CLIMA 2025

REHVA Federation of European Heating, Ventilation and Air Conditioning Associations

[SHASE] The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan

REHVA and SHASE workshop on Zero Emission and Zero Energy Buildings

ZEB energy and CO_2 indicators in EU: definitions & calculation examples

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ZEB requirements in recast EPBD (Art 11)

- Energy threshold, energy performance indicator (EP) compared to total primary energy (EP_{tot})
- Covering total primary energy on annual bases
- Capacity to react to external signals and adapt
- Operational CO_2 threshold EP_{CO2}
- Fossil fuels not to be used on site

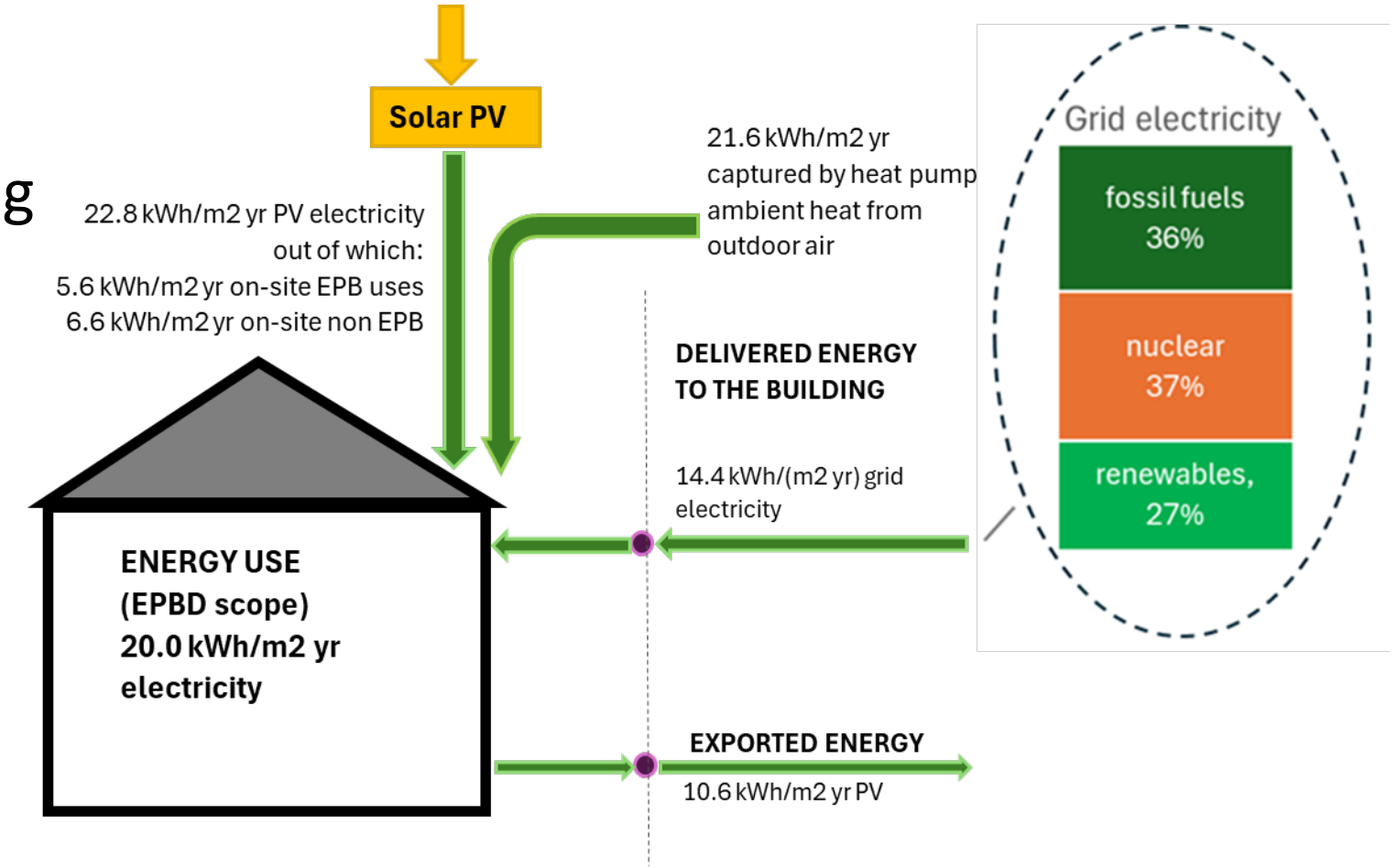
Energy Performance of Buildings Directive **(EU) 2024/1275**
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401275

