

Priority Axis 2: Fostering low-carbon strategies and energy efficiency  
in specific MED territories: cities, islands and remote areas

# TESTING PROTOCOL

## KEY PERFORMANCE INDICATORS URBAN SCALE

February 2018 - Version 1.1

2.1: To raise capacity for better management of energy in public buildings at  
transnational level

Work package: WP3 TESTING

Activity: 3.3 Test of transnational assessment methods and indicators

Deliverable: 3.3.1 – Testing Protocol

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## A 1.7 Conservation of Land

### 1. Intent:

To determine the proportion of land, considered to be of value for ecological or agricultural purposes, that remains undeveloped.

### 2. Assessment methodology

#### 2.1 Description

Most urban areas exist in a state of continuing development and re-development, with the building stock and infrastructure undergoing concurrent construction, operation, renovation and demolition activities. In many cases development or re-development is inefficient in terms of the use of land that would otherwise be valuable for ecological or agricultural purpose. In this context, the amount of such land that remains undeveloped is useful information in developing strategies to ensure efficient urban development, while ensuring the integrity of ecological and agricultural services.

#### 2.2 Data requirement

Indicator	Unit	Data source
The total area of undeveloped land considered to be of value for ecological or agricultural purposes by relevant authorities, as a percent of the total local area	%	Urban area thematic map

#### 2.3 Assessment method

To characterize the indicator's value:

1. Determine the gross surface area of the urban area
2. Determine the aggregate surface area of land that is considered by authorities to be of ecological and agricultural value
3. Subtract the aggregate undeveloped area from the gross surface area of the urban area, which should equal to the total area developed for buildings, streets, vehicle parking and other infrastructures.



## B.3.3 Running costs energy for public buildings

### 1. Intent:

To assess the cost of energy services for public buildings.

### 2. Assessment methodology

#### 2.1 Description

The annual final energy costs of existing buildings are usually a significant part of total operating costs. This criterion provides information on the actual energy costs of public buildings in the urban area.

#### 2.2 Data requirement

Indicator	Unit	Data source
Running cost of energy aggregated	Euro/m <sup>2</sup> /year	Estimation or actual energy bills

#### 2.3 Assessment method

To characterize the indicator's value:

1. Sum of the running energy costs of each building in the area up to an aggregated running costs energy value. The total cost must be normalized per the total indoor useful area of buildings.

The final energy is generally the one metered by the utilities.

It is the energy per 'carrier' (e.g. thermal or electrical energy) supplied to the building, to satisfy end uses within the building (heating, cooling, ventilation, domestic hot water, lighting, appliances, etc.).

In the calculation it is possible to use real or estimated costs. Their percentage on the total costs must be declared in the way to understand the reliability of the result. If both the real energy costs and the estimated one is available, the first one should be used.

The real energy cost is suitable for the indicator's calculation only if the building has been constructed and is occupied for at least 1 year prior to the analysis and preferably has been in use for 3-years, in order to ensure that there has been time enough to have building systems reach their normal operating efficiency levels, and also to factor out unusual seasonal variations. This means that the buildings assessed are at least 3 years old.

In case of more recently constructed/occupied buildings, the estimated value must be used.

The calculation has to take in account one full year of operation.



## C.1.1 Total final thermal energy consumption for building operations

### 1. Intent:

To estimate urban thermal energy consumption for building operations.

### 2. Assessment methodology

#### 2.1 Description

The criterion allows to understand the buildings' final thermal energy consumption in the use stage. Use stage energy consumptions are in general responsible for the majority of life cycle energy use in the case of buildings constructed before the turn of the millennium.

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Aggregated annual total final thermal energy consumption / gross floor area of all buildings	kWh/m <sup>2</sup> /year	Metered or Estimated data

#### 2.3 Assessment method

To characterize the indicator's value there are two options:

- Use of estimated data
- OR
- Use of metered data

Use of estimated data:

1. Calculate the annual total final thermal energy consumption for building operations (heating, cooling, domestic hot water), in kWh, for each building in the local area.
2. Calculate the aggregated annual total final thermal energy consumption for all buildings.
3. Calculate: Aggregated annual total final thermal energy consumption / Total gross area of all buildings.

Calculations are based on EN 13790 using the quasi-steady state monthly method

Use of metered data:

1. Data collection of the monitored annual total final thermal energy consumption for building operations (heating, cooling, domestic hot water), in kWh, for each building in the local area. The consumption data have to be estimated taking the average over 3 years period;
2. Calculate the aggregated annual total final thermal energy consumption for all buildings.
3. Calculate: Aggregated annual total final thermal energy consumption / Total gross area of all buildings.



### 3. References and standards

EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling)

[ec.europa.eu/energy/en/topics/energy-efficiency/buildings](http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings)

[https://www.iea.org/publications/freepublications/.../buildings\\_certification.pdf](https://www.iea.org/publications/freepublications/.../buildings_certification.pdf)

[www.theicct.org/sites/default/files/.../ICCTupdate\\_EU-95gram\\_jan2014.pdf](http://www.theicct.org/sites/default/files/.../ICCTupdate_EU-95gram_jan2014.pdf)



## C.1.4 Total final electric energy consumption for building operations

### 1. Intent:

To estimate urban electric energy consumption for building operations.

### 2. Assessment methodology

#### 2.1 Description

The criterion allows to understand the buildings' final electric energy consumption in the use stage. Use stage energy consumptions are in general responsible for the majority of life cycle energy use in the case of buildings constructed before the turn of the millennium.

#### 2.2 Data requirement

Indicator	Unit	Data source
Aggregated annual total final electric energy consumption / Total gross floor area of all buildings	kWh/m <sup>2</sup> /year	Estimated or metered data

#### 2.3 Assessment method

To characterize the indicator's value there are two options:

- Use of estimated data
- OR
- Use of metered data

Use of estimated data:

1. Calculate the annual total final electric energy consumption for building operations (heating, cooling, ventilation, auxiliaries, domestic hot water and lighting), in kWh, for each building in the local area (i.e. residential and non-residential).
2. Calculate the aggregated annual total final electric energy consumption for all buildings.
3. Calculate: aggregated annual total final electric energy consumption / total gross area of all buildings

Calculations are based on EN 13790 using the quasi-steady state monthly method.

Use of metered data:

1. Data collection of the monitored annual total final electric energy consumption for building operations (heating, cooling, ventilation, auxiliaries, domestic hot water and lighting), in kWh, for each building in the local area. The consumption data have to be estimated taking the average value over 3 years period;
2. Calculate the aggregated annual total final electric energy consumption for all buildings.
3. Calculate: Aggregated annual total final electric energy consumption / Total gross area of all buildings.



### 3. References and standards

EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling)





## C.1.7 Total primary energy demand for building operations

### 1. Intent:

To reduce the need of primary energy for building operations.

### 2. Assessment methodology

#### 2.1 Description

The criterion allows to understand the the buildings' primary energy consumption in the area. "Primary energy" means energy from renewable and nonrenewable sources which has not undergone any conversion or transformation process

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Buildings total primary energy consumption / local minimum value	%	Calculation

#### 2.3 Assessment method

To characterize the indicator's value:

1. Calculate the annual total primary energy consumption of non-renewable energy for building operations (heating, cooling, ventilation, auxiliaries, domestic hot water and lighting), in kWh/m<sup>2</sup> of useful internal floor area for each building in the local area (i.e. residential and non-residential).
2. Calculate urban area total primary energy consumption as the weighted mean value of total primary energy consumption over the floor surfaces of all buildings in the area.
3. Calculate: Buildings total primary energy consumption / local minimum value x 100

Calculations are based on EN 13790 using the quasi-steady state monthly method.

### 3. References and standards

EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling)



## C.2.1 Share of thermal energy generation from on-site renewable sources on final thermal energy

### 1. Intent:

To incentive the consumption and production of renewable energy.

### 2. Assessment methodology

#### 2.1 Description

The criterion assesses the share of renewable thermal energy in final thermal energy consumptions and, by implication, the degree to which renewable fuels have substituted fossil and/or nuclear fuels and therefore contributed to the decarbonisation of the Mediterranean area economy. It also shows what is the progress towards Europe 2020 target for renewable energies.

#### 2.2 Data requirement

Indicator	Unit	Data source
Share of renewable thermal energy in final thermal energy consumptions	%	Estimated or metered data

#### 2.3 Assessment method

To characterize the indicator's value there are two options:

- Use of estimated data
- OR
- Use of metered data

Use of estimated data:

1. Calculate the annual total final thermal energy consumption for building operations (heating, cooling, domestic hot water), in kWh, for each building in the local area (i.e. residential and non-residential) including renewables, if applicable, in the existing condition.
2. Calculate the aggregated annual total thermal final energy consumption for all buildings.
3. Calculate the annual total final thermal energy consumption for building operations (heating, cooling, domestic hot water), in kWh, for each building in the local area (i.e. residential and non-residential) from on-site renewable energy sources.
4. Calculate the aggregated annual total final thermal energy consumption from on-site renewable energy sources.
5. Calculate: Aggregated annual total final thermal energy consumption from on-site renewable energy sources / Aggregated annual total final thermal energy consumption.

