Module 2
Indoor Energy, Renewables, GHG emission and Operational energy cost

Training Material
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Hochschule München University of Applied Sciences

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1 – Energy consumption

KPI 1 - Delivered annual energy demand per area unit

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1 – Energy consomption

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 1	Delivered annual energy demand per area unit	[kWh/(m²a)]	1.1 Level(s)

Objective

- The Net delivered energy demand, is the energy required to meet the demand of buildings (EPB) services of the assessed building only. It represents delivered minus exported energy, both expressed per energy carrier

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 1 Delivered annual energy demand per area unit

Description

- Energy can be delivered to the building and exported from the building through the system boundary.

It is important to differentiate between:
- Delivered energy demand and
- Net delivered energy demand.

- The delivered energy demand is used for satisfying the uses taken into account or to produce the exported energy.

- The Net delivered energy demand, is the energy required to meet the energy demand of considered energy performance of buildings (EPB) services of the assessed building only, represents delivered minus exported energy, both expressed per energy carrier

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KPI 1 Delivered annual energy demand per area unit

Scope

- The indicator addresses both residential and non-residential buildings with the default energy performance of buildings (EPB) services .
- KPI addresses the following module of the building life-cycle: B6 Operational energy use
- Calculation or measurement of the energy flows (delivered and exported energy) is performed at the assessment boundary. Inside the assessment boundary, the energy losses are taken into account by technical building system efficiency factors and thus are already accounted for in delivered energy values

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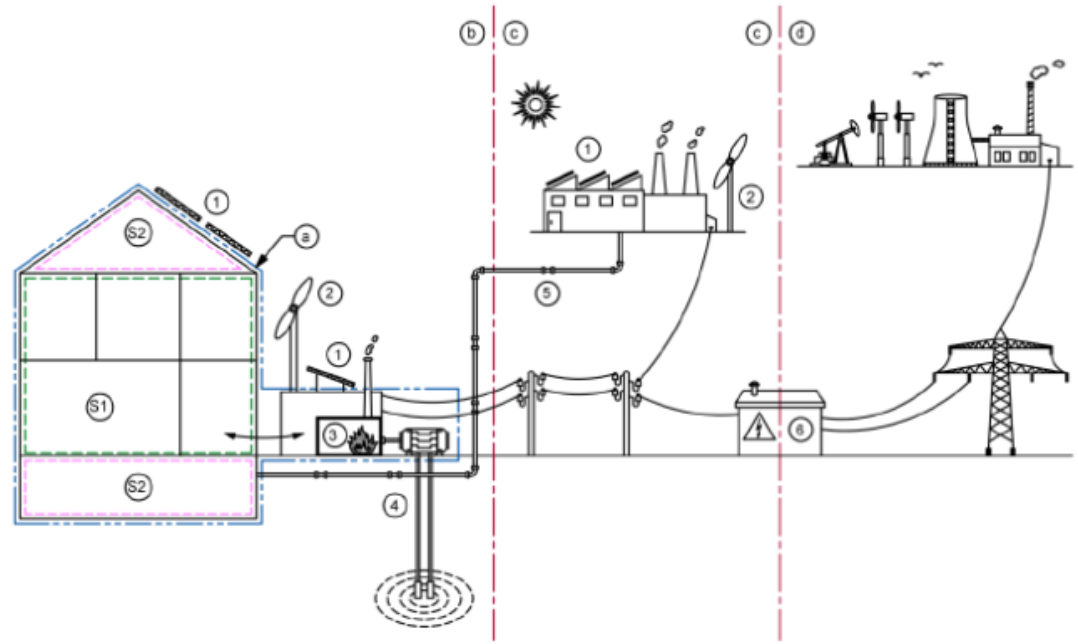
KPI 1 Delivered annual energy demand per area unit

Unit of measure

- Delivered annual energy demand per area unit for EPB services $\boldsymbol{E_{del}}$ in [kWh/(m2a)]



Key

a	Assessment boundary (use energy balance)	S1	Thermally conditioned space	1	PV
b	On-site	S2,	Space outside thermal envelope	2	Wind
c	Nearby			3	Boiler room
d	Distant			4	Heat pump
				5	District heating / cooling
				6	Substation (low voltage and possible storage)

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KPI 1 Delivered annual energy demand per area unit

Reference Standards

The energy calculation method for energy performance available across the EU include:

- use of national standards still applied (e.g., EN 15603 and its associated standards - EN 15316 series),
- use of national or regional calculation methods and associated software tools (which must comply with Annex I of the EPBD) or
- use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480.