ZEB compliance calculations

1. Energy demand/total primary energy threshold
2. Operational GHG threshold
3. Total primary energy covering

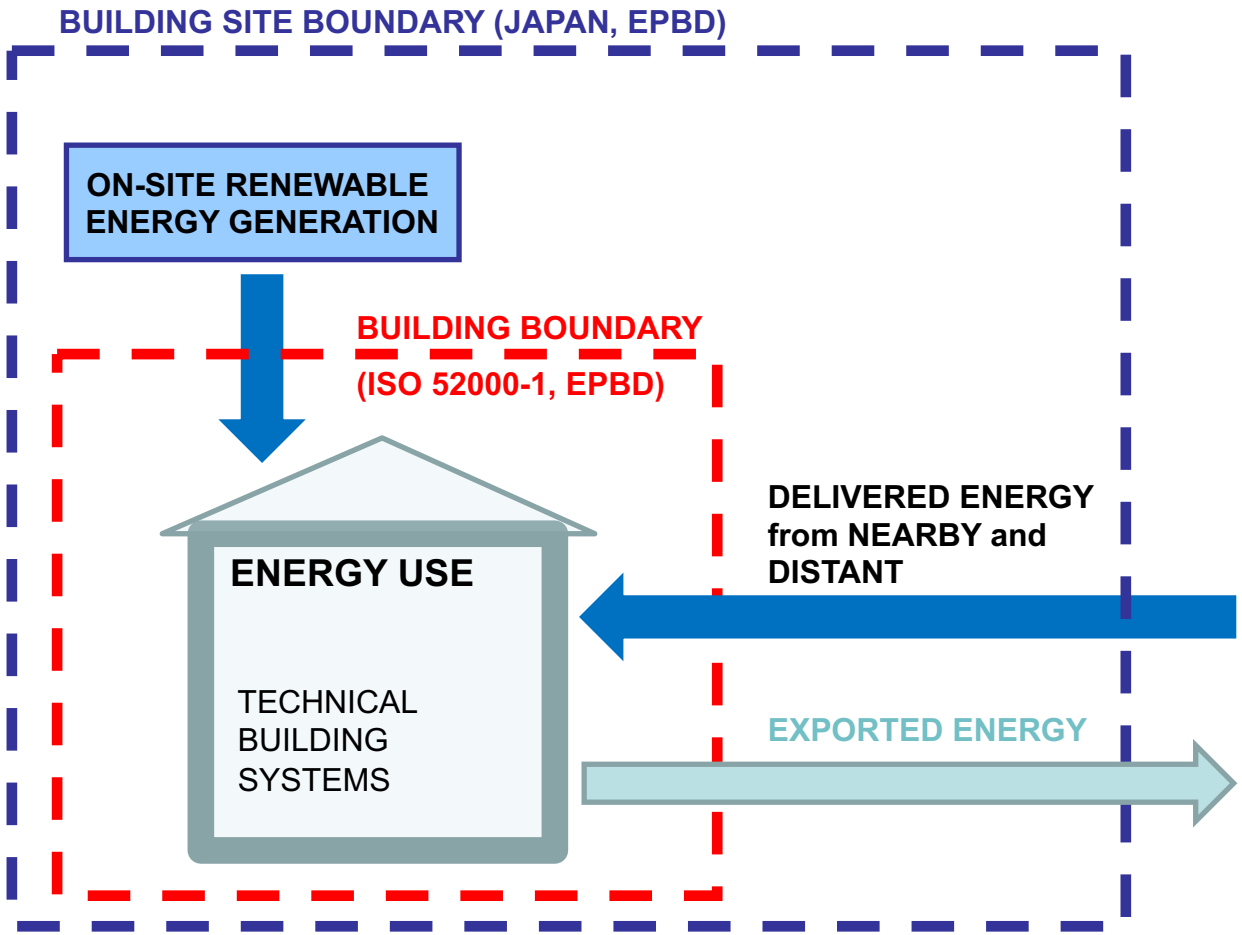
In total primary energy calculation:

- selection of assessment boundary
- treatment of on-site generation and ambient heat



Building and building site assessment boundary

- Energy calculation depends on the assessment boundary
- EPBD accepts both building and building site boundary
- In the case of building boundary, on-site energy generation is **delivered energy** (similar to grid electricity) and a multiplier of 0 is to be applied in total primary energy calculation for PV and ambient
- In this way both assessment boundaries provide the same result



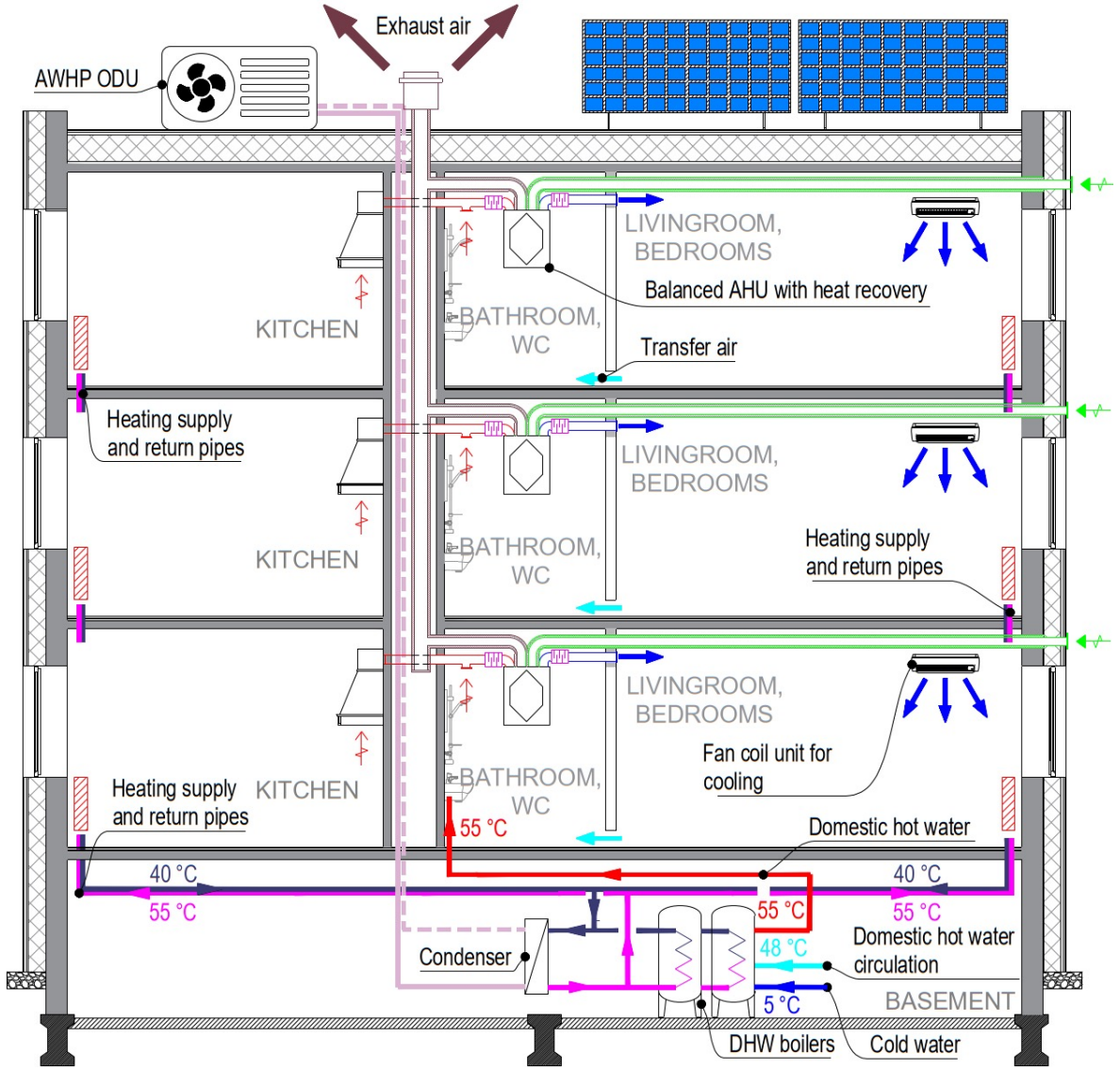
Examples on calculating energy performance and compliance with Article 11 recast EPBD