Calculations are based on EN 13790 using the quasi-steady state monthly method.

Use of metered data:

1. Data collection of the monitored annual total final thermal energy consumption for building operations (heating, cooling, domestic hot water), in kWh, for each building in the local area



- (i.e. residential and non-residential). The consumption data have to be the average over 3 years period;
2. Calculate the aggregated annual total thermal final energy consumption for all buildings.
  3. Data collection of the annual total final thermal energy consumptions for building operations (heating, cooling, domestic hot water), in kWh, for each building in the local area (i.e. residential and non-residential) from on-site renewable energy sources.
  4. Calculate the aggregated annual total final thermal energy consumptions from on-site renewable energy sources.
  5. Calculate: Aggregated annual total final thermal energy consumption from on-site renewable energy sources/ Aggregated annual total final thermal energy consumption.

### 3. References and standards

EN 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling)



## C.2.4 Share of renewable energy on-site, on total primary energy consumptions for buildings operation

### 1. Intent:

To incentive the consumption and production of renewable energy.

### 2. Assessment methodology

#### 2.1 Description

The criterion assesses the share of renewable energy in primary energy consumptions and, by implication, the degree to which renewable fuels have substituted fossil and/or nuclear fuels and therefore contributed to the decarbonisation of the Mediterranean area economy. It also shows what is the progress towards Europe 2020 target for renewable energies.

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Share of renewable energy in primary energy consumptions	%	Calculation

#### 2.3 Assessment method

To characterize the indicator's value:

1. Calculate the annual total primary energy consumption for building operations (heating, cooling, ventilation, auxiliaries, domestic hot water and lighting), in kWh, for each building in the local area (i.e. residential and non-residential) including renewables, if applicable, in the existing condition.
2. Calculate the aggregated annual total primary energy consumption for all buildings.
3. Calculate the annual total primary energy consumption for building operations (heating, cooling, domestic hot water and lighting), in kWh, for each building in the local area (i.e. residential and non-residential) from on-site renewable energy sources, if applicable.
4. Calculate the aggregated annual total primary energy consumption from on-site renewable energy sources for all buildings.
5. Calculate: Aggregated annual total primary energy consumption / Aggregated annual total primary energy consumption without the renewables.

Calculations are based on EN 13790 using the quasi-steady state monthly method

### 3. References and standards

EN 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling)



## C.2.7 Share of electric energy generation from on-site renewable sources on final electric energy

### 1. Intent:

To incentive the consumption and production of renewable energy.

### 2. Assessment methodology

#### 2.1 Description

The criterion assesses the share of renewable electric energy in final electric energy consumptions and, by implication, the degree to which renewable fuels have substituted fossil and/or nuclear fuels and therefore contributed to the decarbonisation of the Mediterranean area economy. It also shows what is the progress towards Europe 2020 target for renewable energies.

#### 2.2 Data requirement

Indicator	Unit	Data source
Share of renewable electric energy in final electric energy consumptions	%	Estimated or metered data

#### 2.3 Assessment method

To characterize the indicator's value there are two options:

- Use of estimated data
- OR
- Use of metered data

Use of estimated data:

1. Calculate the annual total final electric energy consumption for building operations (heating, cooling, domestic hot water, ventilation, lighting, auxiliaries), in kWh, for each building in the local area (i.e. residential and non-residential) including renewables, if applicable, in the existing condition.
2. Calculate the aggregated annual total electric final energy consumption for all buildings.
3. Calculate the annual total final electric energy consumption for building operations (heating, cooling, domestic hot water, lighting, ventilation, auxiliaries), in kWh, for each building in the local area (i.e. residential and non-residential) from on-site renewable energy sources, if applicable.
4. Calculate the aggregated annual total final electric energy consumption from on-site renewable energy sources.
5. Calculate: Aggregated annual total final electric energy consumption from on-site renewable energy sources/ Aggregated annual total final electric energy consumption.

Calculations are based on EN 13790 using the quasi-steady state monthly method.



#### Use of metered data:

1. Data collection of the monitored annual total final electric energy consumption for building operations (heating, cooling, domestic hot water, lighting, ventilation, auxiliaries), in kWh, for each building in the local area (i.e. residential and non-residential). The energy consumption data is averaged over 3 years period;
2. Calculate the aggregated annual total thermal final energy consumption for all buildings.
3. Data collection of the annual total final electric energy consumptions for building operations (heating, cooling, domestic hot water, lighting, ventilation, auxiliaries), in kWh, for each building in the local area (i.e. residential and non-residential) from on-site renewable energy sources.
4. Calculate the aggregated annual total final electric energy consumptions from on-site renewable energy sources.
5. Calculate: Aggregated annual total final electric energy consumption from on-site renewable energy sources/ Aggregated annual total final electric energy consumption.

### 3. References and standards

EN 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling)



## D.1.2 Total GHG Emissions from energy used in building operations

### 1. Intent:

To minimise the total greenhouse gas emissions from buildings' operations.

### 2. Assessment methodology

#### 2.1 Description

The criterion measures the contribution of the greenhouse gas (GHG) emissions associated with the building's operational phase on the earth's global warming or climate change. The Global Warming Potential (GWP) was developed to allow for the comparison of the impact on global warming caused by different gases. Specifically, it is a relative measure of how much energy can be trapped in the atmosphere over a set time horizon by a mass of gas in comparison with the same mass of carbon dioxide (CO<sub>2</sub>). A higher GWP means a larger warming effect in that period of time.

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
CO <sub>2</sub> equivalent emissions per useful internal floor area per year	kg CO <sub>2</sub> eq./m <sup>2</sup> /yr	Calculation

#### 2.3 Assessment method

The scope of the indicator comprises the use stage of the building and includes the emissions correlated to the following energy uses: heating, cooling, ventilation, domestic hot water, lighting, auxiliaries.

To characterize the indicator's value:

- For each building in the area calculate the emissions of CO<sub>2</sub> eq. with the following formula:

$$E = \left[ \sum (Q_{fuel,i} \times LHV_i \times k_{em,i}) + (Q_{el} \times k_{em,el}) + (Q_{dh} \times k_{em,dh}) \right]$$

$Q_{fuel,i}$  = annual quantity of i-th fuel (m<sup>3</sup> or Kg)

$Q_{el}$  = annual quantity of electric energy from the grid (kWh)

$Q_{dh}$  = annual quantity of energy from district heating/cooling (kWh)

$LHV_i$  = lower heating value of the i-th fuel (kWh/m<sup>3</sup> or kWh/Kg)

$k_{em,i}$  = CO<sub>2</sub> eq. emission factor of the i-th fuel (Kg CO<sub>2</sub>/kWh)

$k_{em,i}$  = CO<sub>2</sub> eq. emission factor of the electric energy from the grid (Kg CO<sub>2</sub>/kWh)

$k_{em,i}$  = CO<sub>2</sub> eq. emission factor of energy from district heating/cooling (Kg CO<sub>2</sub>/kWh)

Calculate the aggregated annual total CO<sub>2</sub> equivalent emissions from all buildings / total useful internal floor area of all buildings

### 3. References and standards

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)



## E.1.6 Consumption of potable water for residential population

### 1. Intent:

Make efficient use of water resources

### 2. Assessment methodology

#### 2.1 Description

The criterion estimates or measures the water consumption of sanitary fittings/devices and water consuming appliances by residential population.

#### 2.2 Data requirement

Indicator	Unit	Data source
Water consumption per occupant	m <sup>3</sup> per occupant*yr	Estimated or metered data

#### 2.3 Assessment method

The water consumption is calculated based on metered data when available or on the estimated use of water consuming appliances and sanitary fittings in the buildings. The scope of the criterion includes the use of both potable water and non-potable water and applies to processes for:

- drinking water;
- water for sanitation;
- domestic hot water;
- water for cleaning

Use of estimated data.

To characterize the indicator's value:

- 1) For each residential building calculate the total water consumption. The principle of the per occupant water consumption calculation for taps and showers is as follows:

$$\text{Total consumption} = \text{consumption rate} \left( \frac{L}{\text{min}} \right) \times \text{usage factor} \times \left( \frac{\text{min}}{\text{occupant day}} \right) \times \text{occupant}$$

The exact same principle applies for calculations for toilets (except that flushes are used instead of minutes). For cleaning, the basis of the calculation is as follows:

$$\text{Total consumption} \left( \frac{L}{\text{year}} \right) = \text{consumption rate} \left( \frac{L}{\text{m}^2} \right) \times \text{area}(\text{m}^2) \times \text{no. cleans per year}(\text{year}^{-1})$$

$$\text{Total consump} \left( \frac{\text{m}^3}{\text{occupant year}} \right) = \text{total consump} \left( \frac{L}{\text{year}} \right) \times 0.001 \left( \frac{\text{m}^3}{L} \right) + \text{full time eq. occ}(\text{occupant})$$

- 2) Calculate the aggregated annual total water consumptions from all residential buildings / number of residential buildings occupants.