EN 15603:2008 Energy performance of buildings – Overall energy use and definition of energy ratings

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1 – Energy consumption

KPI 2 - Total annual primary energy demand per area unit

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1 – Energy consomption

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 2	Total annual primary energy demand per area unit	[kWh/(m²a)]	1.1 Level(s)

Objective

- The total primary energy demand is the energy found in nature and used to satisfy the energy performance of buildings services (EPB services) or to produce the exported energy. The total primary energy takes into account the actual energy demand for the building itself and the energy needed to deliver this energy to the building

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 2 Total annual primary energy demand per area unit

Description

- Primary energy is the energy found in nature from renewable and non-renewable sources, which has not undergone any conversion or transformation process, such as sunlight, wind, biomass, coal, crude oil, natural gas, or uranium. The term total primary energy is used when both non-renewable and renewable sources are considered.

- This indicator measures the total energy performance of a building.

- The total primary energy is measured by assigning the correct primary energy factor per energy carrier to the actual metered or calculated energy that is consumed, to meet different energy needs associated with its typical

- The primary energy use is calculated based on the quantities of energy carriers required and the primary energy factors associated with each energy carrier

It is important to differentiate between:

- Total primary energy demand and
- Net primary energy demand.

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KPI 2 Total annual primary energy demand per area unit

Scope

- The indicator addresses both residential and non-residential buildings with the default energy performance of buildings (EPB) services .
- KPI addresses the following module of the building life-cycle: B6 Operational energy use
- The total primary energy demand is the energy found in nature and used to satisfy the energy performance of buildings services (EPB services) or to produce the exported energy.
- The net primary energy demand means subtracting any exported renewable primary energy from the total primary energy demand.
- Multiplying total primary energy factors with the delivered/exported energy to calculate total primary energy demand follows **outside the assessment boundary**.

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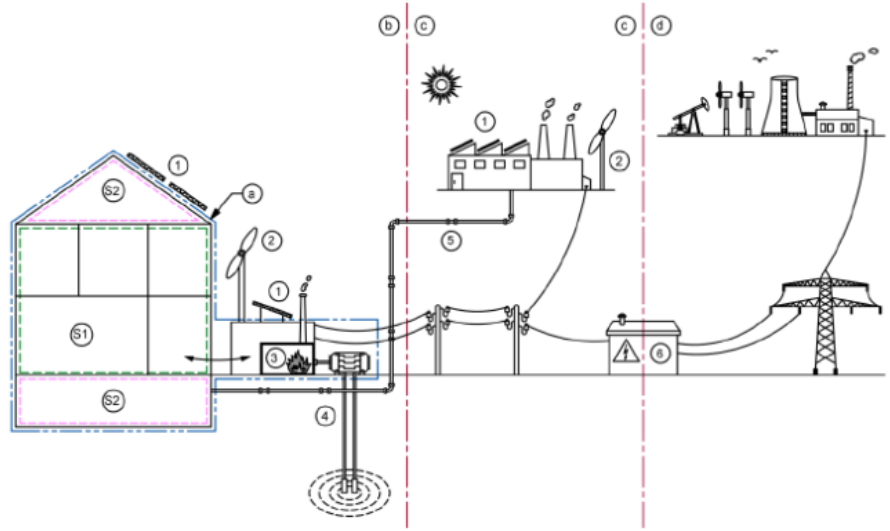
KPI 2 Total annual primary energy demand per area unit

Unit of measure

- Total annual primary energy demand per area unit E_{Ptot} in [kWh/(m^{2}a)] to satisfy the energy performance of buildings services (EPB services) or to produce the exported energy

- Multiplying total primary energy factors with the delivered/exported energy to calculate total primary energy demand follows **outside the assessment boundary**.



