REHVA

EPBD 2nd recast: OPPORTUNITIES & CRITICAL ASPECTS

A JOINT SEMINAR with

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SMART READINESS INDICATOR FOR BUILDINGS

EPBD 2nd recast: SRI 1/5

The 2nd EPBD recast is going to introduce a new indicator, the Smart Readiness Indicator (SRI)

"*an assessment of the capabilities of a building or building unit to adapt its operation to the needs of the occupant and the grid and to improve its energy efficiency and overall performance*"

EPBD 2nd recast: SRI 2/5

A delegated act will establish an optional common EU scheme for rating the smart readiness, that:

- define the building smart readiness indicator
- establish a methodology to calculate it

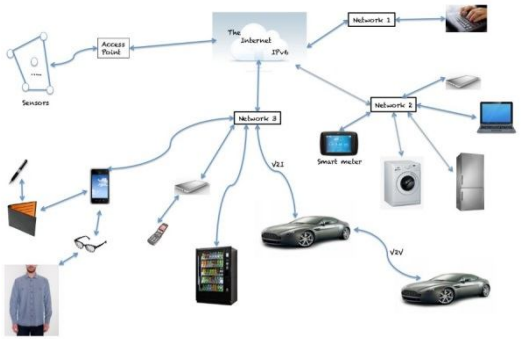
Meanwhile, European Commission has commissioned a technical study to VITO, Waide Strategic Efficiency, Ecofys and OFFIS towards the development of a smart readiness indicator for buildings.

EPBD 2nd recast: SRI 3/5

The indicator shall cover features for enhanced energy savings, benchmarking and flexibility, enhanced functionalities and capabilities resulting from more interconnected and intelligent devices.

EPBD 2nd recast: SRI 4/5

The methodology shall take into account features such as smart meters, building automation and control systems, self-regulating devices for indoor temperature, built-in home appliances, recharging points for electric vehicles, energy storage and detailed functionalities and the interoperability of these features, as well as benefits for the indoor climate condition, energy efficiency, performance levels and enabled flexibility



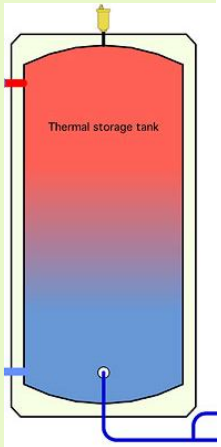
EPBD 2nd recast: SRI 5/5

The methodology shall rely on three key functionalities :

a) the ability to maintain energy efficiency performance and operation of the building through the adaptation of energy consumption for example through use of energy from renewable sources;

It implies:

- High performance building technical systems at partial load operations
- Use of thermal and electrical energy storages, if renewable energy sources have to be used



EPBD 2nd recast: SRI 5/5

The methodology shall rely on three key functionalities :

a) the ability to maintain energy efficiency performance and operation of the building through the adaptation of energy consumption for example through use of energy from renewable sources;

b) the ability to adapt its operation mode in response to the needs of the occupant paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and ability to report on energy use;

It implies:

- BEMS (Building Energy Management System) has to be installed and used instead of a BACS (Building Automation and Control System), if this does not employ the Energy Management feature.

EPBD 2nd recast: SRI 5/5

The methodology shall rely on three key functionalities :

a) the ability to maintain energy efficiency performance and operation of the building through the adaptation of energy consumption for example through use of energy from renewable sources;

b) the ability to adapt its operation mode in response to the needs of the occupant paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and ability to report on energy use; and

c) the flexibility of a building's overall electricity demand, including its ability to enable participation in active and passive as well as implicit and explicit demand-response, in relation to the grid, for example through flexibility and load shifting capacities.

EPBD 2nd recast: SRI 5/5

The methodology shall rely on three key functionalities :

It implies:

- Use of thermal and electrical energy storages, to allow load shifting capabilities;
- Electricity generation systems at the building level (PV system, micro-wind power system, cogeneration and trigeneration systems, etc.) smartly interconnected to the grid.

c) the flexibility of a building's overall electricity demand, including its ability to enable participation in active and passive as well as implicit and explicit demand-response, in relation to the grid, for example through flexibility and load shifting capacities.

SRI Indicator hierarchical structure

SRI INDICATOR

By VITO et alt. based on multi-criteria decision making method

└ 11 DOMAINS — Same importance or weighted importance?

