eXTENDing the energy performance assessment and

certification schemes via a mOdular approach

Guidance document for Feature 1:

Smart readiness Indicator

Adapted from original version to X-tendo project

BETA version
August 2021

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

Deliverable No.	D3.3
Dissemination Level	Internal
Work Package	WP3
Lead beneficiary	VITO
Contributing beneficiary(ies)	VITO
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Reviewed by	e-think
Date	31/08/2021
File Name	X-tendo_F4_Guidelines_Draft_v3

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LIST OF ABBREVIATIONS

BACS	Building Automation and Control System
CHP	Combined Heat and Power
CW	Cold Water
DHW	Domestic Hot Water
DR	Demand Response
DSM	Demand Side Management
EV	Electric Vehicle
HW	Hot Water
IAQ	Indoor Air Quality
RES	Renewable Energy Source
SOC	State Of Charge
TABS	Thermally Activated Building Systems
TBS	Technical Building System
TES	Thermal Energy Storage
VOC	Volatile Organic Compounds

1. INTRODUCTION TO THE CALCULATION METHOD

This document provides guidance to pilot building assessors to test the draft version of the calculation methodology and assessment process of the Smart Readiness Indicator (SRI) for Buildings.

This document is accompanied by a calculation spreadsheet. Both this guidance document and the calculation sheet are draft deliverables of X-tendo project which explores the synergies between SRI, EPC and other features. The methodology and look and feel of the SRI which might eventually be implemented by the European Union Member States might still differ significantly from the current draft deliverables.

In this testing, X-tendo assessors and pilot buildings are invited to test the draft SRI assessment process and provide feedback to the technical study team. Although the extended SRI methodology includes different assessment options, the following default parameters have been set for X-tendo:

- ⊙ Simplified calculation method A: calculation excel provided[1]
- ⊙ Default weighting factors
- ⊙ Default ordinal scores

You will find more information about the feature "Real Energy Consumption" of the EU X-tendo project in the following link: https://x-tendo.eu/toolboxes/smart-readiness/

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[1] It exist an alternative Method B calculation sheet – more detailed. For the shake of clarity, it has been decided that it will not be used in X-tendo.

2. ASSESSMENT INSTRUCTIONS: STEP BY STEP

2.1 Before you begin…

Building included in the X-tendo pilot phase can be a residential- or non-residential building, both newly constructed and existing. Performing the SRI assessment will require the assessor to have a walk-through of the building with appropriate access to the technical building systems. Access to documentation or contact with the facility manager will likely also be of relevance.

The following lines describe the steps and information that the assessor needs to perform the assessment using the calculation sheet. Not all the sheets require direct action from the assessor:

Colour codes:

- ⊙ Sheets in green – no action is required; contain instructions, value-codes needed to perform the assessment and the display of results
- ⊙ Sheets in red – action required
- ⊙ Sheets in yellow – SRI summary of results

2.2 The "summary building input data" sheet

Start by filling out general building information. This step is the first to take and will allow the assessor to determine the building services available (in the calculation sheet is referred as: *"Building Information"*).

2.2.1 Assessor information

Provide information on the assessor. The study team may use this information to contact you after the field trial to discuss your findings.

2.2.2 General building information

Please fill out the fields as indicated.

Field: Building type

Choose from the following options:

- ⊙ Residential
- ⊙ Non-residential

Field: Building usage

In case of a residential building, please choose from the following options:

- ⊙ **Single family house**
- ⊙ **Small multi-family house:** 10 residential units or less
- ⊙ **Large multi-family house:** more than 10 residential units

⊙ **Other:** student housing, care homes, …

In case of a non-residential building: please choose from the following options:

⊙ Offices
⊙ Educational buildings
⊙ Healthcare
⊙ Other

The selected building type and usage will be used to select the appropriate weighting factors. Note that in the current version, no differentiation has been made in the weighting factors within a building type. In other words, all non-residential buildings currently use the same weighting factors, regardless of their building usage. Further differentiation is envisioned but has not been implemented at this time due to lack of data.