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401275

Model apartment ZEB used for examples

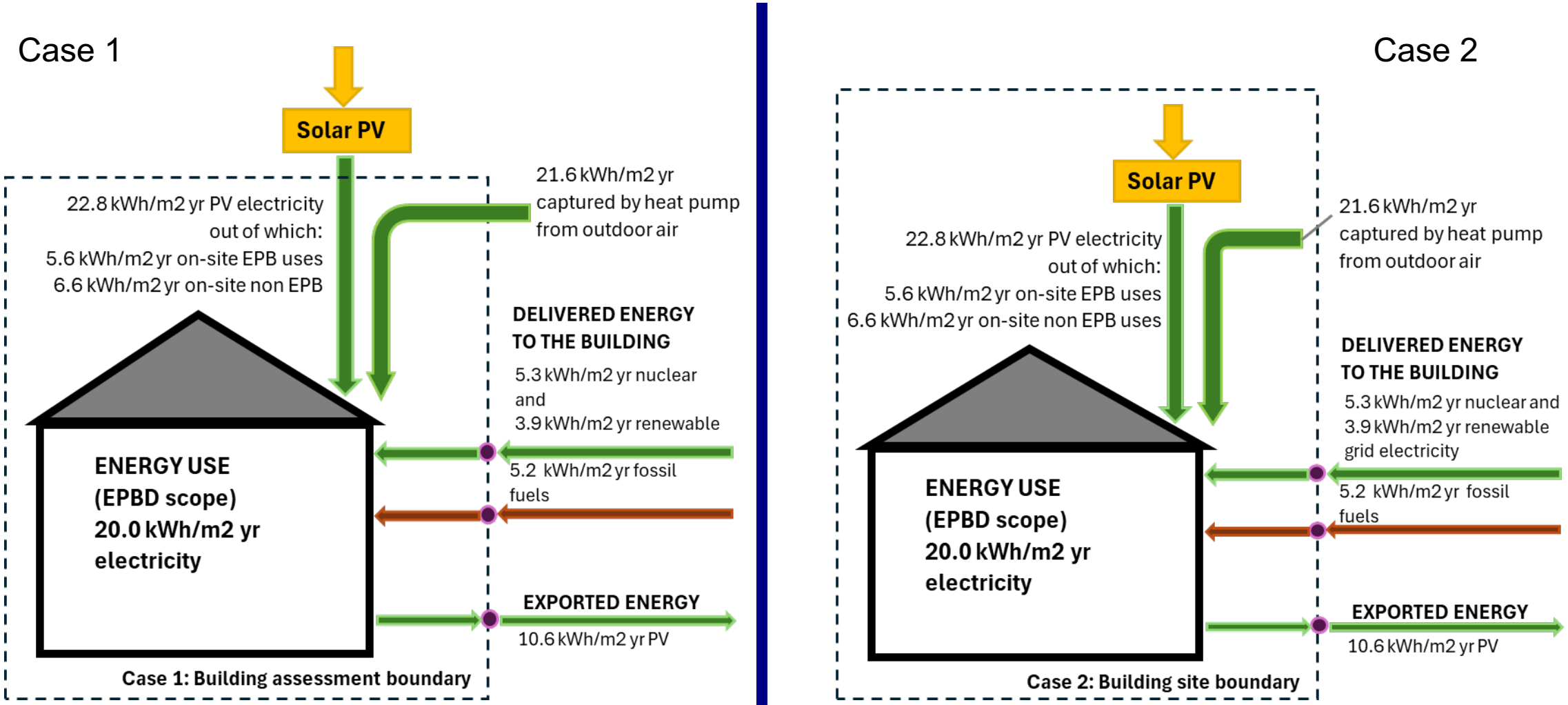
- 3-storey, 12 apartments, 1120 m^2 heated area
- U-values depend on the climate
- Heat recovery ventilation
- 30 kW PV system
- Cooling system
- Air to water heat pump (+ effective district heating of 50% renewables, or gas boiler)