└ SERVICES — Same importance or weighted importance? — each domain: 3 to 17

└ FUNCTIONALITY LEVELS — each service: 2 to 5

Different importance given by the score

└ IMPACT SCORES — 8 impact categories

Same importance or weighted importance?

SRI Domains

By VITO et alt.

- 11 Domains:
  - Heating
  - Domestic hot water
  - Cooling
  - Mechanical ventilation
  - Lighting
  - Dynamic building envelope
  - Energy generation
  - Demand side management
  - Electric vehicle charging
  - Monitoring and control
  - Various

Same importance or weighted importance?

SRI Services: ex. Heating Domain

Domain	Service	Sub-service	Description
Heating	**Heating-1**		**Heat control – demand side**
		Heating-1a	Heat emission control
		Heating-1b	Emission control for TABS (heating mode)
		Heating-1c	Control of distribution network hot water temperature (supply or return) - Similar function can be applied to the control of direct electric heating networks
		Heating-1d	Control of distribution pumps in networks
		Heating-1e	Intermittent control of emission and/or distribution - One controller can control different rooms/zones having same occupancy patterns
		Heating-1f	Thermal Energy Storage (TES) for building heating
		Heating-1g	Building preheating control
	Heating-2		**Control heat production facilities**
		Heating-2a	Heat generator control (combustion and district heating)
		Heating-2b	Heat generator control (heat pump)
		Heating-2c	Sequencing of different heat generators
		Heating-2d	Heat system control according to external signal (such as electricity tariff, gas pricing, load shedding signal etc.)
		Heating-2e	Heat recovery control (e.g. excess heat from data centers)

Same importance or weighted importance?

SRI Functionality Levels

- Functionality levels are ordinal numbers, implying that ranks cannot be compared in between distinct services.
- The number of functionality levels varies from service to service, the maximum level can be as low as 1 or as high as 5.
- A higher functionality level means "smarter" service

Functionality levels for Subservice Heat Emission Control - Heating-1a	
level 0	No automatic control
level 1	Central automatic control (e.g. central thermostat)
level 2	Individual room control (e.g. thermostatic valves, or electronic controller)
level 3	Individual room control with communication between controllers and to BACS
level 4	Individual room control with communication and presence control

SRI Impact Categories

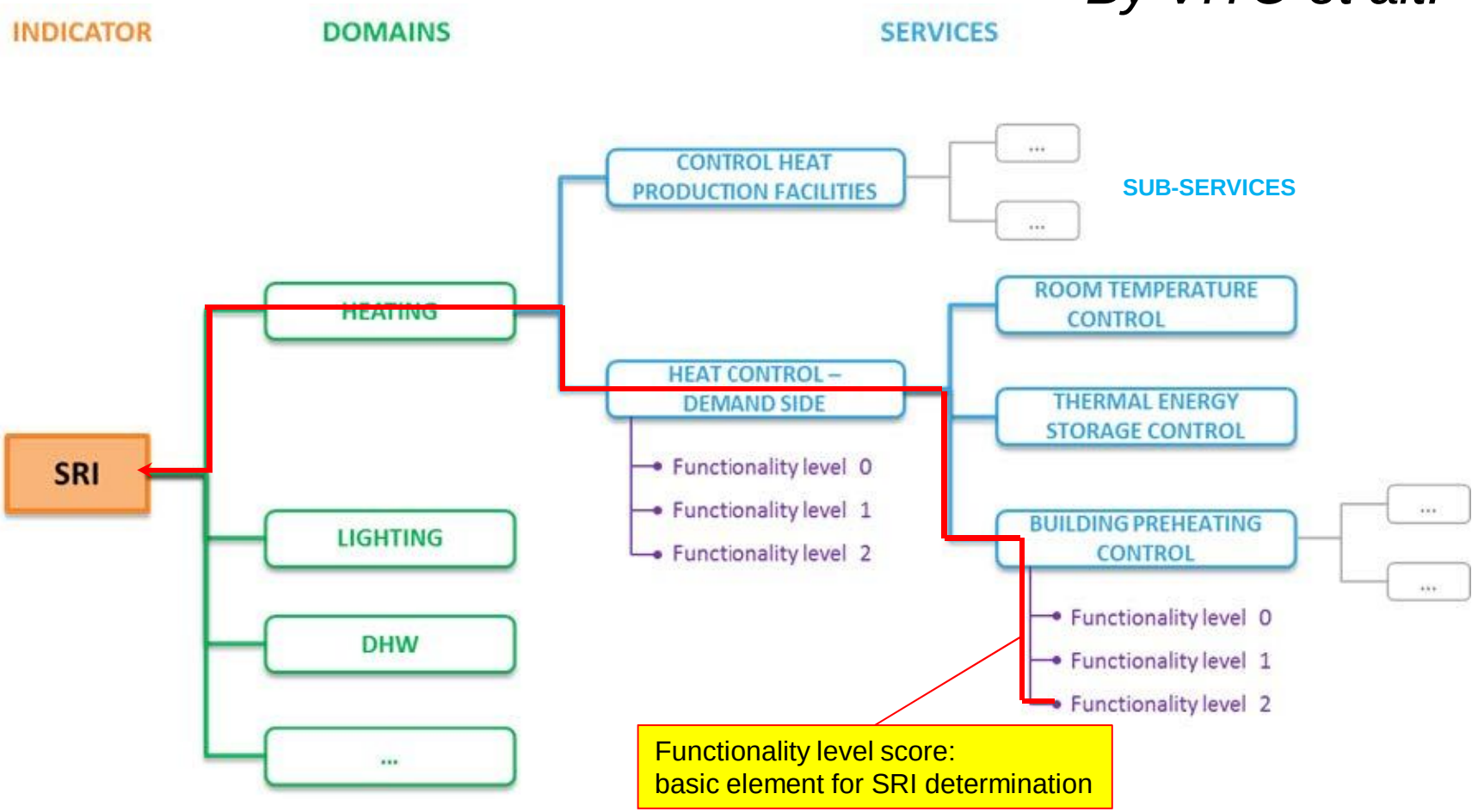
By VITO et alt.