Key

a	Assessment boundary (use energy balance)	S1	Thermally conditioned space	1	PV
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KPI 2 Total annual primary energy demand per area unit

Reference Standards

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- use of national or regional calculation methods and associated software tools (which must comply with Annex I of the EPBD) or
- use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480.

EN 15603:2008 Energy performance of buildings – Overall energy use and definition of energy ratings

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1 – Energy consumption

KPI 3 - Non-renewable annual primary energy demand per area unit

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1 – Energy consomption

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 3	Non-renewable annual primary energy demand per area unit	[kWh/(m²a)]	1.1 Level(s)

Objective

- The indicator uses non-renewable primary energy factors defined for different fuels to calculate the non-renewable primary energy demand based on the delivered energy demand, which is obtained either through a calculation or from metered data

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 3 Non-renewable annual primary energy demand per area unit

Description

- Non-renewable primary energy means energy from non-renewable sources which has not undergone any conversion or transformation process.

- The indicator uses non-renewable primary energy factors defined for different fuels to calculate the non-renewable primary energy demand based on the delivered energy demand, which is obtained either through a calculation or from metered data

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KPI 3 Non-renewable annual primary energy demand per area unit

Scope

- The indicator addresses both residential and non-residential buildings with the default energy performance of buildings (EPB) services .
- KPI addresses the following module of the building life-cycle: B6 Operational energy use
- Multiplying non-renewable primary energy factors with the delivered/exported energy to calculate non-renewable primary energy demand follows outside the assessment boundary.

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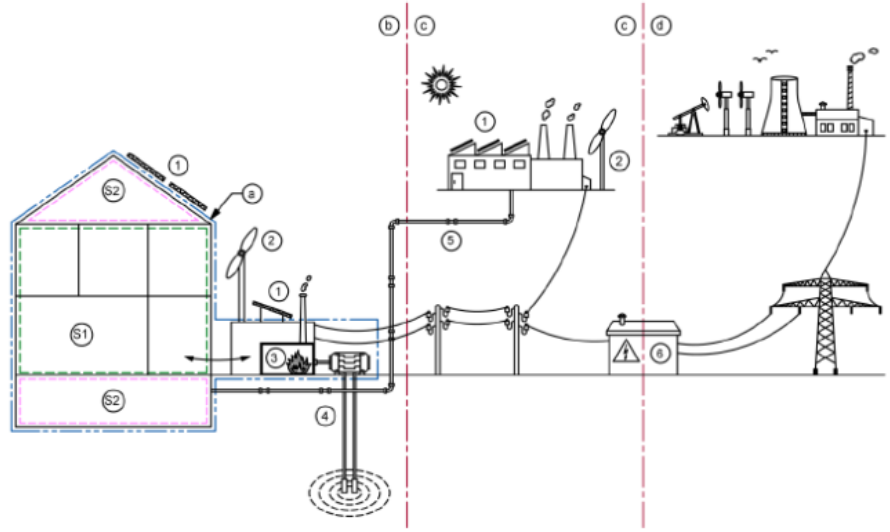
KPI 3 Non-renewable annual primary energy demand per area unit

Unit of measure

- Non-renewable annual primary energy demand per area unit for EPB services E_{Pnren} in [kWh/(m^{2}a)]

- Multiplying total primary energy factors with the delivered/exported energy to calculate total primary energy demand follows **outside the assessment boundary**.



Key

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KPI 3 Non-renewable annual primary energy demand per area unit

Reference Standards

The energy calculation method for energy performance available across the EU include:

- use of national standards still applied (e.g., EN 15603 and its associated standards - EN 15316 series),
- use of national or regional calculation methods and associated software tools (which must comply with Annex I of the EPBD) or
- use of calculation methods compliant with the EN ISO 52000 series and standards developed under mandate 480.

