new - Palermo

TOTAL SRI SCORE	**40%**

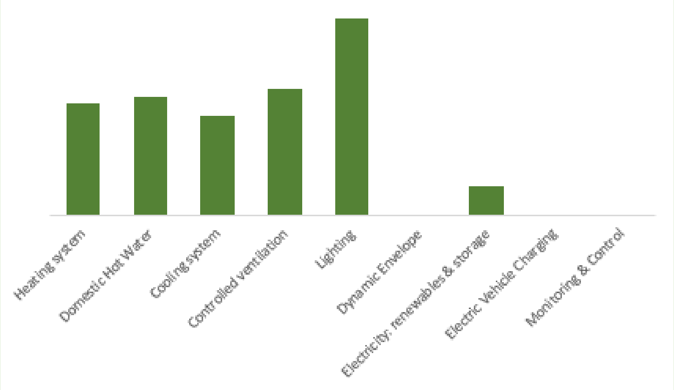
IMPACT SCORES

Energy savings on site	55%
Maintenance & fault prediction	34%
Comfort	78%
Convenience	31%
Wellbeing and health	82%
Information to occupants	39%
Flexibility for the grid and stora	17%



DOMAIN SCORES

Heating system	57%
Domestic Hot Water	60%
Cooling system	51%
Controlled ventilation	64%
Lighting	100%
Dynamic Envelope	
Electricity: renewables & storag	15%
Electric Vehicle Charging	
Monitoring & Control	0%

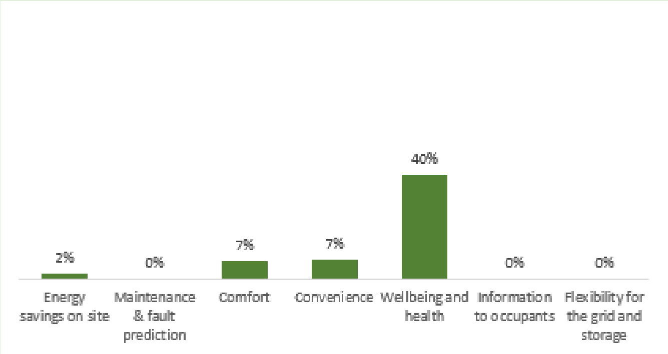


2. SFH old - Palermo

TOTAL SRI SCORE	**3%**

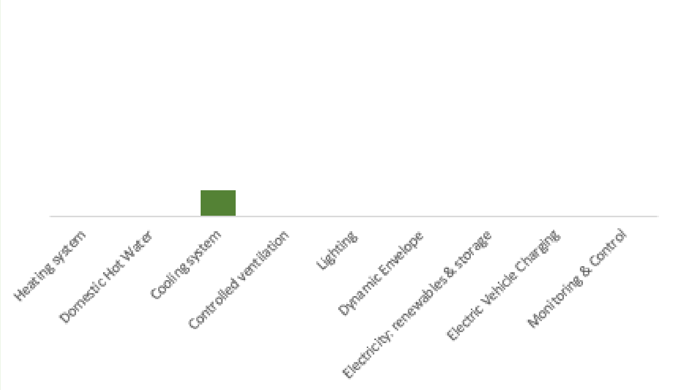
IMPACT SCORES

Energy savings on site	2%
Maintenance & fault prediction	0%
Comfort	7%
Convenience	7%
Wellbeing and health	40%
Information to occupants	0%
Flexibility for the grid and stora	0%



DOMAIN SCORES

Heating system	0%
Domestic Hot Water	0%
Cooling system	13%
Controlled ventilation	
Lighting	0%
Dynamic Envelope	
Electricity: renewables & storag	
Electric Vehicle Charging	
Monitoring & Control	0%