- 8 Impact field
  - Energy savings on site
  - Flexibility for the grid and storage
  - Self generation
  - Comfort
  - Convenience
  - Health
  - Maintenance & fault prediction
  - Information to occupants

Same importance or weighted importance?

SRI Calculation Methodology

By VITO et alt.



Impact of a Functionality Level

By VITO et alt.

- Qualitative relation between Functionality Level of a Subservice and its Impact
- 9 levels cardinal scale : ----,---,--,-,0,+,++,+++,++++

code	service	Subservice?		
Heating-1a	**Heat emission control**	**yes**	If subservice: overarching service is:	**Heat control - demand side**

Functionality levels		**IMPACTS**							
		Energy savings on site	Flexibility for the grid and storage	Self generation	Comfort	Convenience	Health	maintenance & fault prediction	information to occupants
level 0	No automatic control	0	0	0	0	0	0	0	0
level 1	Central automatic control (e.g. central thermostat)	+	0	0	+	+	0	0	0
level 2	Individual room control (e.g. thermostatic valves, or electronic controller)	++	0	0	++	++	0	0	0
level 3	Individual room control with communication between controllers and to BACS	++	0	0	++	+++	0	+	**0**
level 4	Individual room control with communication and presence control	+++	0	0	++	+++	0	+	**0**

Impact Scores

- Ordinal functionality level rankings mapped to nominal impact scores
- 9 qualitative values: ----,---,--,-,0,+,++,+++,++++
- 9 score values (cardinal numbers)

Ordinal ranking	Nominal impact score
++++	4
+++	3
++	2
+	1
0	0
-	-1
- -	-2
- - -	-3
- - - -	-4

Impact Scores of a Functionality Level of a Sub-service

- Qualitative relation between Functionality Level of a Subservice and its Impacts
- Score cardinal values, $SC_{I,D,SS,F}$ (I=impact, D=domain, SS=sub-service, Functionality level)

code	service	Subservice?		
Heating-1a	**Heat emission control**	**yes**	If subservice: overarching service is:	**Heat control - demand side**