The study team welcomes assessors to provide additional sources to support alternative weighting factors. It should be noted – however – that any weighting factors presented in the second technical study are provisional. **Final weighting factors will be defined by the Member States and/or the European Commission as part of the implementation process.**

Field: Location

Please indicate the location (country) the building is located in. The appropriate climate zone will be determined automatically. **5 climate zones have been defined:**

⊙ **Northern Europe**: Denmark, Finland, Sweden, Norway, Iceland
⊙ **Western Europe**: Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, United Kingdom, Liechtenstein, Switzerland
⊙ **Southern Europe**: Greece, Italy, Malta, Portugal, Spain, Cyprus
⊙ **North-Eastern Europe:** Czechia, Estonia, Latvia, Lithuania, Poland, Slovakia
⊙ **South-Eastern Europe**: Bulgaria, Croatia, Hungary, Romania, Slovenia

Field: Building state

Please indicate the current state of the building:

⊙ **Renovated**: applies to buildings that have undergone important energetic upgrades such as thermal insulation and/or upgrades to the technical building systems since the year of construction.
⊙ **Original:** applies to building that have not undergone important energetic upgrades.

Field: Preferred weightings

• Default

In the context of the X-tendo building tests, please select "default". More information on the calculation of these default weighting factors is provided in chapter 3 of this document.

2.2.3 Triage Process

The SRI calculation implements a triage process to identify which services should be taken into account 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 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.

In this section and the subsequent sections, a number of inputs are required to perform the triage process as described above.

Triage process:

Please indicate for each of the technical building systems (TBS) whether they are present in the building or not. In some cases, if the TBS is not present, the user will be asked to indicate whether the TBS is mandatory in their country or region. This is the case for certain domains that may be desirable from a policy perspective, as described above (Controlled ventilation, Renewables and EV charging).

Please note that in the final version of the SRI the choice between mandatory and non-mandatory should not be made by the individual assessor, but by the implementing body.

2.2.4 Heating

Field: Emission type

Please select from the options below:

- **TABS (Thermally Activated Building System):** this typically applies to embedded water-based surface heating and/or cooling systems, where pipes are embedded in the concrete core of a building's construction (floor slabs, walls). This does not include underfloor heating.
- **Other hydronic system (e.g. radiators):** this applies to systems that use a liquid heat transfer medium, typically water, glycol or mineral oil.
- **Non-hydronic system**: this applies to systems that do not use a liquid heat transfer medium, for instance, an all-air heating system.

Field: Production type

Please select from the options below:

- ⊙ **District heating**: this applies to buildings connected to a district heating system;
- ⊙ **Heat pump**: this applies to heating systems that make use of a heat pump;
- ⊙ **Central heating – combustion**: this applies to central heating systems using a combustion heat generator, such as oil or gas fired boilers;
- ⊙ **Central heating – other**: this applies to other central heating systems;
- ⊙ **Decentral heating (e.g. stoves)**: this applies to systems with individual heaters, such as stoves, electrical heaters or split-unit room air conditioning equipment.

Field: Thermal energy storage

Please select from the options below:

- ⊙ **Storage present:** this applies to heating systems that include storage capabilities, e.g. under the form of a vessel or thermally activate building systems. This does not include underfloor heating.
- ⊙ **No storage present:** this applies to heating systems without storage capabilities.

2.2.5 Domestic Hot Water

Field: Production type

Please select from the options below:

- ⊙ **Non-electric**: this applies to non-electric production of hot water, such as oil or gas fired boilers;
- ⊙ **Electric:** this applies to electric hot water heaters.

Field: Storage present

Please select from the options below:

- ⊙ **Storage present:** this applies to DHW systems that include a storage vessel;
- ⊙ **No storage present:** this applies to DHW systems without storage capabilities.