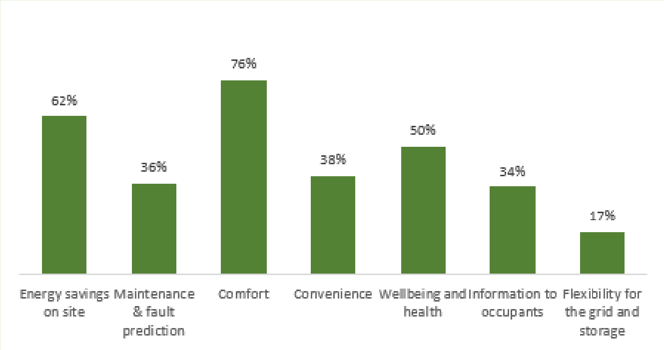


3. APT new - Palermo

TOTAL SRI SCORE	**41%**

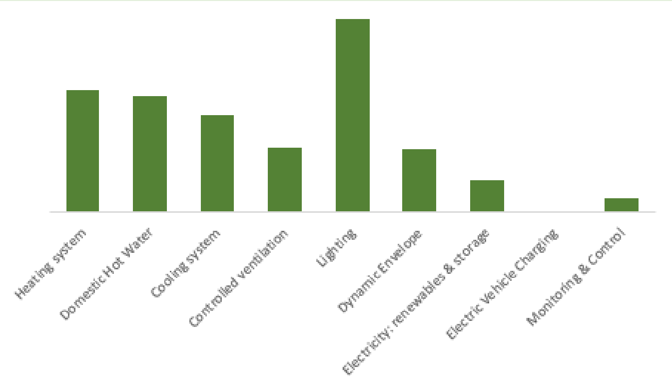
IMPACT SCORES

Energy savings on site	62%
Maintenance & fault prediction	36%
Comfort	76%
Convenience	38%
Wellbeing and health	50%
Information to occupants	34%
Flexibility for the grid and storage	17%



DOMAIN SCORES

Heating system	64%
Domestic Hot Water	60%
Cooling system	51%
Controlled ventilation	34%
Lighting	100%
Dynamic Envelope	33%
Electricity: renewables & storage	17%
Electric Vehicle Charging	
Monitoring & Control	8%

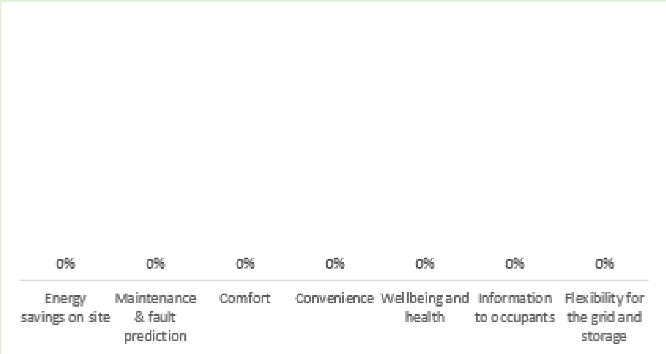


4. APT old - Palermo

TOTAL SRI SCORE	**0%**

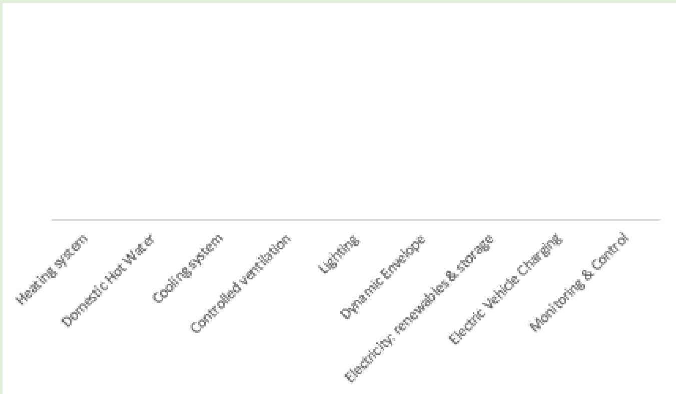
IMPACT SCORES

Energy savings on site	0%
Maintenance & fault prediction	0%
Comfort	0%
Convenience	0%
Wellbeing and health	0%
Information to occupants	0%
Flexibility for the grid and stora	0%



DOMAIN SCORES

Heating system	0%
Domestic Hot Water	0%
Cooling system	0%
Controlled ventilation	0%
Lighting	
Dynamic Envelope	
Electricity: renewables & storag	
Electric Vehicle Charging	
Monitoring & Control	0%