Functionality levels		**IMPACTS**							
		Energy savings on site	Flexibility for the grid and storage	Self generation	Comfort	Convenience	Health	maintenance & fault prediction	information to occupants
level 0	No automatic control	0	0	0	0	0	0	0	0
level 1	Central automatic control (e.g. central thermostat)	1	0	0		1	0	0	0
level 2	Individual room control (e.g. thermostatic valves, or electronic controller)	2	0	0	2	2	0	0	0
level 3	Individual room control with communication between controllers and to BACS	3	0	0	2	3	0	1	**0**
level 4	Individual room control with communication and presence control	4	0	0	2	3	0	1	0

SR Impacts Scores

For any given sub-service (SS) in each domain (D) there is a maximum score value for any **impact criterion** (I), $SC_{I,D,SS,Fmax}$

When aggregated across all the sub-services in the domain, a weighting procedure can be applied or not to these maxima as:

$$SC_{I,D,MAX} = \sum_{SS=1}^{N_{SS}} SC_{I,D,SS_{Fmax}} \cdot w_{SS} \quad ; \quad \sum_{SS=1}^{N_{SS}} w_{SS} = 1$$

and these maxima can be used to derive normalised scores as:

$$NSC_{I,D,SS_F} = \frac{SC_{I,D,SS_F} \cdot w_{SS}}{SRS_{I,D,MAX}} 100 \Rightarrow NSC_{I,D} = \sum_{SS=1}^{N_{SS}} NSC_{I,D,SS_F} \leq 100$$

Max Impacts Scores for each S-S

Domain	Service	Sub-service	Impacts Max Score Values							
			E.S.	Flex.	S.G.	Com.	Conv.	Health	M&FP	INFO
Heating	**Heating-1**		**2**	**0**	**0**	**2**	**2**	**0**	**0**	**0**
		Heating-1a	3	0	0	2	3	0	1	0
		Heating-1b	2	0	0	2	3	0	1	1
		Heating-1c	2	0	0	1	2	0	1	0
		Heating-1d	3	0	0	3	0	0	0	0
		Heating-1e	3	0	0	3	3	0	0	0
		Heating-1f	2	0	0	1	0	0	0	0
		Heating-1g	2	0	0	2	2	0	0	1
	Heating-2		**2**	**0**	**0**	**2**	**1**	**0**	**0**	**0**
		Heating-2a	2	0	0	2	0	0	0	0
		Heating-2b	2	1	0	2	0	0	0	0
		Heating-2c	1	1	0	0	0	0	0	0
		Heating-2d	2	1	0	1	1	0	0	0
		Heating-2e	3	0	0	0	0	0	0	0
	Subservices max scores sum		**27**	**3**	**0**	**19**	**14**	**0**	**3**	**2**

Two possibilities:

- sum over all possible sub-services (as in table $N_{ss} = 12$);
- sum only over the actually present sub-services: $N_{ss} < 12$.

Different meaning and values;
not clearly stated in VITO report

SR Impacts Scores Aggregation among Domains

To determine the total impacts scores for each impact field, a weighted sum has to be carried on all the domains:

$$SC_I = \sum_{D=1}^{N_D} NSC_{I,D} \cdot w_D \leq 100 \cdot N_D \quad ; \quad \sum_{D=1}^{N_D} w_D = 1$$

and to normalize between 0 and 100:

$$NSC_I = \frac{1}{N_D} \sum_{D=1}^{N_D} NSC_{I,D} \cdot w_D \leq 100$$

Impacts Scores Aggregation among Domains: weighting factors

An example for a Single Family House is given in VITO report, where the total number of possible domains are considered, i.e. N_D = 10, not the actual ones (i.e. no cooling ➔ N_D = 9)

Domain	Impact criterion							
	Energy savings on site	Flexibility for the grid and storage	Self generation	Comfort	Convenience	Health	maintenance & fault prediction	information to occupants
Heating	66	14	0	40	10	10	10	7
Domestic hot water	18	14	0	10	10	10	10	7
Cooling	4	14	0	15	10	10	10	7
Mechanical ventilation	3	0	0	10	10	10	10	7
Lighting	7	0	0	10	10	10	10	7
Dynamic building envelope	2	0	0	5	10	10	10	7
Energy generation	0	14	80	0	10	10	10	7
Demand side management	0	14	10	5	10	10	10	7
Electric vehicle charging	0	14	10	0	10	10	10	7
Monitoring and control	0	14	0	5	10	10	10	40
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

