U-CERT energiamärgise arendused sisekliima ja SRI hindamiseks



U-CERT

User-Centred Energy Performance Assessment and Certification

Teadmistepõhine Ehitus 2022

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H2020 ja HorizonEU projektiklaster energiamärgiste edasiarendamiseks



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Väljundid

U-CERT pakub välja **lisandväärtust loovad indikaatorid** hoonete energiatõhususe hindamisel energiamärgiste edasiarenduses

- Sisekliima ja nutivalmiduse indikaatorite (Smart Readiness Indicator) kaasamine hoone energiatõhususe hindamisse



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Võimalikke uusi näitajaid - võimsusindikaatorid

- Praegused energiamärgised kajastavad ainult hoone (primaar)energia tarbimist, võimsusvajadustega ei arvestata
- Sarnase energiatarbega hoonetel võib olla märgatavalt erinev mõju jaotusvõrkudele (elekter, kaugküte/-jahutus, vesi)
- Paindlikkusteenustest osavõtt? Resilientsus?
- Lähtepunktiks kestuskõver tarnitud/eksporditud energiakandjatest, et kirjeldada hoone mõju jaotusvõrkudele.



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Sisekliima indikaatorid – uued/oluliselt rek. hooned

- Hoone projektdokumentatsioon sisaldab üldise sisekliima hindamiseks juba piisavalt informatsiooni:
  - arvutuslikud ventilatsiooni õhuvooluhulgad (õhu kvaliteet)
  - kütte ja jahutussüsteemide arvutuslikud temperatuuri seadeväärtused (soojuslik mugavus)
  - seadmete väljatrükid (müra, akustika)

- Lokaalse soojusliku mugavuse hindamine keerulisem – palju on kaebusi tõmbustunde esinemise osas. Vajadus hinnata õhujugasid detailsemalt – kas energiatõhususe hindaja on pädev selleks?



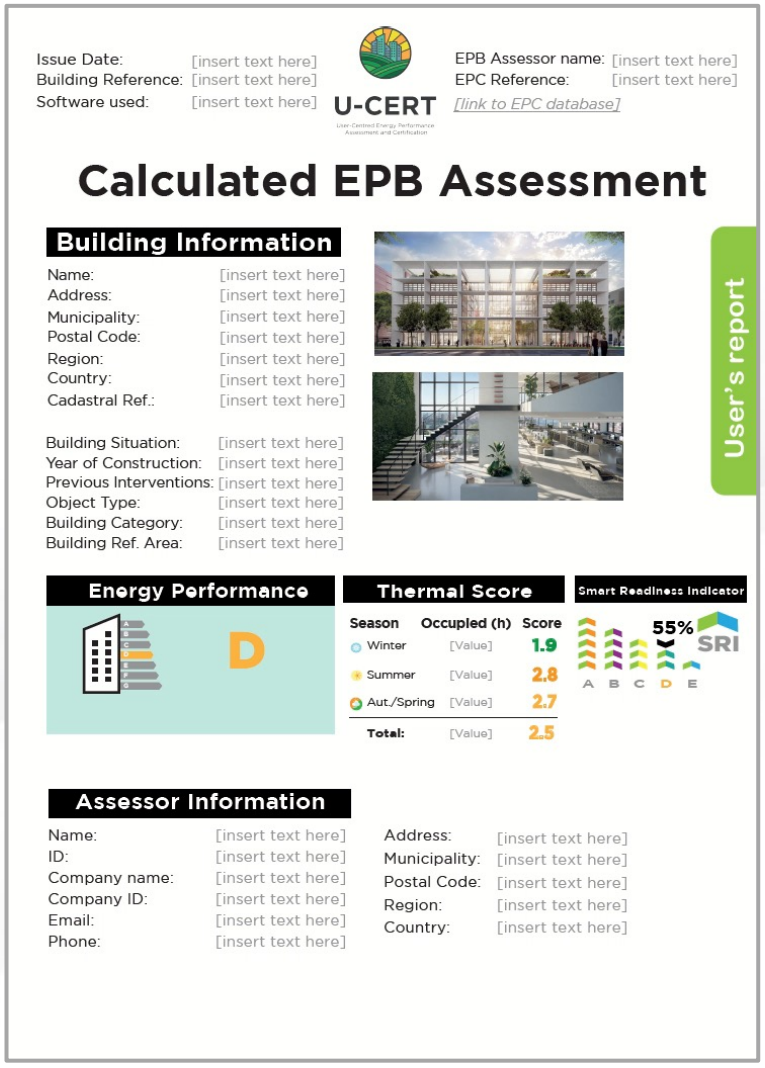
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Aga olemasolevad hooned?