Field: Solar collectors

Please select from the options below:

- ⊙ **Solar collector present:** this applies to DHW systems that include a solar collector;
- ⊙ **No solar collector present:** this applies to DHW systems without a solar collector.

2.2.6 Cooling

Field: Emission type

Please select from the options below:

- ◉ **TABS (Thermally Activated Building System):** this typically applies to embedded water-based surface heating and/or cooling systems, where pipes are embedded in the concrete core of a building's construction (floor slabs, walls). This does not include underfloor heating.
- ◉ **Other hydronic system (e.g. radiators):** this applies to systems that use a liquid heat transfer medium, typically water, glycol or mineral oil.
- ◉ **Non-hydronic system:** this applies to systems that do not use a liquid heat transfer medium, for instance, an all-air heating system.

Field: Thermal energy storage present

Please select from the options below:

- ◉ **Storage present:** this applies to cooling systems that include storage capabilities, e.g. under the form of a vessel.
- ◉ **No storage present:** this applies to cooling systems without storage capabilities.

2.2.7 Controlled ventilation

Field: System type

Please select from the options below:

- ◉ **Mechanical ventilation:** this applies to all mechanically driven ventilation systems, including balanced ventilation (mechanical exhaust and supply), mechanical exhaust, mechanical supply and hybrid ventilation.
- ◉ **Controlled natural ventilation:** this applies to controlled natural ventilation systems, e.g. automated opening of windows or other dedicated ventilation openings. Manual control of openings is not considered to be controlled natural ventilation. If manual control is needed, please indicate in the triage process that the TBS controlled ventilation is not present.

Field: Heat recovery

This field is only applicable in case of mechanical ventilation.

Please select from the options below:

- ◉ Heat recovery
- ◉ No heat recovery

Field: Space heating

This field is only applicable in case of mechanical ventilation.

Please select from the options below:

- ◉ Used for space heating
- ◉ Not used for space heating

2.2.8 Dynamic Envelope

Field: Movable shades, screens or blinds

Please select from the options below:

- ⊙ **Present:** this applies both to devices providing solar protection (to avoid overheating) and devices avoiding glare;
- ⊙ **Not present:** this is applicable when no devices are present providing solar protection (to avoid overheating) and devices avoiding glare.

2.2.9 Electricity: renewables & storage

Field: On-site renewable electricity generation

Please select from the options below:

- ⊙ **On-site renewable electricity generation**: this includes, but is not limited to photovoltaic cells, electricity from wind and CHP. Note that this field focuses on electricity, solar-thermal panels is covered under DHW;
- ⊙ **Storage of on-site generated renewable electricity:** this includes batteries and thermal energy storage (TES)

2.2.10 Electric Vehicle Charging

Field: On-site parking spots

Please select from the options below:

- ⊙ **On-site parking:** this is applicable if parking is available on-site.
- ⊙ For residential buildings, this may typically include a driveway, garage(s) or dedicated parking spot(s) in a (underground) car park.
- ⊙ For non-residential buildings, this may typically include a garage(s), parking lots or dedicated parking spot(s) in a (underground) car park.
- ⊙ **EV charging:** this applies when at least one of the aforementioned on-site parking spots provides a recharge point;

2.3 The "Calculation sheet" sheet

The calculation sheet is where the actual assessment takes place. Every line in the sheet represents a service of the smart service catalogue. (In the calculation sheet is referred as: *"Calculation Sheet"*)

Based on the triage process, the services that are not applicable to this particular building will be greyed out. No assessment is required for these services. Column O of the calculation sheet explicitly mentions whether a service is to be assessed (1 = to be assessed; 0 = not to be assessed).