U-values W/(m^2K)	Nordic and Continental	Mediterranean
External walls	0.14	0.23
Cellar wall	0.15	0.23
Windows U_w	0.80	1.30
g-value	0.50	0.50
Roof (insulated)	0.11	0.20
Attic floor (insulated)	0.10	0.20
Ground floor to cellar	0.18	0.25
Floor on ground	0.49	0.49



https://www.rehva.eu/fileadmin/user_upload/2024/EPBD_Guidance_2024.pdf

Two possible assessment boundaries



- Non EPB electricity use of 21.9 kWh/m2 yr not shown in figures (appliances and lighting)
- PV self-use divided proportionally to on-site EPB and non EPB uses

Example: energy balances in kWh/(m2.yr)

Note: With a building assessment boundary – a multiplier factor to primary energy is necessary when follow Comm recommendations

	Case 1: Building assessment boundary				Case 2: Building site boundary		
	Delivered and exported energy	PEF	Mprimary	Total primary energy	Delivered and exported energy	PEF	Total primary energy
	[kWh/m2 yr]	[-]	[-]	[kWh/m2 yr]	[kWh/m2 yr]	[-]	[kWh/m2 yr]
rooftop PV	22.8	1	0	0			
ambient heat HP	21.6	1	0	0			
exported PV electricity to grid	10.6	0.9	1	9.54	10.6	0.9	9.54
PV electricity to other on-site non-EPBD uses	6.6	1	1	6.6	6.6	1	6.6
electricity from the grid:	14.40	2.28	1.0	32.83	14.40	2.28	32.83
out of which:							
renewable	3.89	1.0	1	3.89	3.89	1	3.89
nuclear	5.33	3.0	1	15.98	5.33	3	15.98
fossil	5.18	2.5	1	12.96	5.18	2.5	12.96
Total primary energy (for energy demand threshold)				**16.7**			**16.7**

Covering total primary energy by a) – d) options Art 11(7)

	Case 1: Building assessment boundary				Case 2: Building site boundary		
	Delivered and exported energy	PEF	Mprimary	Total primary energy	Delivered and exported energy	PEF	Total primary energy
	[kWh/m2 yr]	[-]	[-]	[kWh/m2 yr]	[kWh/m2 yr]	[-]	[kWh/m2 yr]
Covering total primary energy by a)-d) options from Article 11(7)				**53.6**			**53.6**
out of which:							
covering by rooftop PV				22.8			22.8
covering by heat pump ambient				21.6			21.6
covering by renewable electricity				3.888			3.888
covering by nuclear				5.328			5.328

- Requirement is fulfilled as 53.6 > 16.7

Calculating the operational GHG emissions with Article 11(5) recast EPBD

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401275

Calculation of operational GHG emissions

- **For the purpose of calculating the operational emissions of a building, the operational GHG emissions displaced in the energy system** by the renewable energy produced on-site and exported to the grid or used on-site for non-EPB uses **may be deducted** from the sum of the direct and indirect operational GHG emissions **if such option for compensation is part of national rules or regulation**.
- **In all other cases it is recommended to provide information on the amount of exported energy as well as on potentially avoided GHG emissions elsewhere as additional information.**
- In case of including the operational GHG emissions displaced in the energy system in the calculation
  be **aware about possible double counting & "double rewarding"**.
- To avoid/limit double counting, **it is recommended to stop possible offset of GHG emissions at net zero** and declare separately the avoided impacts elsewhere due to the exported renewable energy (at GWP calculation in module D2 in accordance with EN 15978:2025. For more see LCA&GWP).