- Põhiprobleem on andmete vähesus või lünklikkus. Tulemusena on arvutustulemused väga jäme hinnang hoone energiatõhususele.
  - Leidus ka arvutusmetoodikaid, kus tarbimisandmeid üldse ei kasutatud
- Detailseks energiatõhususe ja sisekliima hinadmiseks on vaja ning täiendavaid sisekliima mõõtmisi. Laiapõhjaliselt kõikide märgiste osana/lisana ei saa seda aga pidada mõistlikuks:
  - Aja- ja rahakulu
  - Energiatõhususspetsialist ei pruugi omada piisavat kompententsi
  - Vajadus sisekliimaküsitluste järgi

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U-CERT's EPC structure



Issue Date: [insert text here]
Building Reference: [insert text here]
Software used: [insert text here]

U-CERT

EPB Assessor name: [insert text here]
EPC Reference: [insert text here]
[link to EPC database]

Calculated EPB Assessment

User's report

Building Information

Name: [insert text here]
Address: [insert text here]
Municipality: [insert text here]
Postal Code: [insert text here]
Region: [insert text here]
Country: [insert text here]
Cadastral Ref.: [insert text here]

Building Situation: [insert text here]
Year of Construction: [insert text here]
Previous Interventions: [insert text here]
Object Type: [insert text here]
Building Category: [insert text here]
Building Ref. Area: [insert text here]

Energy Performance

D

Thermal Score

Season	Occupied (h)	Score
Winter	[Value]	1.9
Summer	[Value]	2.8
Aut./Spring	[Value]	2.7
Total:	[Value]	2.5

Smart Readiness Indicator

55% SRI

A B C D E

Assessor Information

Name: [insert text here]
ID: [insert text here]
Company name: [insert text here]
Company ID: [insert text here]
Email: [insert text here]
Phone: [insert text here]

Address: [insert text here]
Municipality: [insert text here]
Postal Code: [insert text here]
Region: [insert text here]
Country: [insert text here]



- Energy performance - energiatõhususe hindamine
- Thermal Score – soojusliku mugavuse hindamine
- Smart Readiness Indicator – hoonesüsteemide nutivalmiduse hindamine

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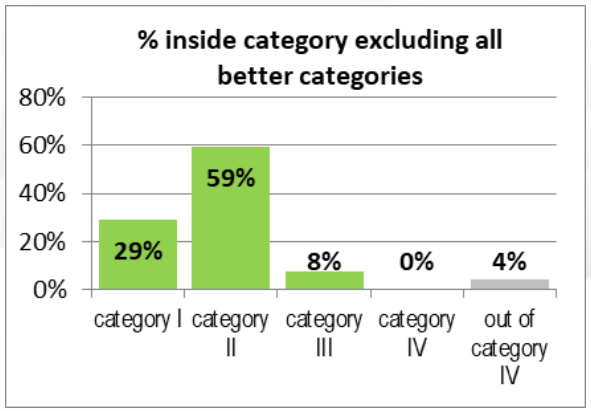
ALDREN Thermal Comfort Score

Example of calculation and reporting

Distribution of occupancy hours during the **winter (heating) season** into IEQ categories

Estimation of the score for **winter (heating) season**:

Category	Weight	% of hours out of category	% inside category, except for all better categories
IEQ I	1	71%	29%
IEQ II	2	12.0%	59%
IEQ III	3	4.4%	8%
IEQ IV	4	4%	0%
out of IEQ IV	5		**4%**
		Score	**1.9**



(Bjarne Olesen):