For each service to be assessed, three fields may be completed:

- ⊙ **Main functionality level** (column E): please enter the functionality level of the service. A description of the different functionality levels is provided in columns J through N. Please note:
- ⊙ If the field is left blank, or the functionality level is not valid (e.g. higher than the maximum possible functionality level), a warning will be displayed in column I, and no SRI score will be calculated.
- ⊙ If the functionality level is valid, the chosen functionality level (column J-N) will turn orange, to facilitate visual validation.
- ⊙ **Share of the functionality level** (column F): this field enables to test partial compliance of a building to the main functionality level. If you do not wish to test partial compliance, please keep the default value of 100%. Else, indicate the percentage of net surface area of the building that complies with the main functionality level. For further instructions on partial compliance, refer to section 0.
- ⊙ **Optional: additional functionality level** (column G): if the share of the functionality level (column F) is set to less than 100%, please provide the functionality level that applies to the remaining surface area.
- ⊙ **Estimated assessment time** (column P): for testing purposes, please provide the time required to determine this functionality level, including the time needed for visual inspection and/or the time needed to look up technical data.
- ⊙ **Optional: assessor comments** (column Q): please provide comments if desired. This may include, but is not restricted to:
    - ○ Notes
    - ○ Clarifications
    - ○ Difficulties encountered while attempting an assessment

After having completed the assessment, the total SRI score will be displayed in the top right corner.

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 <u>relative importance for the considered impact</u>. 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.

2.4 The "summary of results" sheet

Three types of results are displayed in the "results" sheet:

- ⊙ **Total SRI score**: the total SRI score, taking into account domain weightings and impact weightings.
- ⊙ **Impact scores**: the impact scores for each impact criterion, taking into account domain weightings.
- ⊙ **Domain scores**: the domain scores for each domain, taking into account impact weightings.

(The objective of this tab is to display the results, <u>no action is required by the assessor</u>. In the calculation sheet is referred as: *"Results"*).

Disclaimer: please note that the presentation of results does not reflect the final intended presentation/format of the SRI, but is merely provided for testing purposes. Research on the proper format is ongoing.

2.5 The "assessors evaluation" sheet

The final step included in the assessment is to respond to a few questions regarding the quality and perceived value of the assessment including:

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

(The sheet also includes a summary and a visualization of results. (In the calculation sheet it is referred as: *"Assessor Evaluation"*).

2.6 The "OVERVIEW OF SERVICES" sheet

This section aims at providing a "dictionary" to fill in the values of column E, in the sheet "*Calculation sheet"*. While no modification is needed here, the section provides essential information to complete the exercise and need to be slowly considered. The objective is to identify the services presented in the building and transpose the values to the column E in the sheet "*Calculation sheet"*.

2.7 The "information of weightings" and "Description of domains" sheets

The "weightings sheet" shows the default weights used for the calculations. These figures are given by different aspects such as building typology, the climate or the relevance of a domain with regard to the impact factor.

(In the calculation excel is referred as: *"Weightings"*).

The sheets describing the domains summarize the list of domains that are evaluated, divided in a series of smart ready services applicable to each of them. The smart services are on its

turn subdivided according to a five- level ordinal scale (0-4) that include a definition of the technology installed.

(In the calculation excel these sheets sare referred by each of the domain names: *"heating"*, *"dhw", etc.*).

> These sheets are merely informative and <u>do not need</u> to be modified for the X tendo testing.

2.8 Optional: test partial compliance

In some cases, a building will not comply fully with a given functionality level. For instance, control of artificial lighting power based on daylight levels may be installed in the open office space, but not in corridors. There is only one way in X-tendo to implement this in the SRI calculation:

- ⊙ By default, it is assumed that the selected functionality level applies to the *entire building*. Therefore, the highest functionality level that applies to the entire surface area of the building should be selected. Alternatively, one might also indicate the functionality level that applies to the most relevant share of the building (e.g. a services present throughout a dwelling apart from the attic and corridors).

3. DETAILED DESCRIPTION OF THE DETERMINATION OF WEIGHTING FACTORS

Disclaimer:

Final weighting factors will be defined by the Member States and/or the European Commission as part of the implementation process. The weighting factors defined in the technical study (and in the calculation sheet; *"Weightings tab"*) are therefore provisional, and subject to change.