EN 15603:2008 Energy performance of buildings – Overall energy use and definition of energy ratings

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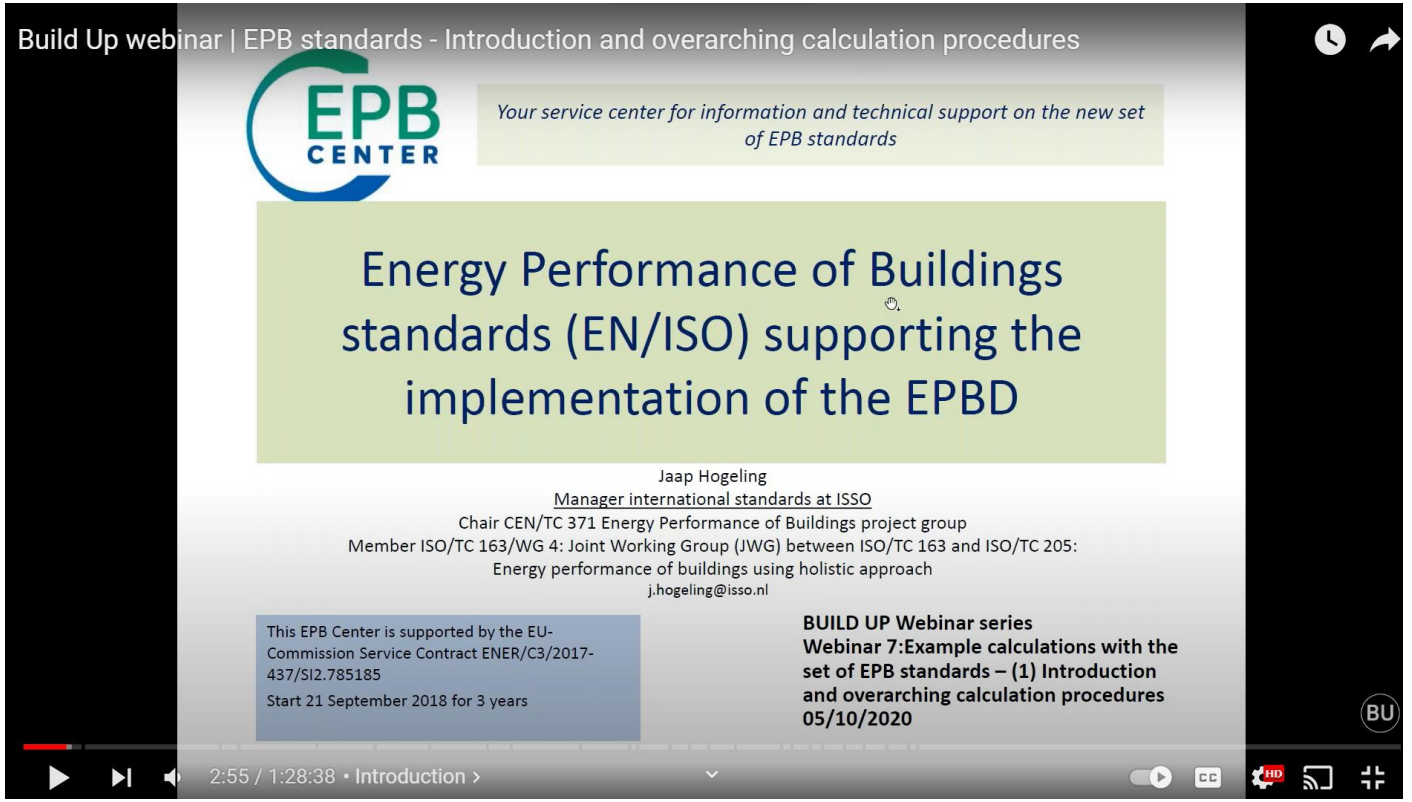
Helpful links



https://www.youtube.com/watch?v=uqnRkUMtOGA

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1 – Energy consumption

KPI 4 - Embodied energy

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1 – Energy consomption

Thematic area	Key Performance Indicator (KPI)		Unit	Reference framework
Energy consumption	KPI 4	Embodied energy	[[kWh/m2] or [MJ]	EN 15978

Objective

- The part of the EN 15978 indicator “Total use of non-renewable primary energy resources” limited to the life cycle of products is frequently called embodied energy and is a commonly specified environmental impact indicator used in Life Cycle Assessment. This indicator is not among the EN 15978 tables of indicators, it may be considered as a sub-indicator.