Use of metered data:

To characterize the indicator's value:

- 1) Data collection of the monitored annual water consumption for residential building operations in the local area. The consumption data have to be estimated taking the average over 3 years period;
- 2) Calculate the aggregated annual total water consumptions from all residential buildings..



## E.1.7 Consumption of potable water for non-residential building systems

### 1. Intent:

Make efficient use of water resources

### 2. Assessment methodology

#### 2.1 Description

The criterion estimates or measures the water consumption of sanitary fittings/devices and water consuming appliances by non-residential buildings.

#### 2.2 Data requirement

Indicator	Unit	Data source
Water consumption per occupant	m <sup>3</sup> per occupant*yr	Estimated and metered

#### 2.3 Assessment method

The water consumption is calculated based on metered data when available or on the estimated use of water consuming appliances and sanitary fittings in the buildings. The scope of the criterion includes the use of both potable water and non-potable water and applies to processes for:

- drinking water;
- water for sanitation;
- domestic hot water;
- water for cleaning.

Use of estimated data.

To characterize the indicator's value:

1. For each non-residential building calculate the total water consumption. The principle of the per occupant water consumption calculation for taps is as follows:

$$\text{Total consumption} = \text{consumption rate} \left( \frac{L}{\text{min}} \right) \times \text{usage factor} \times \left( \frac{\text{min}}{\text{occupant day}} \right) \times \text{occupant}$$

The exact same principle applies for calculations for toilets (except that flushes are used instead of minutes). For cleaning, the basis of the calculation is as follows:

$$\text{Total consumption} \left( \frac{L}{\text{year}} \right) = \text{consumption rate} \left( \frac{L}{\text{m}^2} \right) \times \text{area}(\text{m}^2) \times \text{no. cleans per year}(\text{year}^{-1})$$

$$\text{Total consump} \left( \frac{\text{m}^3}{\text{occupant year}} \right) = \text{total consump} \left( \frac{L}{\text{year}} \right) \times 0.001 \left( \frac{\text{m}^3}{L} \right) + \text{full time eq. occ}(\text{occupant})$$

2. Calculate the aggregated annual total water consumptions from all non-residential buildings / number of non-residentials' buildings occupants.

Use of metered data:



To characterize the indicator's value:

- 1) Data collection of the monitored annual water consumption for non-residential building operations in the local area. The consumption data have to be estimated taking the average over 3 years period;
- 2) Calculate the aggregated annual total water consumptions from all non-residential buildings..



## E.2.3 Solid waste from construction and demolition projects retained in the area for re-use or recycling

### 1. Intent:

To estimate the proportion of solid waste resulting from construction and demolition projects in the area that is re-used or recycled.

### 2. Assessment methodology

#### 2.1 Description

Construction activities for new buildings and for demolition have traditionally resulted in large amounts of waste materials that have to be taken to solid waste sites. Much of this material is bulky and remains, but not useable, for long periods of time. Experience has shown that significant improvements can be made in reducing waste, either by recycling them or by re-using some of these materials in new projects. For re-use applications, testing or on-site certification by structural engineers may be required.

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Volume of materials that may be re-used or recycled from the local area on the total solid waste from construction and demolition of building projects	%	Calculation

#### 2.3 Assessment method

To characterize the value of the indicator:

1. Identify the annual volume of construction/demolition waste generated over a 3-year period;
2. Sample the waste stream to identify the origin (type of building) for each sample and the approximate proportion of materials that could have been recycled or re-used;
3. Estimate the volume of material that could be re-used or recycled from future projects of the same type;
4. Aggregate the volume of materials that may be re-used or recycled per year from the local area, based on current rates of construction and demolition;
5. Calculate the volume of materials that may be re-used or recycled from the local area on the total solid waste from construction and demolition projects.



## E.3.2 Consumption of non-renewable material resources for construction of infrastructure

### 1. Intent:

To promote the use of non-renewable material resources.

### 2. Assessment methodology

#### 2.1 Description

A non-renewable resource (also called a finite resource) is a resource that does not renew itself at a sufficient rate for sustainable economic extraction in meaningful human time-frames. The criterion estimates the quantity of materials from non-renewable resources that is consumed in the area for the construction of infrastructures in a 5 years period (i.e. bridges, roads, services).

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Quantity of materials from non-renewable material resources for construction or renovation of infrastructures in the local area over a 5-year period	Tonnes/ 1000 m <sup>2</sup>	Calculation

#### 2.3 Assessment method

To characterize the indicator's value:

1. Calculate the aggregate consumption of non-renewable material resources for construction or renovation of infrastructures in the local area over a 5-year period, in tonnes per 1,000 m<sup>2</sup> of surface area.



## F.1.3 Recharge of groundwater through permeable paving or landscaping

### 1. Intent:

To improve the permeability of the area.

### 2. Assessment methodology

#### 2.1 Description

Permeability of land is the capacity to transmit water to the soil. It is a very important issue connected to the water recharging of aquifers and the reduction of effluents. Soil sealing - the covering of the ground by an impermeable material – is one of the main causes of soil degradation in the EU. Soil sealing often affects increases the risk of flooding and water scarcity and contributes to global warming.

#### 2.2 Data requirement

Indicator	Unit	Data source
Permeable area / total area	%	Thematic map – Geographic Information System.

#### 2.3 Assessment method

To characterize the indicator's value:

1. Calculate the size ( $S_a$ ) of the urban area (m<sup>2</sup>)
2. Calculate the size of the surfaces with a different paving or occupied by constructions in the urban area (i.e green areas, surfaces paved with asphalt, surfaces occupied by buildings, etc.). Include all the surfaces in the urban area so that:

$$S_a = \sum_{i=1}^n S_{a,i}$$

$S_a$  = total surface of the urban area

$S_{a,i}$  = surface i-th in the area (m<sup>2</sup>)

3. Calculate the real permeability of soil considering the permeability coefficient of each surface.

$$S_{a,perm} = \sum_{i=1}^n (S_{a,i} \times \alpha_i)$$

$S_{a,i}$  = i-th surface in the area (m<sup>2</sup>)

$\alpha_i$  = permeability coefficient of the i-th surface

4. Examples of permeability coefficients: Grass = 1, Gravel = 0,9, Permeable interlocking concrete pavement = 0,3, Asphalt or built areas= 0
5. Value of the indicator =  $\frac{S_{a,perm}}{S_a} \times 100$



## F.2.3 Ambient air quality with respect to particulates <10 µm (PM10) over a one year period

### 1. Intent

To assess the long-term ambient air quality with respect to particulates <10 µm (PM10) in the local area.

### 2. Assessment methodology

#### 2.1 Description

Particulate matter (PM10) pollution consists of very small liquid and solid particles floating in the air. PM10 is a mixture of materials that can include smoke, soot, dust, salt, acids, and metals. Particulate matter also forms when gases emitted from motor vehicles and industry undergo chemical reactions in the atmosphere. PM10 is among the most harmful of all air pollutants. When inhaled these particles evade the respiratory system's natural defences and lodge deep in the lungs. The criterion allows to evaluate the level of exposition of inhabitants to PM10 in the urban area.

#### 2.2 Data requirement

Indicator	Unit	Data source
Number of days exceeding the daily limits in a year	n	Measurement

#### 2.3 Assessment method

To characterize the indicator's value:

1. Daily test air samples in accordance with national or regional procedures over a period of one year;
2. Evaluate the number of days exceeding the daily limits in a year.



## G.2.1 Performance of the public transport

### 1. Intent

To determine the performance of the public transportation system.

### 2. Assessment methodology

#### 2.1 Description

Most urban areas are serviced by a public transportation service, but the quality of service, including the density of the route network, scheduling to suit the needs of the local population and affordable fares, vary widely.

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Percentage of inhabitants that are within 400 meters walking distance of at least one public transportation service stop.	%	Calculation

#### 2.3 Assessment method

To characterize the indicator's value:

- 1- Calculate the percentage of the inhabitants in the area that are within 400 meters walking distance of at least one public transportation service stop (bus, tram, metro).

Note: to be considered valid for the calculation, a stop must have a daily total service frequency of at least 20 trips.

### 3. References and Standards

Global Platform for Sustainable Cities – Urban Sustainability Framework





## G.2.4 Quality of pedestrian and bicycle network

### 1. Intent

To promote cycling and walking as an alternative to vehicle use by providing a safe and efficient mobility networks. Travelling by bicycle or by foot means less cars on the roads which reduces traffic congestion. Efficient alternative and environmentally-friendly modes of transport are key to not only improve mobility but the quality of life as well.

### 2. Assessment methodology

#### 2.1 Description

Increasing zero emission mobility is crucial to lower the carbon footprint of human activities.