Two types of weighting factors exist:

- ⊙ Weighting factors for domains (vertical aggregation)
- ⊙ Weighting factors for impact criteria (horizontal aggregation)

3.1 Weighting factors for domains

A two-step approach is applied to aggregate the scores of the individual services to a single impact score for each impact criterion. First, the ordinal scores of the individual services are aggregated to a domain score. Second, the domain scores are aggregated to a single impact score. Different approaches can be envisioned for defining the weighting factors for domains.

For the aggregation of services to the domain level, equal weighting is assumed. In other words - each service within a domain is assumed to be equally important.

The aggregation of domain scores for a single impact score accounts for the relative importance of the domains in relation to the impact criteria. As discussed elaborately in the second interim report, the study team has suggested a mixed approach, using weighting factors based on an energy balance wherever deemed relevant, and supplemented with equal/fixed weighting factors elsewhere. A summary of the approach is illustrated below:
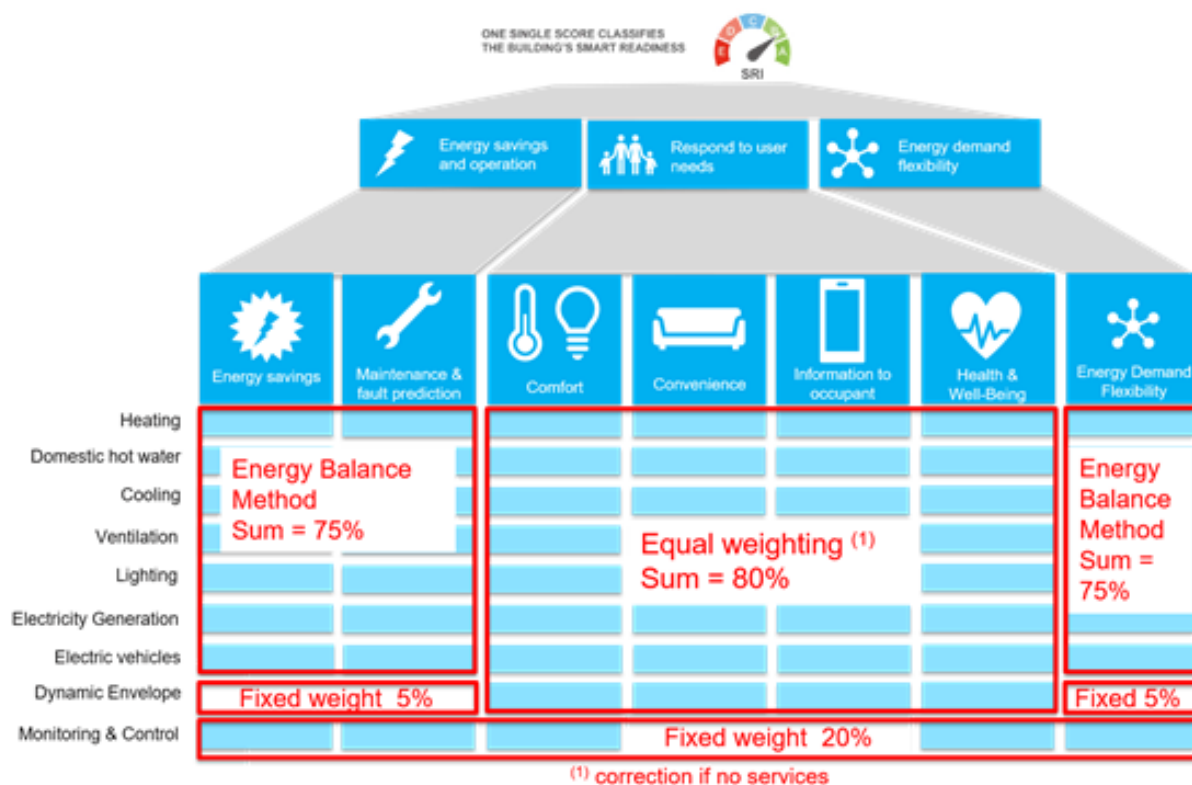
Two approaches can be envisioned to derive weighting factors based on the energy balance:

- ⊙ The use of statistical building stock data;
- ⊙ The use of a building-specific energy balance, for instance from EPC calculations.