((100-IEQI,%out)*1 +
(IEQI,%out - IEQII,%out)*2 +
(IEQII,%out - IEQIII,%out)*3 +
(IEQIII,%out - IEQIV,%out) *4 +
(IEQIV,%out*5)) /100

Thermal environment
for standard use (1=best, 4-worse)

Season	Occupied hours	Score
Winter	1218	1.9
Summer	738	2.8
Spring/Fall	501	2.7
Overall thermal comfort		**2.3**

The scale

≤ 2
>2.0 ≤ 2.5
>2.5 ≤ 3
>3

Level of expectation for IEQ categories (EN 16798-1:2019):

- IEQ_I High – special needs (children, elderly, handicapped)
- **IEQ_{II} Medium – normal, used for design and operation**
- IEQ_{III} Moderate – still provides acceptable environment
- IEQ_{IV} Low – should only be used for a short time

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ALDREN Thermal Comfort Score

Example of calculation and reporting

Location	Copenhagen						Palermo					
Case	A	B	C	D	E	F	A	B	C	D	E	F
TCS	1.93	1.27	1.49	1.71	1.28	2.31	2.37	1.21	1.79	1.10	1.30	2.06
Energy use kWh/m² year	37	41	39	38	39	39	36	40	39	6	40	39
IEQ category	II	II	II	II	II	III	III	II	II	I	II	II

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U-CERT IAQ score

Two scenarios

- New building/major renovation – based on design data. Result is IAQ category according to EN 16798-1 ventilation rate (according to Method 1 – Perceived air quality)
- Building in operation – based on existing room use plan and measurements of CO_2 or air flow rates. Result is IAQ catgory or IAQ score.
  - In the case of CAV system, valid air flow rates measurement protocol may also be used

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IAQ score – calculation principle

- Based on Method 1 of EN 16798 (Perceived air quality)
  - For new building – data from design documentation
  - For existing building – number of people according to current plan of the room
  - Weighed average of IAQ categories over measurement period of 1 week

IAQ Category	LPB-1, L/sm^2	LPB-2, L/sm^2	LPB-3, L/sm^2	Airflow per non-adapted person, L/s	Airflow per adapted person, L/s
1	0.50	1.00	2.00	10.00	3.50
2	0.35	0.70	1.40	7.00	2.50
3	0.20	0.40	0.80	4.00	1.50
4	0.15	0.30	0.60	2.50	1.00

$$q_{tot} = n \cdot q_p + A_R \cdot q_B$$

where

q_{tot} = total ventilation rate for the breathing zone, l/s

n = design value for the number of the persons in the room,

q_p = ventilation rate for occupancy per person, l/(s person)

A_R = floor area, m^2

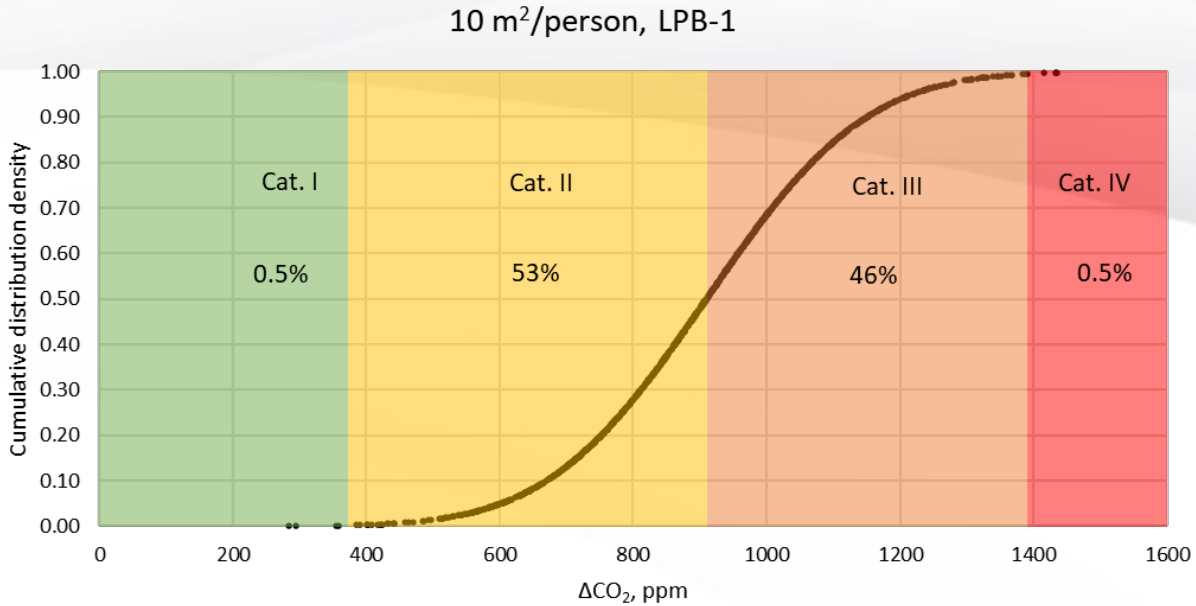
q_B = ventilation rate for emissions from building, l/(s·m^2)