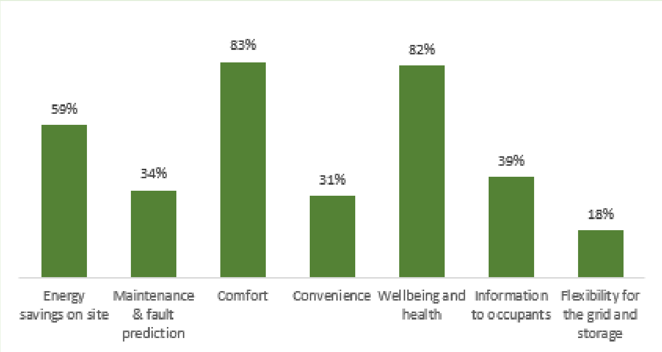


5. SFH new - Bratislava

TOTAL SRI SCORE	**43%**

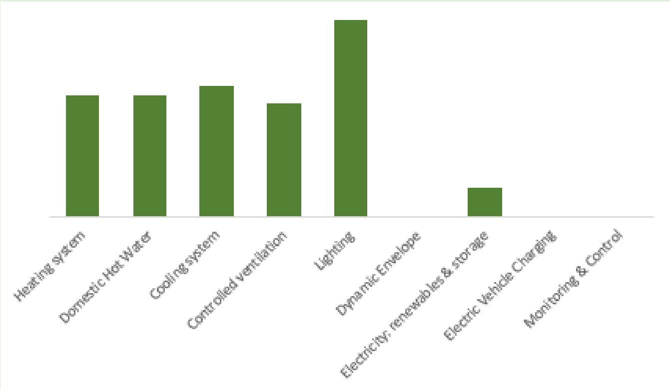
IMPACT SCORES

Energy savings on site	59%
Maintenance & fault prediction	34%
Comfort	83%
Convenience	31%
Wellbeing and health	82%
Information to occupants	39%
Flexibility for the grid and stora	18%



DOMAIN SCORES

Heating system	62%
Domestic Hot Water	61%
Cooling system	66%
Controlled ventilation	58%
Lighting	100%
Dynamic Envelope	
Electricity: renewables & storag	14%
Electric Vehicle Charging	
Monitoring & Control	0%

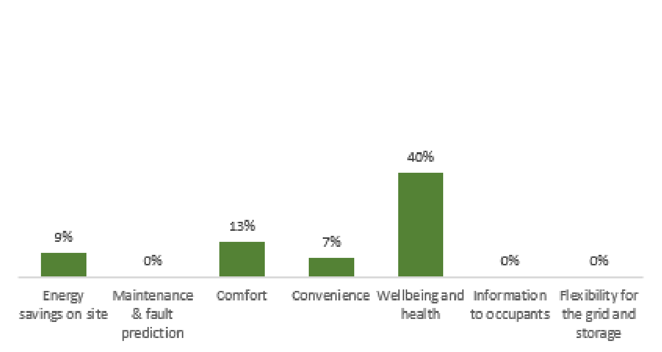


6. SFH old - Bratislava

TOTAL SRI SCORE	5%

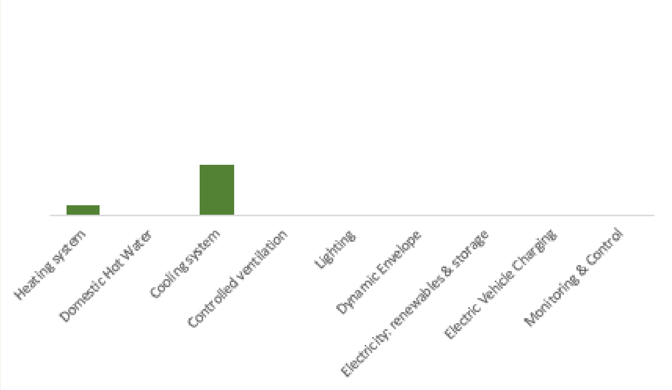
IMPACT SCORES

Energy savings on site	9%
Maintenance & fault prediction	0%
Comfort	13%
Convenience	7%
Wellbeing and health	40%
Information to occupants	0%
Flexibility for the grid and stora	0%



DOMAIN SCORES

Heating system	5%
Domestic Hot Water	0%
Cooling system	26%
Controlled ventilation	
Lighting	0%
Dynamic Envelope	
Electricity: renewables & storag	
Electric Vehicle Charging	
Monitoring & Control	0%