The calculation sheet includes a set of default weighting factors, derived from statistical data. The methodology and sources for deriving these weighting factors is provided below. For the purpose of this testing phase, the weighting factors may be altered manually in the calculation sheet, for instance if the assessor is in the possession of a more relevant or specific energy balance (e.g. EPC calculations).

3.1.1 Derivation of default domain weighting factors

Data source: the data used for the determination of the weighting factors is the Building Stock Observatory (BSO): https://ec.europa.eu/energy/en/eu-buildings-database

To reflect the importance of the domains, tailoring to geographical context and building context is foreseen.

Regarding the building context, the default weighting factors currently distinguish between:

- ⊙ Residential buildings
- ⊙ Non-residential buildings

Although a break-down of non-residential buildings into various building types (offices, healthcare, educational, …) is desirable, insufficient data is currently available to quantify this breakdown. X-tendo assessors in possession of such data are invited to provide this information to the study team.

Regarding the geographical context, 5 climate zones have been defined: Northern Europe, Western Europe, Southern Europe, North-Eastern Europe and South-Eastern Europe. The assessor is asked to indicate the location (country) of the building. The climate zone will be attributed automatically.

To determine the weighting factor for a climate zone, national statistical data from the BSO is used and a weighted average is calculated using the population of the respective countries.

The building stock observatory data distinguishes between the following end-uses:

- ⊙ Space heating
- ⊙ Space cooling
- ⊙ Water heating
- ⊙ Lighting

Additional operations are needed to obtain a weighting factor for the domain "controlled ventilation", as it is not included in the BSO energy balance. The energy demand related to controlled ventilation consists of two components: the (auxiliary) electricity demand for fans and the contribution of ventilation to the energy demand for space heating (= ventilation losses). The ratio between the average transmission heat loss coefficient and the average ventilation heat loss coefficient is used. For more information, please consult paragraph 3.1.1.1.

Domains "heating" and "controlled ventilation"

Additional operations are needed to obtain a weighting factor for the domain "controlled ventilation", as it is not included in the BSO energy balance. The energy demand related to controlled ventilation consists of two components: the (auxiliary) electricity demand for fans and the contribution of ventilation to the energy demand for space heating (= ventilation losses).

The total energy demand for space heating may be calculated as follows:

$$Q_H = Q_T + Q_V - \eta * (Q_S + Q_I)$$

where

Q_H is the total energy demand for space heating (W)

Q_T are transmission heat losses (W)

Q_V are the ventilation heat losses (W)

η is the utilization factor for free heat gains

Q_s are the solar gains (W)

Q_I are the internal heat gains (W)

and

$QT = (U * A) * \Delta T = HT * \Delta T$

$QV = (cp * \rho * v) * \Delta T = HV * \Delta T$

where

U is the overall heat transmission coefficient (W/m²K)

A is the area of the exposed surface (m²)

ΔT is the temperature difference (K)

cp is the specific heat of air (J/kgK)

ρ is the density of air (kg/m³)

v is the volume flow rate (m³/s)

HT is the transmission loss coefficient (W/K)

HV is the ventilation loss coefficient (W/K)

To attribute a share of the energy demand for space heating to the "heating" domain, and a share to the "ventilation" domain, the ratio of the transmission loss coefficient and the ventilation loss coefficient will be used. Abstraction has been made of the heat gains.

The following assumptions were made for these coefficients. The numbers were taken from the impact assessment and assume newly constructed buildings (> 2010).