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Total walkway meters of dedicated pedestrian paths and meters of bicycle path per 100 inhabitants.	m/100 inhabitants	Calculation

#### 2.3 Assessment method

To characterize the indicator's value:

1. Estimation of the number of inhabitants in the area
2. Calculation of the walkway meters of dedicated pedestrian paths in the area (A)
3. Calculation of the meters of bicycle paths in the area (B)
4. Calculation of the indicator's value as  $\frac{(A+B)}{100 \text{ INHABITANTS}}$

Bicycle paths and pedestrian paths have to be safe and physically separated to traffic roads to be considered in the calculation. A walkway adjacent and not separated from a traffic road is not acceptable.

### 3. References and standards

Global Platform for Sustainable Cities – Urban Sustainability Framework  
The pedestrian and the City- Carmen Hass-Klau



## G.4.2 Availability and proximity of key services

### 1. Intent:

To determine the accessibility and proximity of key services for local residents (e.g. schools, sports facilities, supermarket, community buildings, etc.)

### 2. Assessment methodology

#### 2.1 Description

Convenient locations of key services for access by local residents (e.g. schools, sports facilities, supermarket, community buildings, etc.) is a major factor in reducing the use of private vehicles and in ensuring that residents can obtain access to the services they need.

#### 2.2 Data requirement

Indicator	Unit	Data source
Percentage of inhabitants that are within 800 meters walking distance of at least 3 key services.	%	Calculation

#### 2.3 Assessment method

To characterize the indicator's value:

1. Identify locations of key services in the local area.
2. Calculate the percentage of the inhabitants that are within 800 meters walking distance from at least 3 key services.

Key services include: education, health, police station, food shop, bank, post office, pharmacy, shopping center.

### 3. References and standards

Global Platform for Sustainable Cities – Urban Sustainability Framework



## G.6.3 Community involvement in urban planning activities

### 1. Intent

To involve citizens in urban planning activities

### 2. Assessment methodology

#### 2.1 Description

Participatory planning is an urban planning paradigm that emphasizes the involvement of the entire community in the strategic and management processes of urban planning. Participatory planning aims to harmonize views among all of its participants as well as prevent conflict between opposing parties. In addition, marginalized groups have an opportunity to participate in the planning process.

#### 2.2 Data requirement

Information/Attribute	Unit	Data source
Level of involvement of users in urban planning	Level	Process documentation

#### 2.3 Assessment method

To characterize the indicator's value:

- 1- Use of the Sherry Arnstein ladder on citizen participation. Rate the level of users' involvement on planning.

LEVEL 1 – Non-Participation (therapy, manipulation, etc.)

LEVEL 2 – Degree of tokenism (placation, consultation, informing, etc.).

LEVEL 3 – Degree of citizens power (citizens control, delegated power, partnership, etc.) for at least one of the phases of the project ("diagnosis" i.e. prior assessment, design of the project, assessment after delivery of the project).

LEVEL 4 - Degree of citizens power (citizens control, delegated power, partnership, etc.) at every stages of the project ("diagnosis" i.e. prior assessment, design of the project, assessment after delivery of the project).

### 3. References and standards

Sheery Arnstein, 1969, original article

<http://www.participatorymethods.org/sites/participatorymethods.org/files/Arnstein%20ladder%201969.pdf>



# TESTING PROTOCOL

## KEY PERFORMANCE INDICATORS BUILDING SCALE

**March 2018 - Version 2.0**

2.1: To raise capacity for better management of energy in public buildings at transnational level  
Work package: WP3 TESTING  
Activity: 3.3 Test of transnational assessment methods and indicators  
Deliverable: 3.3.1 – Testing Protocol

**Responsible Partner: Andrea Moro, iiSBE Italia R&D**



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## B.1.1 Primary energy demand

[LEVELS – Headline indicator]

**1. Intent:** to minimise the total energy consumptions in the use stage.

### 2. Assessment methodology

#### 2.1 Description

The indicator provides an understanding of a building's primary energy consumptions in the use stage.

Primary energy is defined by Article 2(5) of the Energy Performance of Buildings Directive 6 as 'the energy that has not undergone any conversion in the transformation process, calculated by energy carrier using a primary energy factor'. It is the energy that is required to generate the electricity, heating and cooling used by a building.

This is a calculation of the overall system efficiency of the building's technical systems (HVAC installation, heat and power generation, domestic hot water supply, built-in lighting installation) and the fuels and energy carriers used.

#### 2.2 Indicator

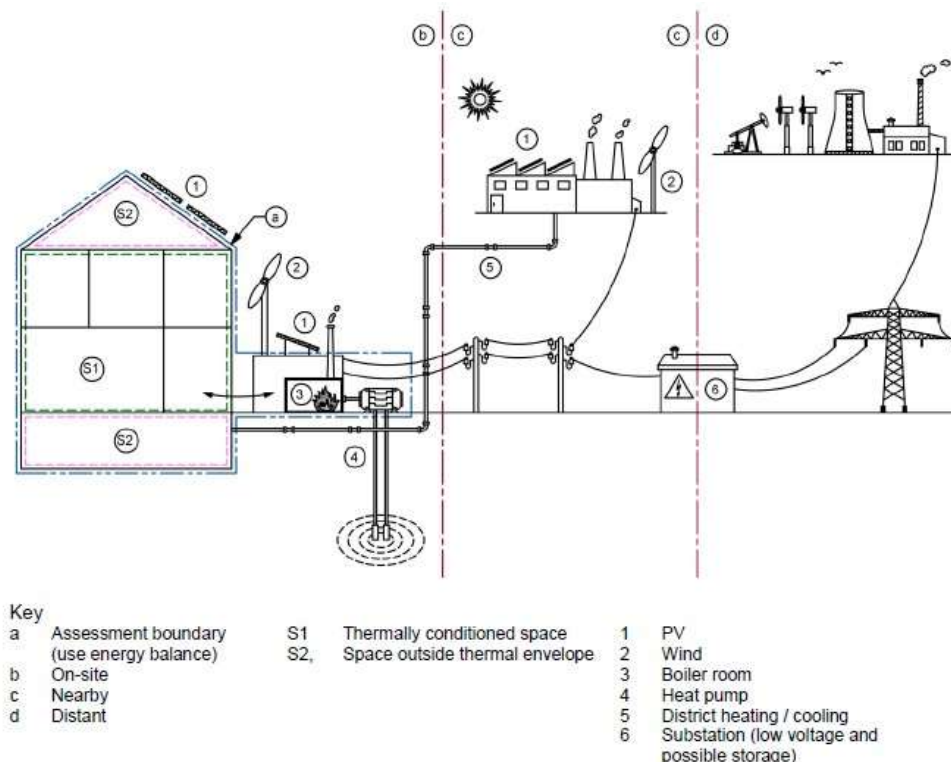
Description	Unit	Project stage	Data source
Primary energy demand per area per year	kWh/m <sup>2</sup> /y	Design	Estimation
		Occupation	Estimation

#### 2.3 Boundary and scope

The scope of the indicator includes the following energy uses, which are also referred to as technical building services – heating, cooling, ventilation, domestic hot water, (built-in) lighting, auxiliaries. For office buildings the electric consumption of appliances must be taken in account. In a life cycle approach, these uses are referred to as operational energy consumption.

The assessment boundary is the building. Energy can be imported or exported through the assessment boundary (the building) from/to on-site, nearby and distant locations – as illustrated by Figure 1. Inside the assessment boundary, the system losses are taken into account explicitly in the conversion factor applied to the energy carrier, also referred to as a primary energy factor.





*Fig.1: Building assessment boundary and energy balance locations Source: CEN (2017)*

## 2.4 Assessment method

The underlying calculation method for each sub-indicator is provided by the CEN standards series that support implementation of the Energy Performance of Buildings Directive (EPBD) across the EU.

The CEN standards series that currently forms the basis for most of national calculation methods includes EN 15603 (Energy performance of buildings. Overall energy use and definition of energy ratings) and EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling). This means that most national calculation methods that are required to be used to meet performance requirements or to complete Energy Performance Certificates (EPCs), and which are aligned with the EN standards series, can be used.

In-built lighting may not be specifically covered in all national or regional calculation methods. As a result, either the omission from the calculations, or a separate calculation method if used, shall be noted in the reporting. The reference standard for lighting estimates shall be EN 15193.

The unit of measure is kilowatt hours per square metre per year. The reference unit is one square meter of useful internal floor area (Level(s) Part 3 – 1.3.1).