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IAQ score – calculation example

- Low polluting building (LPB-1).
- 10 m^2/person
- CO_2 emission per person – 20 L/h
- Measured ΔCO_2 values 300-1450 ppm
- Room IAQ_{score} = (0.5*1+53*2+46*3+0.5*4)/100 = **2.47**
- Room IAQ_{cat} = III (5 % + 1% TAIL criteria)

IAQ Category	ΔCO_2 LPB-1, ppm	ΔCO_2 LPB-2, ppm	ΔCO_2 LPB-3, ppm
1	370	278	185
2	529	397	265
3	926	694	463
4	1389	1010	654



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SMART READINESS INDICATOR

- The SRI assesses buildings (or building units), based on their capacity to satisfy three key functionalities:



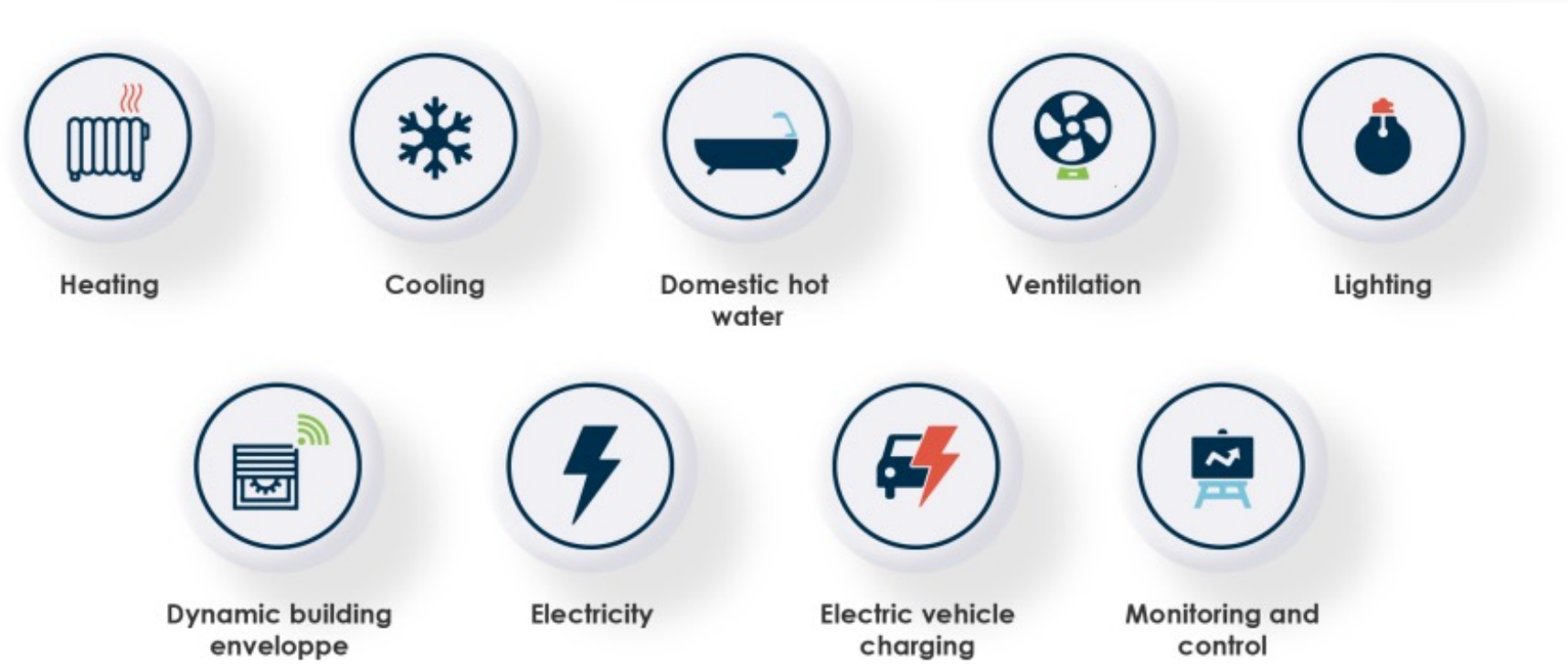
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The three key smart-readiness functionalities are further detailed into seven impact criteria