Example – operational GHG emissions

Grid electricity	Mix	CO_2 emission coefficient
	[%]	[g CO2eq/kWh]
renewables	27%	0
nuclear	37%	0
fossil fuels	36%	400
Grid mix	100%	**144**

	Delivered and exported energy	CO_2 emission coefficient	Offset factor	Operational GHG emissions
	[kWh/m2 yr]	[g CO2eq/kWh]	[-]	[kg CO2eq/m2 yr]
electricity from the grid:				
renewable	3.89	0		0.00
nuclear	5.33	0		0.00
fossil	5.18	400		2.07
rooftop PV:				
exported PV electricity to grid	10.6	144	0.9	1.37
PV electricity to other non-EPBD uses	6.6	144	1	0.95
Operational greenhouse gas emissions				**-0.25**

- Deducting exported electricity may be seen problematic as it results in negative operational CO2
- Dynamic CO_2 coefficient may provide different result

Conclusions

- Important to understand calculation principles for:
  - Total primary energy threshold
  - Requirement to cover total primary energy use from Art 11 a) - d) options – everybody should get the same result

- Both building or building site assessment boundary may be used with the same results.
- Important to pay attention that on-site renewable energy generation and ambient heat are treated correctly in both above approaches

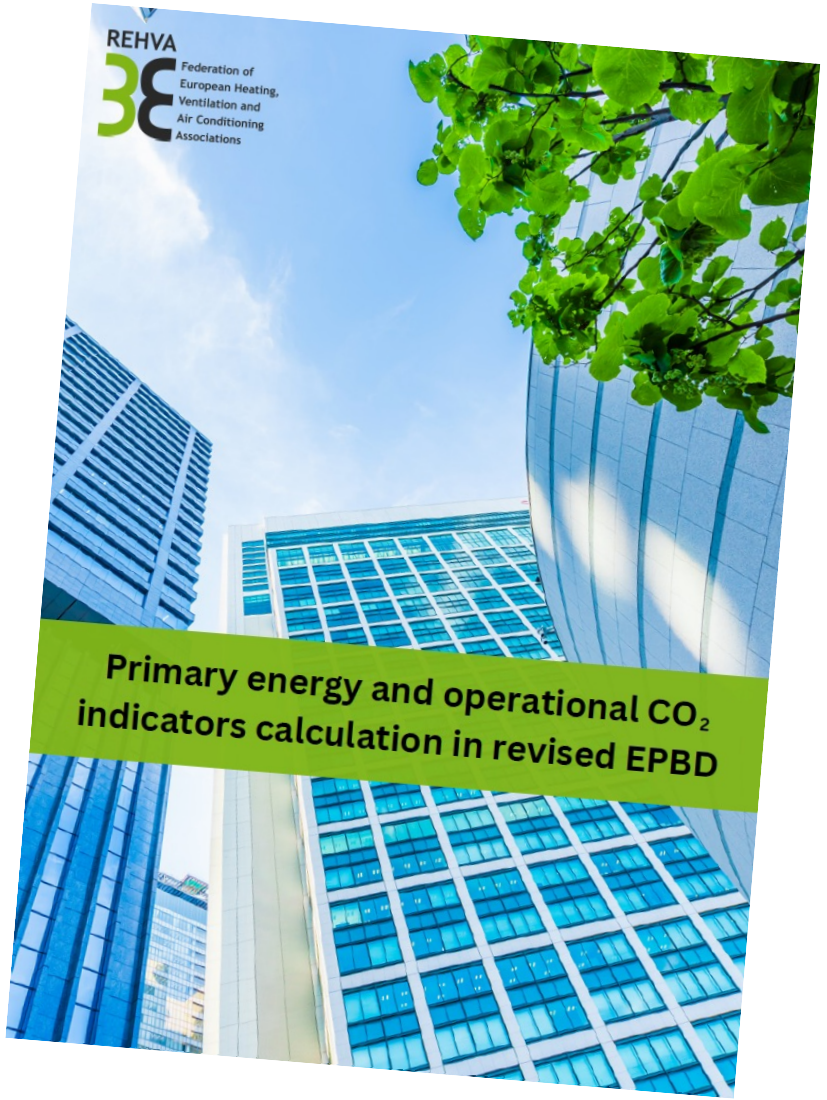
- PV self-use must be considered in the calculation when exported renewable energy (e.g. PV) has different PEF
- Exported energy either may be deducted with factor 0.9 or it maybe excluded, as forward-looking PEF and CO_2 coefficients already include exported energy impacts

See full calculation example with another heat sources and climates in:

https://www.rehva.eu/fileadmin/user_upload/2024/EPBD_Guidance_2024.pdf

New report by REHVA and SHASE in July 2025:

Zero energy and zero emission buildings perspectives in EU and Japan – Joint position document by REHVA (EU) and SHASE (Japan)



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