## 2.5 Potential data sources

Data item	Potential source	
	Default EU values	National, regional or locally specific values
Conditions of use and occupancy	EN ISO 13790 (Annex G8) ISO/TR 52000-1/2 EN ISO 52016-1	National or regional calculation method
Thermal envelope description	EN ISO 13790 (Annex G) EN ISO 52016-1	National or regional calculation method: certified products and details
Building services description	EN ISO 13790 (Annex G) EN ISO 52016-1	National or regional calculation method: certified products
Reference year climate file	Three climate zones (EN 15265 test cases)	National or regional calculation method Member State Meteorological Offices
Primary energy factors	EN 15603 (Annex E) EN 52000-1 (Annex B.10)	National or regional calculation method
Internal temperature set points	EN ISO 13790 (Annex G) EN ISO 52016-1	National or regional calculation method
Ventilation and infiltration rates	EN 15241 EN 15242	National or regional calculation method
Internal gains as heat flows	EN ISO 13790 (Annex J) EN ISO 52016-1	National or regional calculation method
Heating/cooling system characteristics and capacity	-	National or regional calculation method: certified products

## 3. References and standards

Level(s) Part 1-2 – Beta version

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)





## B.1.2 Delivered thermal energy demand

[LEVELS – Supporting indicator]

**1. Intent:** to minimise the total thermal energy consumptions in the use stage.

### 2. Assessment methodology

#### 2.1 Description

The indicator provides an understanding of a building's thermal energy demand in the use stage. Use stage energy demand is in general responsible for the majority of life cycle energy use in the case of buildings constructed before the turn of the millennium.

Delivered thermal energy is the energy delivered to the building in the form of heat and fuel. It is the energy per 'carrier' supplied to the building, to satisfy uses within the building (heating, cooling, ventilation, domestic hot water). The 'delivered energy' is the one metered by the utilities.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Delivered thermal energy demand per area per year	kWh/m <sup>2</sup> /y	Design	Estimation
		Occupation	Metering

#### 2.3 Boundary and scope

The scope of the indicator includes the following energy uses, which are also referred to as technical building services – heating, cooling, ventilation, domestic hot water. In a life cycle approach, these uses are referred to as operational energy consumption.

The assessment boundary is the building.

#### 2.4 Assessment method

The underlying calculation method for estimating each sub-indicator is provided by the CEN standards series that support implementation of the Energy Performance of Buildings Directive (EPBD) across the EU.

The CEN standards series that currently forms the basis for most of national calculation methods includes EN 15603 (Energy performance of buildings. Overall energy use and definition of energy ratings) and EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling). This means that most national calculation methods that are required to be used to meet performance requirements or to complete Energy Performance Certificates (EPCs), and which are aligned with the EN standards series, can be used.

The unit of measure is kilowatt hours per square metre per year. The reference unit is one square meter of useful internal floor area (Level(s) Part 3 – 1.3.1).

In case of existing buildings, the delivered thermal energy should be evaluated using data from metering.



## CESBA MED: SUSTAINABLE CITIES

Priority Axis 2: Fostering low-carbon strategies and energy efficiency  
in specific MED territories: cities, islands and remote areas



The metered delivered thermal energy demand (i.e. fuel consumption data) has to be calculated taking the average value over 3 years period.

### 3. References and standards

Level(s) Part 1-2 – Beta version

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)



## B.1.3 Delivered electric energy demand

[LEVELS – Supporting indicator]

**1. Intent:** to minimise the total electric energy consumptions in the use stage.

### 2. Assessment methodology

#### 2.1 Description

The indicator provides an understanding of a building's electric energy demand in the use stage. Use stage energy demand is in general responsible for the majority of life cycle energy use in the case of buildings constructed before the turn of the millennium.

Delivered electric energy is the energy delivered to the building in the form of electricity. It is the energy supplied to the building, to satisfy uses within the building (heating, cooling, ventilation, domestic hot water, lighting, appliances). The 'delivered energy' is generally the one metered by the utilities.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Delivered electric energy demand per area per year	kWh/m <sup>2</sup> /y	Design	Estimation
		Occupation	Metering

#### 2.3 Boundary and scope

The scope of the indicator includes the following energy uses, which are also referred to as technical building services – heating, cooling, ventilation, domestic hot water, lighting, auxiliaries. In a life cycle approach, these uses are referred to as operational energy consumption. The assessment boundary is the building.

#### 2.4 Assessment method

The underlying calculation method for estimating the indicator is provided by the CEN standards series that support implementation of the Energy Performance of Buildings Directive (EPBD) across the EU.

The CEN standards series that currently forms the basis for most of national calculation methods includes EN 15603 (Energy performance of buildings. Overall energy use and definition of energy ratings) and EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling). This means that most national calculation methods that are required to be used to meet performance requirements or to complete Energy Performance Certificates (EPCs), and which are aligned with the EN standards series, can be used.

The unit of measure is kilowatt hours per square metre per year. The reference unit is one square meter of useful internal floor area (Level(s) Part 3 – 1.3.1).

In case of existing buildings, the delivered electrical energy should be evaluated using data from



metering.

The metered delivered electric energy demand (i.e. electricity consumption data) has to be calculated taking the average value over 3 years period bills.

### 3. References and standards

Level(s) Part 1-2 – Beta version

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)



## B.1.4 Energy from renewable sources in total primary energy consumption

[LEVELS – Reporting indicator]

**1. Intent:** to maximize the use of renewable energy sources.

### 2. Assessment methodology

#### 2.1 Description

The indicator assesses the share of primary energy demand that is met by renewable sources, without accounting for any export of renewable energy generated on site (such as from solar PV). This is because the CESBA MED Generic Framework takes a life cycle approach and, according to reference standard EN 15978, exported energy is reported as a benefit beyond the building's system boundary.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Primary energy demand of the building that is met by renewable sources on total primary energy demand	%	Design	Estimation
		Occupation	Estimation

#### 2.3 Boundary and scope

The scope of the indicator includes the following energy uses, which are also referred to as technical building services – heating, cooling, ventilation, domestic hot water, lighting, auxiliaries. In a life cycle approach, these uses are referred to as operational energy consumption. The assessment boundary is building.

#### 2.4 Assessment method

The calculation method is provided by the CEN standards series that support implementation of the Energy Performance of Buildings Directive (EPBD) across the EU. The CEN standards series that currently forms the basis for most of national calculation methods includes EN 15603 (Energy performance of buildings. Overall energy use and definition of energy ratings) and EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling).

### 3. References and standards

Level(s) Part 1-2 – Beta version

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)



## B.1.5 Energy from renewable sources in total thermal energy consumption

[LEVELS – Reporting indicator]

**1. Intent:** to maximize the use of renewable energy sources.

### 2. Assessment methodology

#### 2.1 Description

This indicator assesses the share of renewable energy in final thermal energy consumptions and, by implication, the degree to which renewable fuels have substituted fossil and/or nuclear fuels and therefore contributed to the decarbonisation of the Mediterranean space economy. It also shows what is the progress towards Europe 2020 target for renewable energies.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Share of renewable energy in final thermal energy consumptions	%	Design	Estimation
		Occupation	Metering

#### 2.3 Boundary and scope

The scope of the indicator includes the following energy uses, which are also referred to as technical building services – heating, cooling, ventilation, domestic hot water. In a life cycle approach, these uses are referred to as operational energy consumption.

#### 2.4 Assessment method

The underlying calculation method for the indicator is provided by the CEN standards series that support implementation of the Energy Performance of Buildings Directive (EPBD) across the EU. The CEN standards series that currently forms the basis for most of national calculation methods. In case of existing buildings, the share of renewable energy in total final thermal energy consumptions should be evaluated by energy metering.

### 3. References and standards

Level(s) Part 1-2 – Beta version

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)



## B.1.6 Energy from renewable sources in total electric energy consumption

[LEVELS – Reporting indicator]

**1. Intent:** to maximize the use of renewable energy sources.

### 2. Assessment methodology

#### 2.1 Description

This indicator assesses the share of renewable energy in final electric energy consumptions and, by implication, the degree to which renewable sources have substituted fossil and/or nuclear fuels and therefore contributed to the decarbonisation of the Mediterranean space economy.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Share of renewable energy in final electric energy consumption	%	Design	Estimation
		Occupation	Estimation

#### 2.3 Boundary and scope

The scope of the indicator includes the following energy uses, which are also referred to as technical building services – heating, cooling, ventilation, domestic hot water, lighting, auxiliaries. In a life cycle approach, these uses are referred to as operational energy consumption.

#### 2.4 Assessment method

The underlying calculation method for the indicator is provided by the CEN standards series that support implementation of the Energy Performance of Buildings Directive (EPBD) across the EU. The CEN standards series that currently forms the basis for most of national calculation methods. In case of existing buildings, the share of renewable energy in total final electric energy consumption should be evaluated by energy metering.

### 3. References and standards

Level(s) Part 1-2 – Beta version

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)



## B.2.1 Embodied non-renewable primary energy

[CESBA]

**1. Intent:** to promote the use of construction materials with a low embodied energy.

### 2. Assessment methodology

#### 2.1 Description

This indicator measures the embodied non-renewable primary energy of materials used for the building construction. The embodied energy is the energy consumed by all the processes associated with the production of construction materials, from the raw materials supply to manufacturing (cradle-to-gate) energy used for the acquisition of raw materials, processing, manufacturing and assembling building construction materials at the factory gate.