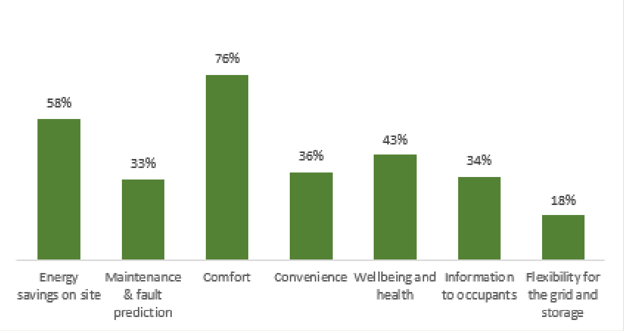


7. APT new - Bratislava

TOTAL SRI SCORE	40%

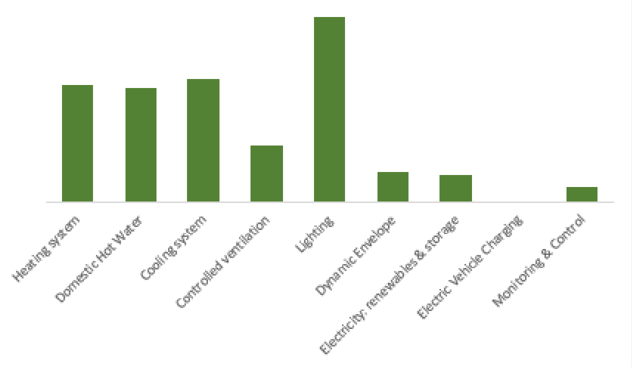
IMPACT SCORES

Energy savings on site	58%
Maintenance & fault prediction	33%
Comfort	76%
Convenience	36%
Wellbeing and health	43%
Information to occupants	34%
Flexibility for the grid and stora	18%



DOMAIN SCORES

Heating system	63%
Domestic Hot Water	61%
Cooling system	66%
Controlled ventilation	31%
Lighting	100%
Dynamic Envelope	16%
Electricity: renewables & storag	14%
Electric Vehicle Charging	
Monitoring & Control	8%

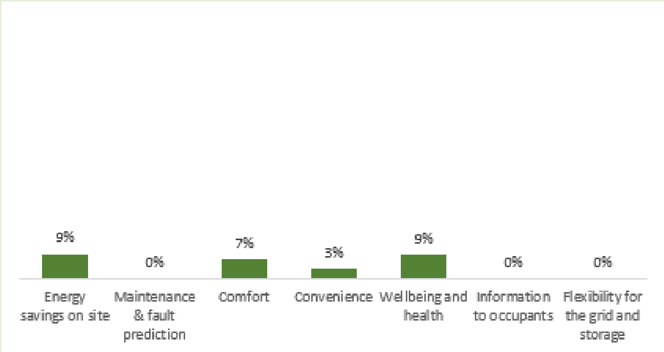


8. APT old - Bratislava

TOTAL SRI SCORE	**4%**

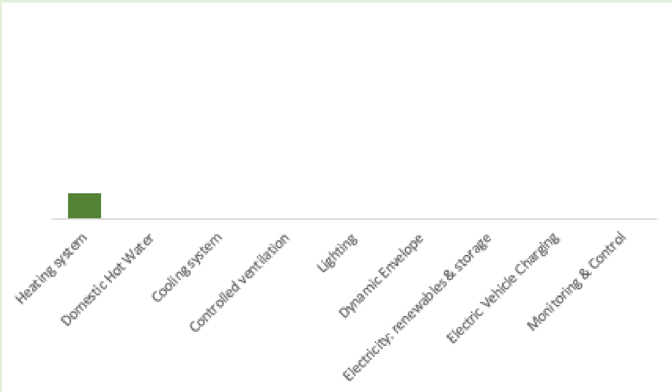
IMPACT SCORES

Energy savings on site	9%
Maintenance & fault prediction	0%
Comfort	7%
Convenience	3%
Wellbeing and health	9%
Information to occupants	0%
Flexibility for the grid and stora	0%



DOMAIN SCORES

Heating system	13%
Domestic Hot Water	0%
Cooling system	0%
Controlled ventilation	0%
Lighting	
Dynamic Envelope	
Electricity: renewables & storag	
Electric Vehicle Charging	
Monitoring & Control	0%