Applicability

Building use:

- Residential
- Non-residential

Project stage:

- Design
- Construction / As Built
- In Use

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KPI 4 Embodied energy

Description

- This indicator measures the embodied non-renewable primary energy of materials, products and services used for the building construction, its service life, until its end-of-life, considering the life cycle of these materials, products, and services.

- It includes non-renewable primary energy uses and non-renewable primary energy resources used as raw materials.

- According to ISO 6707-3:2022 (Buildings and civil engineering works - Vocabulary - Part 3: Sustainability terms), embodied energy is defined as follows: "**total of all the energy used in the processes associated with the extraction, production, transportation, installation, use, refurbishment, replacement and disposal at the end of life of products and services, but excluding the energy used for operation**".

- Embodied energy is not limited to the "cradle-to-gate" perimeter of products life cycle, but it includes all the processes until their end-of-life. It supposes to have an EPD database compliant with EN 15804:2012 +A2:2019, but in certain countries, environmental product data is limited to "cradle-to-gate".

- Embodied energy considers all the products during the reference study period of the building (RSP, 50 years by default), including the initial construction and the replacement of products having a service life shorter than the RSP.

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KPI 4 Embodied energy

Scope

- This KPI addresses both residential and non-residential buildings.

- This indicator supposes a good knowledge of construction products and services (technical equipment) attached to the building. So, it is adapted to new construction and to renovated buildings.

- The life cycle perimeter for calculating this indicator covers the “cradle to grave” processes (raw materials extraction, transport to manufacturing facilities and manufacturing processes), for all the construction materials, products, components, and services used in the construction of the building, its service life (50 years by default) and end-of-life.
- The rules for determining their impacts and aspects are defined in EN 15804 and EN 15978.

Theoretically, the full life cycle of the building and its immediate surroundings on its site (curtilage), have to be considered.

- Are excluded: operational energy use (B6), operational water use (B7) and building related users’ activities not covered in B1-B7 modules (B8).
- If module D exists for products in terms of embodied energy, module D1 captures net embodied energy beyond the system boundary and must be reported separately as additional information.
- Transparency and details are recommended in assessment boundary description and in results presentation. This enables results understanding and comparability.

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KPI 4 Embodied energy

Scope

All the construction elements are considered: from foundations to finishings.
The minimum scope/perimeter of the indicator includes the following building parts and elements:
The elements defined in Level(s) European framework, including also fittings, furnishings, technical services / systems and external works on the plot of land, should be included, and if not, replaced by default values.
Notes:
•Detailed tables are available in Level(s) Indicator 1.2 Manual and in User Manual 2 document, chapter on building description,
•Furniture and equipment brought by the building occupants are not included.

Building parts	**Related building elements**
Shell (substructure and superstructure)	
Foundations (substructure)	• Piles • Basements • Retaining walls
Load-bearing structural frame	• Frame (beams, columns, and slabs) • Upper floors • External walls • Balconies
Non-load bearing elements	• Ground floor slab • Internal walls • Partitions and doors • Stairs and ramps
Facades	• External wall systems • Cladding and shading devices • Façade openings (including windows and external doors) • External paints, coatings, and renders
Roof	• Structure • Weatherproofing
Parking facilities	• Above ground and underground
Table drawn from Level(s) framework, 2021	

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KPI 4 Embodied energy

Unit of measure

Embodied energy is measured as:

[kWh/m^2] or [MJ] (net calorific value)

Note: The EN 15978 standard mentions MJ unit for all energy indicators, but for ensuring homogeneity with the other energy KPIs, it is preferable to use kWh / m^2 (per area unit and for building RSP = 50 years).

RSP = reference study period

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KPI 4 Embodied energy

Reference Standards

- **EN 15978**:2011, Sustainability of construction works - Assessment of environmental performance of buildings – Calculation method (under revision in 2022-2023, to be published in 2024).
- **EN 15804**:2012+A2:2019, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.
- **ISO 14067**:2018, Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification.

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KPI 4 Embodied energy

Helpful Links

https://www.youtube.com/watch?v=fa25pcgkqEw

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