SRI Final Assessment

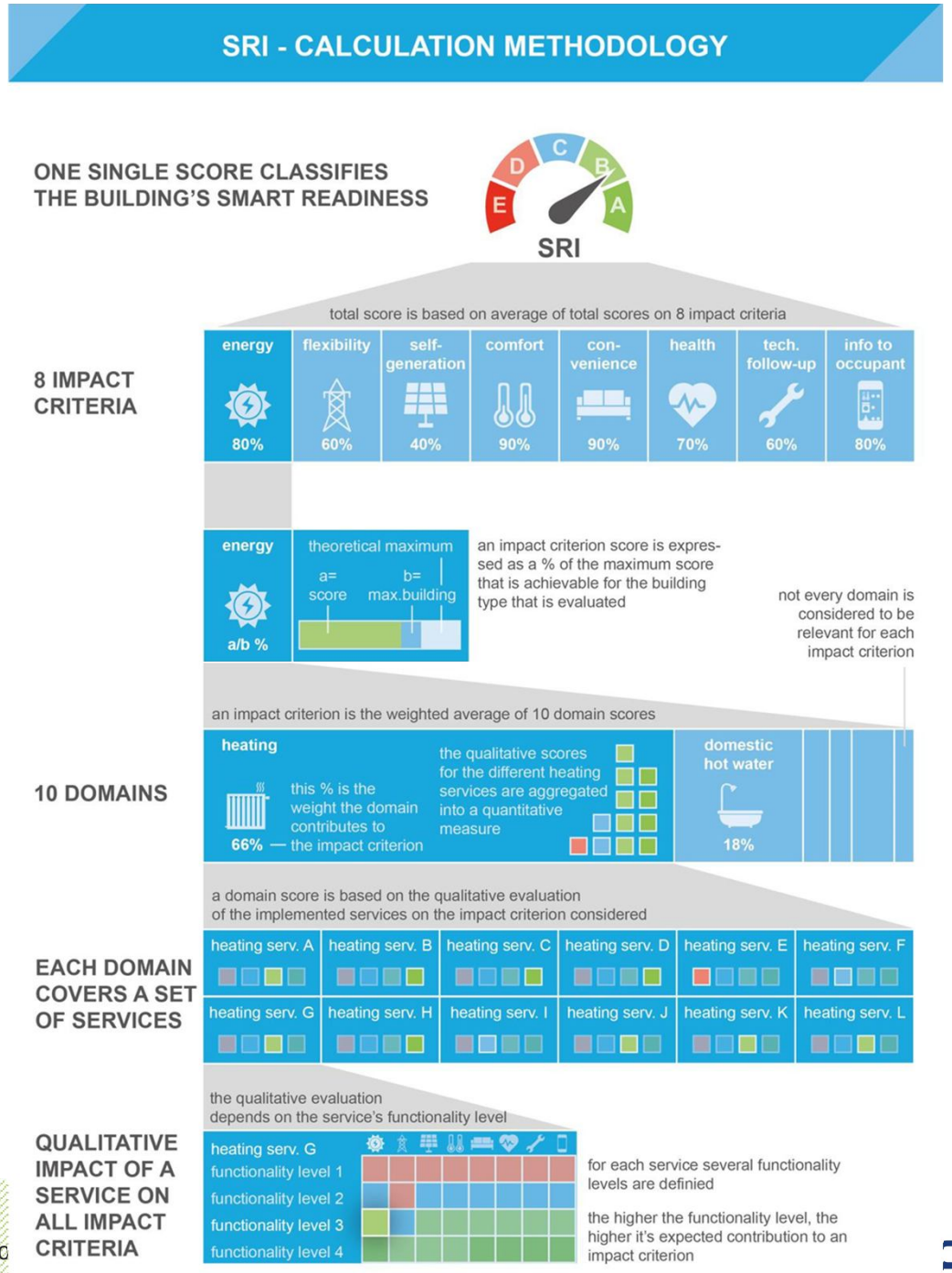
Based on multi-criteria decision making (MCDM) method (linear weighted method), *SRI* is then:

$$SRI = \frac{1}{N_I} \sum_{I=1}^{N_I} NSC_I \cdot w_I \leq 100 \quad ; \quad \sum_{I=1}^{N_I} w_I = 1$$