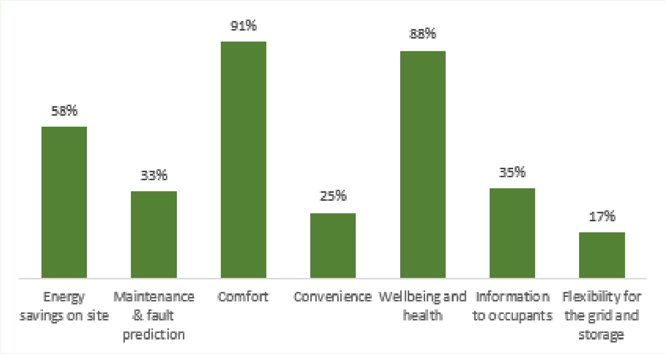


9. SFH new – Helsinki

TOTAL SRI SCORE	**40%**

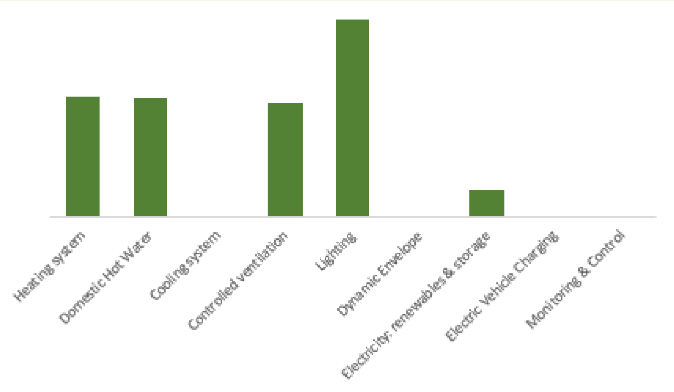
IMPACT SCORES

Energy savings on site	58%
Maintenance & fault prediction	33%
Comfort	91%
Convenience	25%
Wellbeing and health	88%
Information to occupants	35%
Flexibility for the grid and stora	17%



DOMAIN SCORES

Heating system	61%
Domestic Hot Water	60%
Cooling system	
Controlled ventilation	58%
Lighting	100%
Dynamic Envelope	
Electricity: renewables & storag	14%
Electric Vehicle Charging	
Monitoring & Control	0%

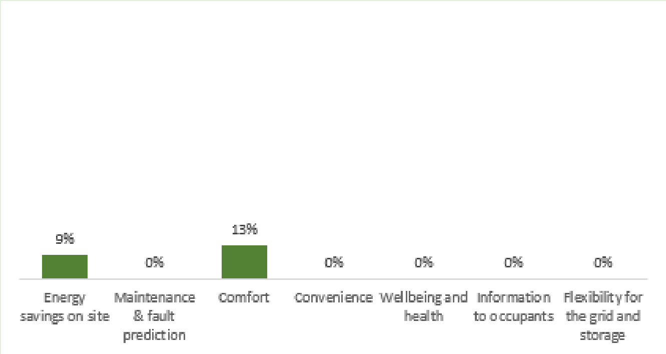


10. SFH old – Helsinki

TOTAL SRI SCORE	**3%**

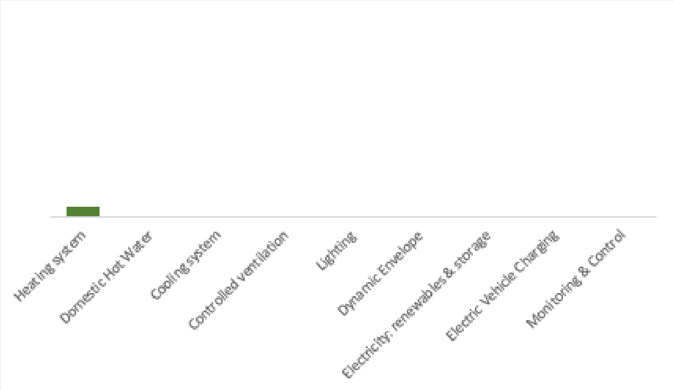
IMPACT SCORES

Energy savings on site	9%
Maintenance & fault prediction	0%
Comfort	13%
Convenience	0%
Wellbeing and health	0%
Information to occupants	0%
Flexibility for the grid and stora	0%



DOMAIN SCORES

Heating system	5%
Domestic Hot Water	0%
Cooling system	
Controlled ventilation	
Lighting	0%
Dynamic Envelope	
Electricity: renewables & storag	
Electric Vehicle Charging	
Monitoring & Control	0%