Cradle to Gate: energy used for the acquisition of raw materials, processing, manufacturing and assembling building construction materials at the factory gate.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Embodied primary non-renewable energy	MJ/m <sup>2</sup>	Design	Estimation
		Occupation	Not applicable

The unit of measurement to be used for reporting on this indicator is MJ /m<sup>2</sup> (MJ = mega joules). The area for the calculation of the indicator is the gross area of the building. This is a commonly specified environmental impact category indicator used in Life Cycle Assessment

#### 2.3 Boundary and scope

The scope comprises the product stage of the building (Module A1-3) i.e. from raw material supply to manufacturing. The scope encompasses the building materials excluding the technical installations. All the elements of the construction are taken in account: foundations, bearing structure, envelope, slabs.





The minimum scope of the indicator shall include the following building parts and elements:

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	Underground

## 2.4 Assessment method

The main reference standards for the indicator are ISO 14040/44, EN 15804 (Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products) and EN 15978 (Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method).

To calculate the value of the indicator it is necessary to compile a Bill of Materials (BoM) that is a mass-based inventory of the different materials (kg) that compose a building. The BoM is organised according to main elements that a building is composed of. The starting point is the Bill of Quantities (BoQ) that specifies the elements of a building (e.g. foundations, columns). The BoQ comprises different categories of elements, which can have different functional performance characteristics. BoM differs from a BoQ in that it describes the different materials (e.g. concrete, steel, aluminium) that are contained in the various building elements.

Once the BoM has been compiled, it is possible to calculate the value of the indicator.

The following steps should be followed in order to compile the BoM:

- Compile the Bill of Quantities: A BoQ is compiled which comprises the building elements accounting for at least 99% of the mass of the building.
- Identify the basic composition of each building element. A breakdown of its **constituent materials** has to be carried out. The mass of each constituent material has to be estimated;
- Aggregation by material: The mass for each **constituent material** should thereafter be aggregated to obtain the total mass for each type of material.

Once the BoM has been compiled, it is possible to calculate the indicator associating to each constituent material the relative embodied primary non-renewable energy by multiplying the



specific mass (i.e. kg) with its corresponding embodied energy coefficient (i.e. MJ/kg). The total value of embodied primary non-renewable energy is finally normalized by the gross area of the building.

### 3. References and standards

EN 15978 “Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method”



## B.3.5 Recycled materials

[CESBA]

**1. Intent:** to reduce the environmental impact of construction materials.

### 2. Assessment methodology

#### 2.1 Description

This indicator assesses the amount of recycled materials used in the building with regards to the total amount of building materials.

The use of recycled materials allows to reduce the use and depletion of new materials.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Weight of recycled materials on total weight of materials.	%	Design	Estimation
		Occupation	Not applicable

#### 2.4 Boundary and scope

The scope encompasses the building materials excluding the technical installations. All the elements of the construction are taken in account: foundations, load bearing structure, envelope, slabs.

It is possible to take in account both the postconsumer and pre-consumer recycled content of a material. It is possible to include the pre-consumer content in the calculation only if it isn't reused in the same industrial process.

The reference standard for the definition of pre-consumer and postconsumer content is the EN ISO 14021 (Environmental labels and declarations - Self-declared environmental claims - Type II environmental labelling).

The minimum scope of the indicator shall include the following building parts and elements:

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	Underground

### 2.3 Assessment method

To calculate the value of the indicator it is necessary to compile a Bill of Materials (BoM) that is a mass-based inventory of the different materials (kg) that compose a building. The BoM is organised according to main elements that a building is composed of.

The starting point is the Bill of Quantities (BoQ) that specifies the elements of a building (e.g. foundations, columns). The BoQ comprises different categories of elements, which can have different functional performance characteristics. A BoM differs from a BoQ in that it describes the different materials (e.g. wood, steel, aluminium) that are contained in the various building elements. Once the BoM has been compiled, it is possible to calculate the value of the indicator.

The following steps should be followed in order to characterize the indicator:

- Compile the Bill of Quantities: A BoQ is compiled which comprises the building elements accounting for at least 99% of the mass of the building.
- Identify the basic composition of each building element. A breakdown of its **constituent materials** has to be elaborated. The mass of each constituent material has to be estimated;
- Aggregation by material: the mass of all constituent material should thereafter be aggregated to obtain the **total mass of materials used in the building (A)**;
- Identify the recycled content of each constituent material (in mass);
- Aggregation by material: the recycled mass of all constituent materials should thereafter be aggregated to obtain the **total recycled mass of materials (B) used in the building**;
- The indicator's value is calculated as  $B/A$  (total mass of recycled materials on the total mass of materials).



## B.4.2 Water consumption for indoor uses

[LEVELS – Headline indicator]

### 1. Intent:

To make efficient use of water resources.

### 2. Assessment methodology

#### 2.1 Description

The “Water consumption” criterion estimates or measures the water consumption of sanitary fittings/devices and water consuming appliances that are relevant to the building. This indicator can be applied to new, renovated or existing buildings in order to understand, and ultimately decrease, the water demand.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Water consumption per occupant per year	m <sup>3</sup> /occupant/year	Design	Estimation
		Occupation	Metering

#### 2.3 Boundary and scope

The water use measured by the indicator relates to life cycle module B7 'operational water use' in the reference standard EN 15978. The scope of the term "operational water use" includes the use of both potable water and non-potable water and applies to processes for:

- drinking water
- water for sanitation
- water for cleaning
- domestic hot water

The boundary covers the time period from the handover of the construction works to the point in time when the building is deconstructed/demolished.

#### 2.3 Assessment method

The user must include in the calculation the sanitary devices/fittings (i.e. toilets, taps and showers) and water using appliances (i.e dishwashers and washing machines). Consumption rates for different sanitary devices and fittings are determined through specific data from suppliers. The specific usage factors have to be established. The number of days that the building is expected to be occupied per year has to be defined by the user.



The principle of the per occupant water consumption calculation for taps and showers is as follows:

$$\begin{aligned} \text{Total consumption} \left( \frac{L}{\text{occupant.d}} \right) &= \text{Consumption rate} \left( \frac{L}{\text{min}} \right) \times \text{Usage factor} \left( \frac{\text{min}}{\text{occupant.d}} \right) \\ \text{Total consumption} \left( \frac{m^3}{\text{occupant.year}} \right) &= \text{Total consumption} \left( \frac{L}{\text{occupant.d}} \right) \times 0.001 \left( \frac{m^3}{L} \right) \times \text{occupancy rate} \left( \frac{d}{\text{year}} \right) \end{aligned}$$

The exact same principle applies for calculations for toilets (except that flushes are used instead of minutes).

For cleaning, the basis of the calculation is as follows:

$$\begin{aligned} \text{Total consumption} \left( \frac{L}{\text{year}} \right) &= \text{Consumption rate} \left( \frac{L}{m^2} \right) \times \text{area} (m^2) \times \text{no. cleans per year} (year^{-1}) \\ \text{Total consumption} \left( \frac{m^3}{\text{occupant.year}} \right) &= \text{Total consumption} \left( \frac{L}{\text{year}} \right) \times 0.001 \left( \frac{m^3}{L} \right) \div \text{full time eqivt. occupancy (occupant)} \end{aligned}$$

The consumption of water from not potable sources has to be specified (i.e. toilet flush from grey water).

In case of existing buildings, the water consumptions should be evaluated using data from metering. The metered consumptions have to be estimated taking the average value over 3 years period bills.



### C.1.3 Global Warming potential

[LEVELS – Headline indicator]

**1. Intent:** to minimise the total greenhouse gas emissions from buildings' operations.

#### 2. Assessment methodology

##### 2.1 Description

This indicator measures the contribution of the greenhouse gas (GHG) emissions associated with the building's operational phase on the earth's global warming. The Global Warming Potential (GWP) was developed to allow for the comparison of the impact on global warming caused by different gases. Specifically, it is a relative measure of how much energy can be trapped in the atmosphere over a set time horizon by a mass of gas in comparison with the same mass of carbon dioxide (CO<sub>2</sub>). A higher GWP means a larger warming effect in that period of time.

##### 2.2 Indicator

Description	Unit	Project stage	Data source
CO <sub>2</sub> equivalent emissions per area per year	kg CO <sub>2</sub> eq./m <sup>2</sup> /yr	Design	Estimation
		Occupation	Estimation

##### 2.3 Boundary and scope

The scope of the indicator comprises the use stage of the building and includes the emissions correlated to the following energy uses: heating, cooling, ventilation, domestic hot water, lighting, auxiliaries.