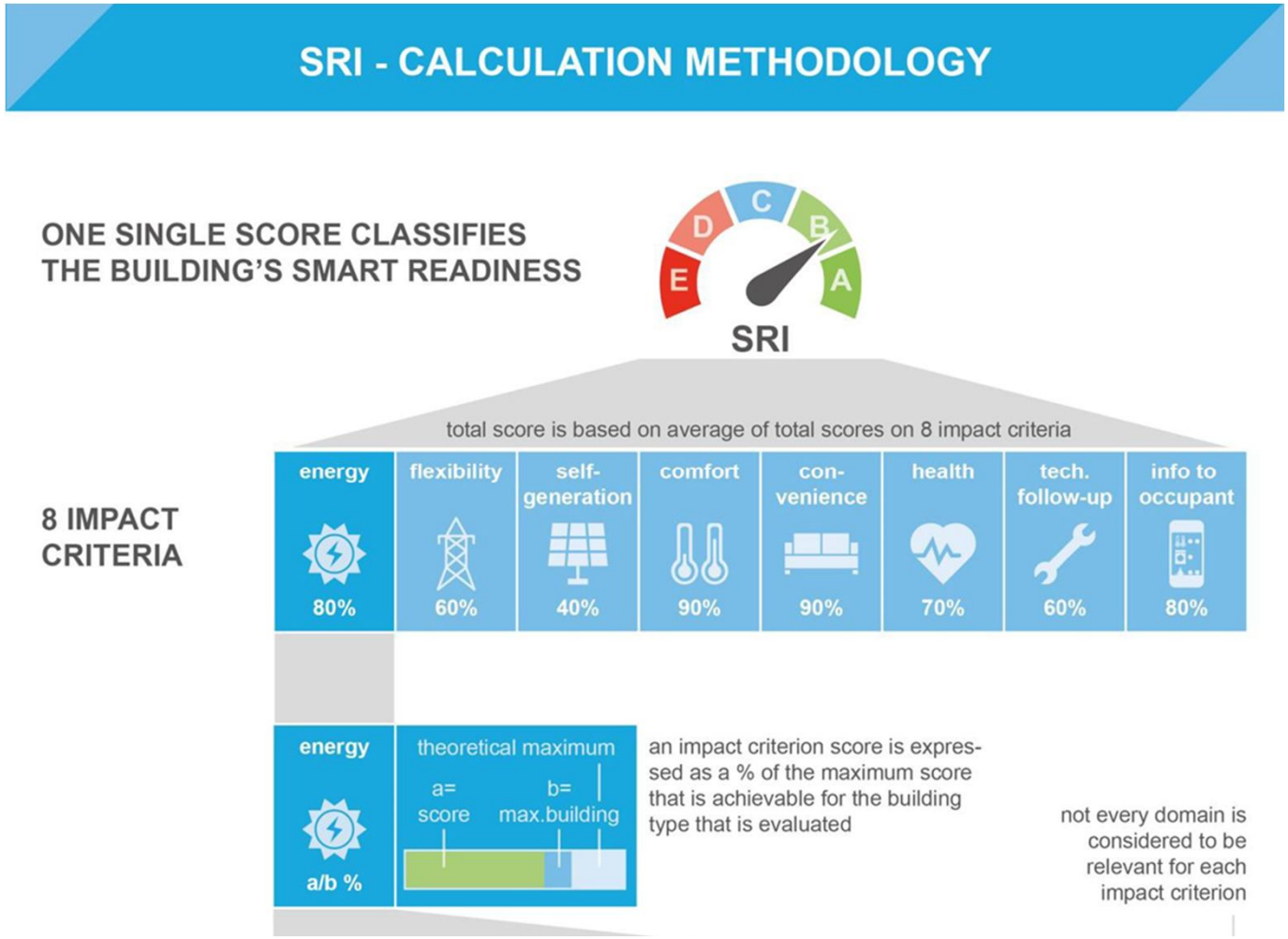
to have a final *smart readiness indicator SRI* between 0 and 100 for the building.

In this case, N_I = 8 always, because all impacts have to be evaluated.