	H_T	H_V
North	78,0	48,9
West	80,6	48,9
South	168,4	48,9

North-East	82,7	48,9
South-East	93,2	48,9

For Northern Europe - for example - the energy demand for space heating will be divided as follows:

- ⊙ 39% for "ventilation" (= 48,9 / (78,0 + 48,9))
- ⊙ 61% for "heating" (= 78,0 / (78,0 + 48,9))

Little detailed information is available on the share of the electricity demand for fans within the total electricity demand of a building. At this moment, the contribution to the electricity demand is neglected in the default weighting factors.

3.1.2 Domain "cooling"

Many buildings across Europe do not have a mechanical cooling system. This means that the national energy consumption for cooling should only be applied to those buildings equipped with a mechanical cooling system.

Two types of data were used to determine the weighting factor for cooling:

- The annual, national energy consumption for space cooling: the building stock observatory: https://ec.europa.eu/energy/en/eu-buildings-database
- The share of buildings equipped with mechanical cooling installations, broken up by country and by building type (residential or non-residential): https://heatroadmap.eu/wp-content/uploads/2018/11/HRE4_D3.2.pdf
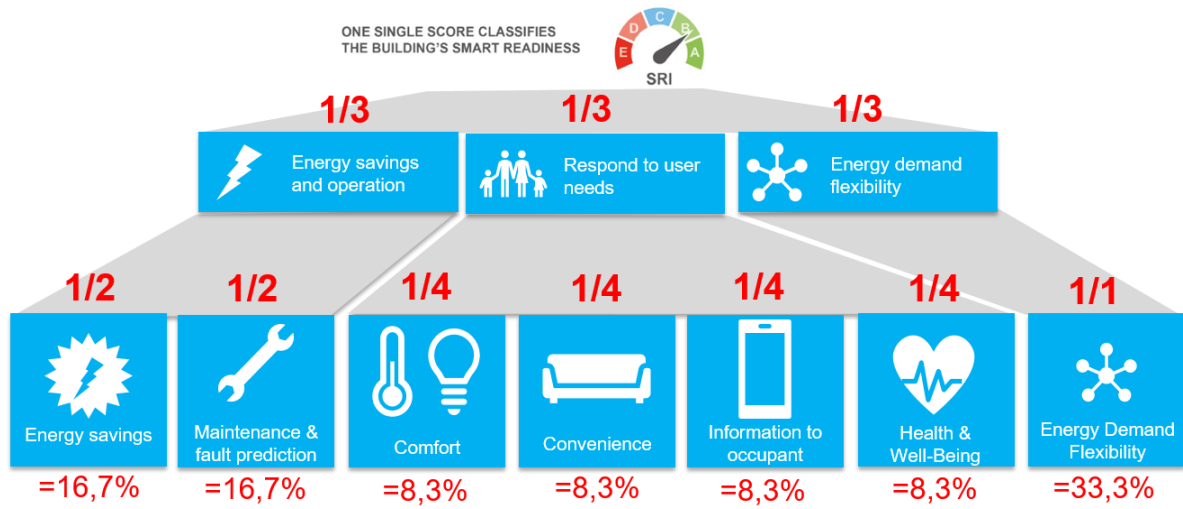
To determine the weighting factor for a climate zone, national data is weighted using the population of the respective countries. Countries with no data on the energy consumption for space cooling have been excluded from the calculation, to avoid a negative impact on the weighting factors.

3.2 Weighting factors for Impact Criteria

To obtain a single SRI score, the 7 impact scores must be aggregated. Different options to define weighting factors for the aggregation are discussed in the interim report of the second technical SRI study. The study team envisions the following approach:

- ⊙ equal weight for the EPBD impact criteria (33.3%)
- ⊙ equal weights within each EPBD criterion:
  - 33% for "energy performance and operation", divided into 16.7% each for "energy savings" and "maintenance & fault prediction";
  - 33% for "needs of the occupant", divided into 8.3% each for "comfort", "convenience", "health and well-being" and "information to occupants";
  - 33% for "energy flexibility and storage".

A graphical summary of the approach is displayed below:

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