##### 2.3 Assessment method

To characterize the indicator's value:

$$E = \left[ \sum (Q_{fuel,i} \times LHV_i \times k_{em,i}) + (Q_{el} \times k_{em,el}) + (Q_{dh} \times k_{em,dh}) \right] \div S_u$$

$Q_{fuel,i}$  = annual quantity of i-th fuel (m<sup>3</sup> or Kg)

$Q_{el}$  = annual quantity of electrical energy from the grid (kWh)

$Q_{dh}$  = annual quantity of energy from district heating/cooling (kWh)

$LHV_i$  = lower heating value of the i-th fuel (kWh/m<sup>3</sup> or kWh/Kg)

$K_{em,i}$  = CO<sub>2</sub> eq. emission factor of the i-th fuel (Kg CO<sub>2</sub>/kWh)

$K_{em,i}$  = CO<sub>2</sub> eq. emission factor of the electrical energy from the grid (Kg CO<sub>2</sub>/kWh)

$K_{em,i}$  = CO<sub>2</sub> eq. emission factor of energy from district heating/cooling (Kg CO<sub>2</sub>/kWh)

$S_u$  = useful internal floor area

#### 3. References and standards

EN 15603 (Energy performance of buildings - Overall energy use and definition of energy ratings)





### C.3.1 Construction and demolition waste

[LEVELS – Headline indicator]

#### 1. Intent:

To minimize the production of construction and demolition waste.

#### 2. Assessment methodology

##### 2.1 Description

The focus of the criterion is on waste that may arise in the life cycle of a building. The demolition of buildings can typically generate between 664 and 1637 kg/m<sup>2</sup> of waste. Major renovations can generate between 20 and 326 kg/m<sup>2</sup> of waste and construction sites can generate a further 48 – 135 kg/m<sup>2</sup> of waste.

Consequently, there are significant opportunities to reduce waste by moving to a more circular economy-based approach that focuses on deconstruction instead of demolition, and on reuse and recycling instead of disposal.

Life cycle stage(s)	Building-related activities
Part of the previous building's life cycle	Deconstruction and demolition of a building(s) in order to clear a site for a new building construction
	Part deconstruction of a building(s) in order to prepare useful parts for in-situ reuse
	Preparation of a building in order to facilitate a major renovation
Life cycle stages A3/5 – Manufacturing, Transport, Construction	Construction on site of a new building and/or the prefabrication/construction of parts and elements off site
Life cycle stages C1/3, D – De-construction, Transport, Waste processing,	Deconstruction and demolition of the building at a future point in time beyond the end of its service life





### Overview of the indicator

The common performance assessment focuses on gathering data to report on the total waste disposed of and waste diverted. This requires confirmation of the waste types and whether the data is estimated or from a site. The reporting is at a basic level, making a distinction between waste disposed of and waste diverted.

For each of the defined stages in the life cycle of a building, and as relevant to the nature of the building project being reported on, the following categories of output flows shall be reported on, with the option to disaggregate each flow by material stream:

- Waste disposed of: hazardous and non-hazardous waste streams. This shall include waste disposed of to landfill and by incineration.
- Components for re-use: This shall include all materials recovered for re- use either on or off site, with a focus on encouraging the reuse of structural elements.
- Materials for recycling: This shall include all materials recovered for recycling either on or off site. Waste materials used in backfilling operations on or off site are excluded.
- Materials for other material recovery operations: This shall include backfilling and processes that meet the EU definition of energy recovery.
- Waste generated during the prefabrication or assembly of parts or elements off site that would otherwise take place on site shall be included within reporting on waste disposed of. This is to ensure that any burden shifting in order to reduce on-site waste is accounted for.

The flows reported on under the scope of this indicator reflect those defined 'indicators describing additional environmental information' in the reference standards EN 15978 (Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method).

## 2.2 Indicator

Description	Unit	Project stage	Data source
Weight of waste and materials generated per 1 m <sup>2</sup> of useful floor area demolished or constructed	kg/m <sup>2</sup> /life cycle stage	Design	Estimation
		Occupation	Not applicable

### 2.2 Boundary and scope

The scope shall encompass waste (output flows) arising from the end-of-life buildings and their parts, as well as all materials that are ready for construction that are brought onto a building site (input flows) and are intended to form part of a building and external works within the site boundary, as well as from associated application and assembly processes.

The boundary of the indicator will depend on the point in the project and its life cycle at which the waste being reported on arises.

Burden shifting of waste from construction sites shall be accounted for by extending the boundary



of the reporting. In practice, this means that for any task that could have taken place on-site but has been shifted off-site to a factory (e.g. prefabricated wall panels or brick facings) the waste arisings associated with that activity in the factory shall be accounted for.

## 2.3 Assessment method

Project stage	Activities
1. Design stage (based on estimations)	Estimations of waste based on surveys of existing buildings that will undergo major renovation or where the structure will be reused (life cycle stage B5). Estimations based on scenarios for deconstruction and demolition of the building at a future point in time beyond the end of its service life (life cycle stages C1/3, D).
2. Construction stage (based on data recorded from the site)	Data from deconstruction and demolition of (a) building(s) in order to clear a site for a new building construction (as part of a previous life cycle). Data from the part deconstruction of (a) building(s) in order to prepare useful parts for in-situ reuse. Data from construction on site of a new building and/or the prefabrication/construction of parts and elements off site (life cycle stages A3/5). Data from preparation of a building in order to facilitate a major renovation.
3. Completion stage (based on estimations supported by as-built drawings)	Estimations based on scenarios for deconstruction and demolition of the building at a future point in time beyond the end of its service life (life cycle stages C1/3, D).
4. Post-completion (based on commissioning and testing)	n/a
5. Occupation (based on measured performance)	n/a
6. End of life (based on planned performance)	Details of measures that were taken at design stage to facilitate deconstruction, reuse and recycling at a future date (life cycle stages C1/3, D).



## C.3.2 Solid waste from building operation

[CESBA]

### 1. Intent:

To facilitate the separate collection and recycle of solid waste from building operation.

### 2. Assessment methodology

#### 2.1 Description

Landfills are an increasingly pressing problem. Less and less land is available to deposit refuse, but the volume of waste is growing continuously. As a result, segregating waste is a priority because this practice gives the possibility to reuse and recycle the solid waste produced from buildings operation reducing the pressure on landfills.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Ratio of the number of collectable solid waste types within a 50 m distance from the building's entrance to the reference solid waste categories	kg/m <sup>2</sup> /life cycle stage	Design	Estimation
		Occupation	Measure

#### 2.3 Assessment method

The seven reference categories of solid waste are:

- Paper
- Plastic
- Metal
- Glass
- Wet waste
- Textiles
- Special hazardous waste.
- 

Identify the availability and position of bins and containers for each of the seven solid waste categories.

Calculate the walking distance (m) from the building's main entrance to each identified bin or container.

Evaluate how many of the 7 categories of solid waste is possible to collect within a 50 m walking distance from the building's entrance (A).

Calculate the value of the indicator as :  $A/7$



## D.1.3 Forlmandeyde concentration

[LEVELS – Headline indicator]

### 1. Intent:

To facilitate the assessment of indoor air quality.

### 2. Assessment methodology

#### 2.1 Description

This indicator for source control of target air pollutants measure one of the most significant potential hazards to human health that can impact indoor air quality, the formaldehyde. In an air tight, modern home or office, the most significant direct emissions sources related to building construction material & products and other building finish materials that may originate from:

- paints and varnishes,
- textile furnishings,
- floor coverings,
- associated adhesives and sealants, and
- finish materials that incorporate particle board.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Formaldehyde concentration in indoor air	$\mu\text{g}/\text{m}^3$	Design	Not applicable. Alternative: use of product testing.
		Occupation	Measure

#### 2.2 Boundary and scope

The boundary for the criterion is the useful conditioned volume and the related indoor air conditions as experienced by occupants of a building within those zones of the building. The indicator has to be evaluated in the post completion phase, prior to occupation.

For buildings in the design phase, product testing shall to be used as a mean of source control

#### 2.3 Assessment method

The indicator's value has to be characterized through in situ measurements prior to occupation (post-completion phase). Testing shall be carried out for a minimum of 10% of the apartments and be representative of any significant variations in the house or apartment typologies, configurations and materials. Samples shall be taken in the living room and the smallest bedroom of each property selected.



Sampling devices shall be placed in the centre of a room so as not to be influenced by doors, windows or heating/cooling inputs.

Sampling and detection method: 30 minutes average in accordance with ISO 16000-3 (Indoor air -- Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air -- Active sampling method)

In the design stage product testing shall to be used as a mean of source control. Test results showing the emissions after 28 days shall be reported for each material or finish to be installed that falls within the identified scope. The determination of emissions shall be in conformance with CEN/TS 16516 (Construction products - Assessment of release of dangerous substances - Determination of emissions into indoor air). Test data is therefore required from manufacturers/suppliers of the selected building products, as defined in the scope. All testing shall be on the as-finished product.

### 3. References and standards

EN 15251 (Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics)



## D.1.4 TVOC concentration in indoor air

[LEVELS – Headline indicator]

### 1. Intent

To facilitate the assessment of indoor air quality.