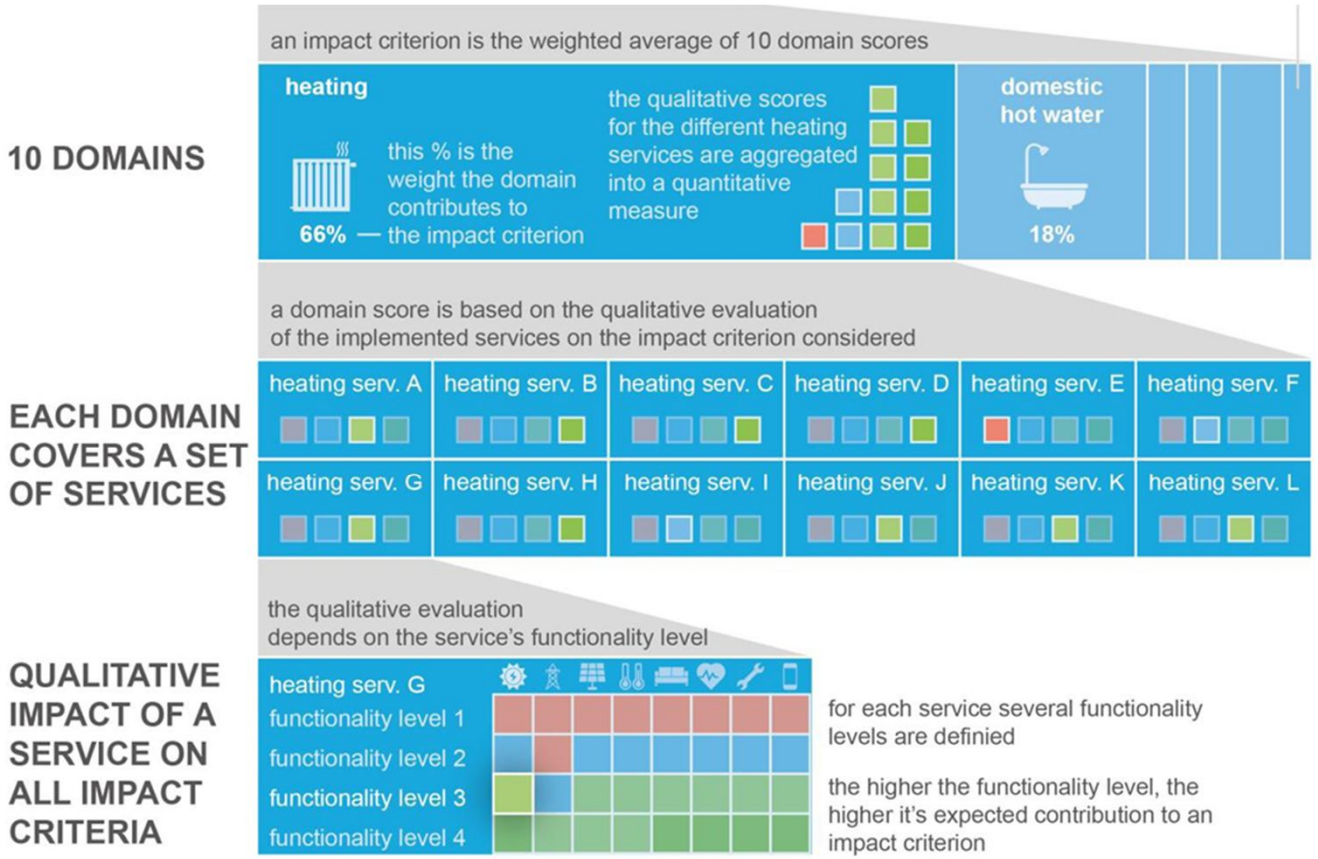
Method Overview



Method Overview



Method Overview



Weak points to be addressed

- Qualitative assessment of scores for almost all functionalities:
  - reference is made to EPBD standards, as EN15232 for BACS, but in an useless way: no any performance based scale is given; ➔ **TOO MUCH SUBJECTIVE**
- The multi-criteria decision making (MCDM) method is based on weights at different levels:
  - to provide significant weighting coefficients a public enquire among buildings energy experts more than politicians has to be carried out;
  - this can be at the National level or at the European Level.

Weak points to be addressed

- The multi-criteria decision making (MCDM) method is based on weights:
  1. among sub-services for each domain (assumed all the same in the VITO report);
  2. among domains for each impacts (an example of weighting coefficients is given in the VITO report);
  3. among impacts (assumed all the same in the VITO report)

All these 3 points must be defined on the basis of National or European enquiring.

Thank You
for your attention

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