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Assessed systems/domains



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	Overall SRI score (%) + SRI class							
	%		%				%	
	1 Optimise energy efficiency and overall in-use performance		2 Adapt its operation to the needs of the occupant				3 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	%	%	%	%	%	%	%	%

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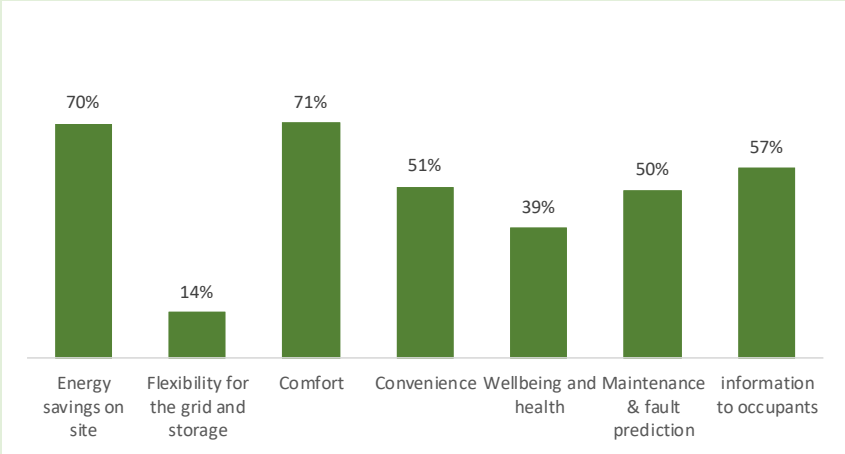
Domain	Code	Service group	Smart ready service	Functionality level 0 (as non-smart default)	Functionality level 1	Functionality level 2	Functionality level 3	Functionality level 4	part of the proposed detailed method	Preconditions / Dependency on other services or building types
Heating	Heating-1a	Heat control - demand side	Heat emission control	No automatic control	Central automatic control (e.g. central thermostat)	Individual room control (e.g. thermostatic valves, or electronic controller)	Individual room control with communication between controllers and to BACS	Individual room control with communication and occupancy detection	1	Always to be assessed
Heating	Heating-1b	Heat control - demand side	Emission control for TABS (heating mode)	No automatic control	Central automatic control	Advanced central automatic control	Advanced central automatic control with intermittent operation and/or room temperature feedback control		1	Triage: only relevant in case of TABS. Mostly restricted to non-residential buildings
Heating	Heating-1c	Heat control - demand side	Control of distribution fluid temperature (supply or return air flow or water flow) - Similar function can be applied to the control of direct electric heating networks	No automatic control	Outside temperature compensated control	Demand based control			1	Not applicable in case of individual heaters (e.g. stoves)
Heating	Heating-1d	Heat control - demand side	Control of distribution pumps in networks	No automatic control	On off control	Multi-Stage control	Variable speed pump control (pump unit (internal) estimations)	Variable speed pump control (external demand signal)	1	Only applicable for hydronic heating systems
Heating	Heating-1f	Heat control - demand side	Thermal Energy Storage (TES) for building heating (excluding TABS)	Continuous storage operation	Time-scheduled storage operation	Load prediction based storage operation	Heat storage capable of flexible control through grid signals (e.g. DSM)		1	Only applicable in case thermal energy storage is present.
Heating	Heating-2a	Control heat production facilities	Heat generator control (all except heat pumps)	Constant temperature control	Variable temperature control depending on outdoor temperature	Variable temperature control depending on the load (e.g. depending on supply water temperature set point)			1	Only applicable in case of combustion heater or district heating
Heating	Heating-2b	Control heat production facilities	Heat generator control (for heat pumps)	On/Off-control of heat generator	Multi-stage control of heat generator capacity depending on the load or demand (e.g. on/off of several compressors)	Variable control of heat generator capacity depending on the load or demand (e.g. hot gas bypass, inverter frequency control)	Variable control of heat generator capacity depending on the load AND external signals from grid		1	Only applicable in case of heat pumps
Heating	Heating-2d	Control heat production facilities	Sequencing in case of different heat generators	Priorities only based on running time	Control according to fixed priority list: e.g. based on rated energy efficiency	Control according to dynamic priority list (based on current energy efficiency, carbon emissions and capacity of generators, e.g. solar, geothermal heat, cogeneration plant, fossil fuels)	Control according to dynamic priority list (based on current AND predicted load, energy efficiency, carbon emissions and capacity of generators)	Control according to dynamic priority list (based on current AND predicted load, energy efficiency, carbon emissions, capacity of generators AND external signals from grid)	1	Only applicable in case of multiple heat generators, mostly restricted to large buildings