### 2. Assessment methodology

#### 2.1 Description

This indicator for source control of target air pollutants measure one of the most significant potential hazards to human health that can impact indoor air, the Total Volatile Organic Compounds (TVOC). In an air tight, modern home or office, the most significant direct emissions sources related to building construction material & products and other building finish materials that may originate from:

- paints and varnishes,
- textile furnishings,
- floor coverings,
- associated adhesives and sealants, and
- finish materials that incorporate particle board.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
TVOC concentration in indoor air	$\mu\text{g}/\text{m}^3$	Design	Not applicable. Alternative: use of product testing.
		Occupation	Measure

#### 2.2 Boundary and scope

The boundary for the criteria is the useful conditioned volume and the related indoor air conditions as experienced by occupants of a building within those zones of the building. The indicator shall to be evaluated in the post completion phase, prior to occupation. For buildings in the design phase, product testing shall to be used as a mean of source control

#### 2.3 Assessment method

The indicator's value shall to be characterized through in situ measurements prior to occupation (post-completion phase). Testing shall be carried out for a minimum of 10% of the apartments and be representative of any significant variations in the house or apartment typologies, configurations and materials. Samples shall be taken in the living room and the smallest bedroom of each property selected.



Sampling devices shall be placed in the centre of a room so as not to be influenced by doors, windows or heating/cooling inputs.

Sampling and detection method shall to be in accordance with ISO 16000-6 or equivalent.

In the design stage product testing shall to be used as a mean of source control. Test results showing the emissions after 28 days shall be reported for each material or finish to be installed that falls within the identified scope. The determination of emissions shall be in conformance with CEN/TS 16516 (Construction products - Assessment of release of dangerous substances - Determination of emissions into indoor air). Test data is therefore required from manufacturers/suppliers of the selected building products, as defined in the scope. All testing shall be on the as-finished product.

### 3. References and standards

EN 15251 (Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics)



## D.1.5 CO<sub>2</sub> concentration in indoor air

[LEVELS – Headline indicator]

### 1. Intent:

To facilitate the assessment of indoor air quality.

### 2. Assessment methodology

#### 2.1 Description

The indicators measure the concentration level of CO<sub>2</sub> that indicates if a healthy and comfortable indoor air is supplied to occupants

#### 2.2 Indicator

Description	Unit	Project stage	Data source
CO <sub>2</sub> concentration in indoor air	ppm	Design	Estimation
		Occupation	Measure

#### 2.3 Boundary and scope

The boundary for the criteria is the useful conditioned space and the related indoor air conditions as experienced by occupants of a building within those zones of the building.

#### 2.3 Assessment method

Design performance assessments of CO<sub>2</sub> levels may be obtained by simplified steady state calculation or a dynamic simulation, in accordance with EN 15242.

The two methods differ in how accurately they are able to simulate the occupied performance of a building, particularly in terms of how air movements and the interaction of occupants are accounted for within a simulation. Priority has to be given to the dynamic simulation.

The measure of CO<sub>2</sub> concentration upon occupation of the building is carried out to check whether the design conditions are being achieved. Internal spaces within a building shall be tested and inspected on-site and upon full occupation of the building after a minimum of one year.

Testing shall be carried out for a minimum of 10% of the apartments and be representative of any significant variations in the house or apartment typologies and configurations. Samples shall be taken in the living room and in the bedrooms of each property selected.

The direct sampling of the air in rooms shall to be carried out over 1 week or 7 working days.

### 3. References and standards

EN 15251 (Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics)





## D.2.1 Time outside of the thermal comfort range

[LEVELS – Headline indicator]

### 1. Intent:

To facilitate the assessment of indoor thermal comfort conditions.

### 2. Assessment methodology

#### 2.1 Description

The focus of this indicator is on the ability of the building to maintain pre-defined thermal comfort conditions during the heating and cooling seasons

The indicator measures, by proxy, the proportion of the year when building occupants may feel thermal discomfort

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Percentage of the time out of the range of defined maximum and minimum temperatures during the heating and cooling seasons	%	Design	Estimation
		Occupation	Metering

#### 2.2 Boundary and scope

The scope of the indicator is the indoor operative temperature and thermal comfort conditions of the occupants within the building.

The assessment boundary is the building. Heat losses and gains that will affect the comfort conditions within the building, as well as the heating and cooling energy that may be required to maintain these conditions, are to be considered. The reported performance shall apply to 95% of the occupied spaces.

#### 2.3 Assessment method

Calculation of the reported performance shall be in accordance with the method described in Annex F of EN 15251 and/or an overheating assessment that forms part of a National Calculation Method. Buildings with and without mechanical cooling shall be assessed. Those buildings which have full or mixed mode mechanical cooling shall additionally assess the building performance under free floating conditions i.e. without mechanical systems such as Heating, Ventilation and Air Conditioning (HVAC).

The quasi-steady state and simplified hourly methods described in EN ISO 13790 (Energy performance of buildings. Calculation of energy use for space heating and cooling) may be used. Alternatively, if a dynamic method is used, the results shall be validated according to EN ISO 52016-1 or the criteria and test cases in EN 15265.

The common unit of measurement is the percentage of the time out of the acceptable range of



defined maximum and minimum temperatures during the heating and cooling seasons. The performance is assessed for the useful floor area of the building and the projected pattern of use for the building.

The performance of a building should always be assessed both with and without mechanical cooling. This shall ensure that the inherent thermal characteristics of the building envelope and structure are assessed.

The indicator has to be evaluated in all main living rooms and all bed rooms. In the case of assessment of multiple apartments, each distinctive configuration and orientation shall be assessed.

To estimate the indicator's value at whole building level, it is necessary to aggregate the indicators' values estimated or measured in the different rooms through a weighted sum:

$$Time\ out\ of\ range_m = \frac{\sum Time\ out\ of\ range_i \times A_{u,i}}{\sum A_{u,i}}$$

Where:

Time out of range<sub>i</sub> = percentage of the time out of the range in the i-th room (%)

A<sub>u,i</sub> = useful internal floor area of the i-th room

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### 3. References and standards

EN 15251 (Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics)



## D.2.2 Thermal comfort index

[CESBA]

### 1. Intent:

To facilitate the assessment of indoor thermal comfort conditions.

### 2. Assessment methodology

#### 2.1 Description

The thermal comfort index PPD (Predicted Percentage Dissatisfied) allows to predict the general thermal sensation and degree of discomfort (thermal dissatisfaction) of people exposed to moderate thermal environments. It enables the analytical determination and interpretation of indoor thermal comfort, giving the environmental conditions considered acceptable for general thermal comfort as well as those representing local discomfort.

#### 2.2 Data requirement

Description	Unit	Project stage	Data source
Predicted Percentage Dissatisfied	%	Design	Estimation
		Occupation	Measure

#### 2.3 Assessment method

Estimation of the PPD through a simulation software for buildings under design.

Measurement of the PPD in the case of operating buildings.

PPD value has to be estimated or measured in accordance to EN 7730 both in summer and winter conditions.

The PPD has to be evaluated in all main living rooms and all bed rooms. In the case of assessment of multiple apartments, each distinctive configuration and orientation shall be assessed.

The calculation or measurement point has to be set at one meter from the center of the main window in each room.

Use the following reference parameters to characterize the PPD value:

- thermal resistance of clothing: 0,5 clo
- metabolic energy = 1,2 met



To estimate a PPD value at whole building level, it is necessary to aggregate the PPD values estimated or measured in the different rooms through a weighted sum:

$$PPD_m = \frac{\sum PPD_i \times A_{u,i}}{\sum A_{u,i}}$$

Where:

$PPD_i$  = PPD value of the i-th room

$A_{u,i}$  = useful internal floor area of the i-th room

### 3. References and standards

EN ISO 7730. Ergonomics of the thermal environment -- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria



## G.1.4 Use stage energy cost

[LEVELS – Sub indicator]

### 1. Intent:

To optimize the operating cost of buildings to reflect the potential for long term performance.

### 2. Assessment methodology

#### 2.1 Description

The focus of the criteria is on the costs of thermal and electric energy during operation for all uses.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Energy annual cost per usable floor area	€/m <sup>2</sup> /yr	Design	Estimation
		Occupation	Energy bills

#### 2.3 Assessment method

Reporting can be based on estimated performance at the design stage and after monitoring of performance during normal building occupancy. This means they can be used by a range of project actors, including during the design stage, to estimate future performance and performance following occupation so as to check how the building is actually performing against projected short, medium and long-term cost schedules.

In case of existing buildings, the total annual cost of actual thermal and electrical energy use from energy bills should be calculated taking the average energy cost over 3 years period.



## G.1.5 Use stage water cost

[LEVELS – Sub indicator]

### 1. Intent:

To optimize the operating cost of buildings to reflect the potential for long term performance.

### 2. Assessment methodology

#### 2.1 Description

The focus of the criteria is on the costs of water during operation for all indoor uses.

#### 2.2 Indicator

Description	Unit	Project stage	Data source
Water annual cost per usable floor area	€/m <sup>2</sup> /yr	Design	Estimation
		Occupation	Water bills

#### 2.3 Assessment method

Reporting can be based on estimated performance at the design stage and after monitoring of performance during normal building occupancy. This means they can be used by a range of project actors, including during the design stage, to estimate future performance and performance following occupation so as to check how the building is actually performing against projected short, medium and long-term cost schedules.

In case of existing buildings, the total annual cost of water use from water bills should be calculated taking the average water cost over 3 years period.