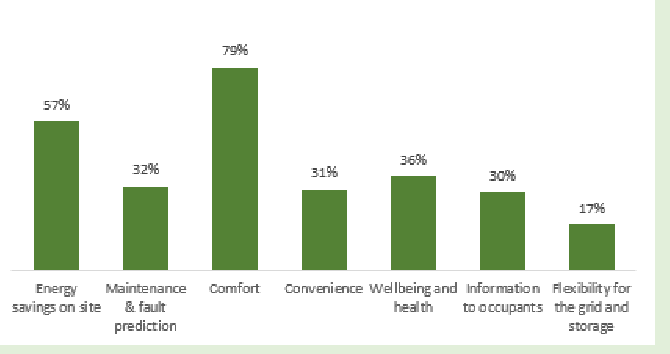


11. APT new – Helsinki

TOTAL SRI SCORE	**38%**

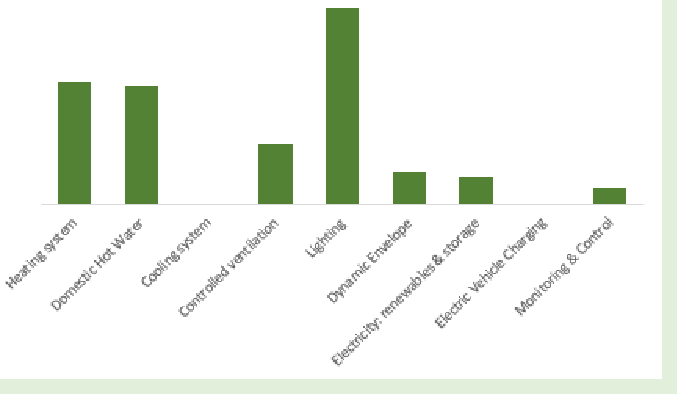
IMPACT SCORES

Energy savings on site	57%
Maintenance & fault prediction	32%
Comfort	79%
Convenience	31%
Wellbeing and health	36%
Information to occupants	30%
Flexibility for the grid and stora	17%



DOMAIN SCORES

Heating system	63%
Domestic Hot Water	60%
Cooling system	
Controlled ventilation	30%
Lighting	100%
Dynamic Envelope	16%
Electricity: renewables & storag	14%
Electric Vehicle Charging	
Monitoring & Control	8%

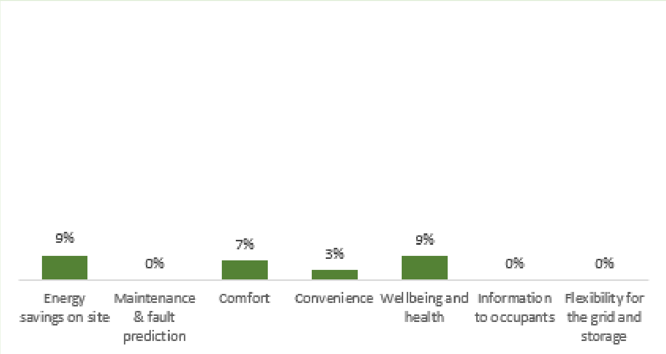


12.APT old - Helsinki

TOTAL SRI SCORE	**4%**

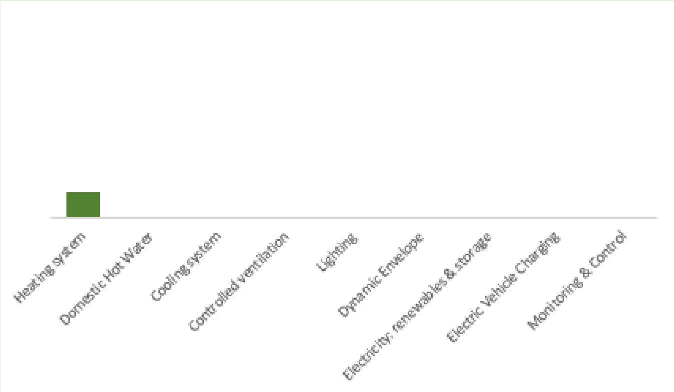
IMPACT SCORES

Energy savings on site	9%
Maintenance & fault prediction	0%
Comfort	7%
Convenience	3%
Wellbeing and health	9%
Information to occupants	0%
Flexibility for the grid and stora	0%



DOMAIN SCORES

Heating system	13%
Domestic Hot Water	0%
Cooling system	0%
Controlled ventilation	0%
Lighting	
Dynamic Envelope	
Electricity: renewables & storag	
Electric Vehicle Charging	
Monitoring & Control	0%



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

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