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TOTAL SRI SCORE **54%**

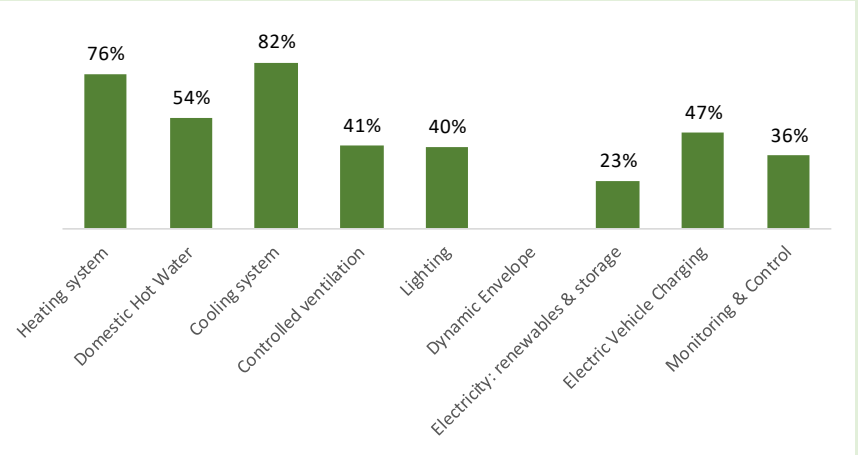
IMPACT SCORES

Energy savings on site	70%
Flexibility for the grid and storage	14%
Comfort	71%
Convenience	51%
Wellbeing and health	39%
Maintenance & fault prediction	50%
information to occupants	57%



DOMAIN SCORES

Heating system	76%
Domestic Hot Water	54%
Cooling system	82%
Controlled ventilation	41%
Lighting	40%
Dynamic Envelope	
Electricity: renewables & storage	23%
Electric Vehicle Charging	47%
Monitoring & Control	36%



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Method A (simplified)

- Simplified service catalogue
- Typically for **existing residential buildings** or **small non-residential buildings** (low complexity)
- Check-list approach
- Assessment time < 1 hour
- Self-assessment possible

Method B (detailed)

- Full, detailed service catalogue
- Typically for **new buildings** and **non-residential buildings** (higher complexity)
- On-site inspection / walk-through needed
- Assessment time < 1 day
- Necessary involvement of an expert, with support from a facility manager

- The assessment process is the same for both methods
- The service catalogue is different, which means the level of expertise required to conduct the assessment is different

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