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Level(s) indicator 1.1: Use stage energy performance

User manual: overview, instructions and guidance

(Publication version 1.0)

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Title
Level(s) indicator 1.1: Use stage energy performance, User manual: Overview, instructions and guidance (Publication version 1.0)

Abstract
Developed as a common EU framework of core indicators for the sustainability of office and residential buildings, Level(s) provides a set of indicators and common metrics for measuring the performance of buildings along their life cycle. As well as environmental performance, which is the main focus, it also enables other important related performance aspects to be assessed using indicators and tools for health and comfort, life cycle cost and potential future risks to performance. Level(s) aims to provide a common language of sustainability for buildings. This common language should enable actions to be taken at building level that can make a clear contribution to broader European environmental policy objectives. It is structured as follows:

1. Macro-objectives: An overarching set of six macro-objectives for the Level(s) framework that contribute to EU and Member State policy objectives in areas such as energy, material use and waste, water and indoor air quality.
2. Core Indicators: A set of 16 common indicators, together with a simplified Life Cycle Assessment (LCA) methodology, that can be used to measure the performance of buildings and their contribution to each macro-objective.

In addition, the Level(s) framework aims to promote life cycle thinking. It guides users from an initial focus on individual aspects of building performance towards a more holistic perspective, with the aim of wider European use of Life Cycle Assessment (LCA) and Life Cycle Cost Assessment (LCCA) methods.

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How this indicator user manual works

Level(s) is a framework of core indicators of sustainability that can be applied to building projects in order to report on and improve their performance. The supporting documentation has been designed to be accessible to all the actors that may be involved in this process.

If you are new to the assessment of a building's sustainability, we recommend reading the **first part of the Level(s) user manual**. This will provide you with an introduction to the basic concepts behind Level(s) and how you can apply it to a building project.

If you haven't yet set up your building project to use Level(s), including completing the project plan and the building description, then we recommend reading the **second part of the Level(s) user manual**.

This indicator user manual forms the third part of the Level(s) user manual where you will find instructions on how to use the indicators themselves. It is designed to help you apply your chosen indicator to a building project. It will help you to do this in the following way:

- **Introductory briefing:** This section provides an overview of the indicator, including:
  - ✓ why you may wish to measure performance with it,
  - ✓ what it measures,
  - ✓ at which stages in a project it can be used,
  - ✓ the unit of measurement, and
  - ✓ the relevant calculation method and reference standards.
- **Instructions on how to use the indicators at each level**: This section provides:
  - ✓ step by step instructions for each level,
  - ✓ what is needed to make an assessment,
  - ✓ a design concept checklist (at Level 1), and
  - ✓ the reporting formats.

  The instructions often refer to the guidance and further information which can be found after the instructions.
- **Guidance and further information for using the indicator**: This section provides more background information and guidance to support you in following specific steps in the instructions, including the design concepts introduced at Level 1 and the practical steps to calculate or measure performance at Levels 2 and 3. They are all cross-referenced to specific instruction steps at either level 1,2 or 3.

This indicator user manual is structured so that once you are familiar with using the indicator and you know how to work with it, you may no longer need to refer to the guidance and background information, but only work directly with the instructions at the level of your choice.

Introductory briefing

Why measure performance with this indicator?

Primary energy use is the required metric for reporting on the energy performance of buildings across the EU. The energy performance of a building expressed in primary energy is used for both compliance with minimum energy performance requirements and for the Energy Performance Certificates (EPCs) based on either design or as-built input data [1].

For buildings constructed indicatively before 2010, use stage primary energy demand will account for the most significant life cycle impacts. For newer buildings[2], , the production stage and other use stages related to material use, such as replacement and refurbishment assume greater importance. This is because proportionately they use less energy in the use stage and the materials used for their construction are more energy intensive. In this case the use stage is potentially responsible for as little as 30% of life cycle energy use, depending on the building type, form and specification.

In addition, reporting on this indicator can provide useful insights on the buildings total emissions of air pollutants to the ambient air. Whereas an overall reduction in primary energy consumption will generally have a positive effect on air quality[3], a fuel switch may also lead to an increase of emissions of specific ambient air pollutants[4].

What does it measure?

The indicator measures the energy performance of a building on the basis of the calculated or actual energy that is consumed in order to meet the different energy needs associated with its typical use. . In practice, this equates to the fuel required to generate and supply the electricity, space heating, hot water and cooling supplied to a building and it's technical building systems, as well as fuels such as natural gas and biomass that are used in the building to provide heating and hot water.

The primary energy use is based on primary energy factors per energy carrier, which may be based on national or regional annual weighted averages or a specific value for on-site production. At the design stage, calculated energy needs can, as a result, be converted into primary energy by applying the relevant primary energy factors. These factors account for any system losses and inefficiencies. Upon completion of the building, measured (metered) fuel and electricity consumption can be converted into primary energy by applying the same primary energy factors.

The primary energy use may relate to the energy needs of installed building systems – such as the heating, air conditioning, ventilation and lighting – as well as building occupiers' appliances that are plugged into the buildings electricity circuit – such as computers and appliances.

With the increasing installation of renewable energy generating technologies on buildings, the indicator also enables reporting on how much of the primary energy demand is supplied by renewable energy generation – either on-site or connected to the building – as well as how much primary energy is exported as a surplus from what the building consumes.

[1] See Annex I of Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency

[2] Dodd et al, *Identifying indicators for the life cycle environmental performance, quality and value of EU office and residential buildings*, July 2016, Technical Report, Joint Research Centre

[3] Commission Impact Assessment accompanying the proposal for a Directive amending Directive 2012/27/EU on Energy Efficiency, SWD(2016) 405 final/2, part 1/3, Brussels, 6 December 2016, p.57: *The residential sector in particular holds big potentials for untapped energy efficiency and, as a result, air pollution abatement* […]. *The size of this potential depends on the fuel choice of households and the efficiency of the heating system.*

[4] See also European Environment Agency, November 2016, Air quality in Europe – 2016 report, chapter 3 *Residential biomass combustion: an important source of air pollution*, https://www.eea.europa.eu/publications/air-quality-in-europe-2016

At what stage of a project

Level	Activities related to the use of indicator 1.1
1. Conceptual design (following design principles)	✓ Design, material selection and detailing according to principles for cost-optimal minimum requirements and Nearly-Zero Energy Buildings (NZEB). ✓ Selection of tailored solutions for major renovation works.
2. Detailed design and construction (based on calculations, simulations and drawings)	✓ Calculated building permitting assessment: design or tailored Calculated EPB assessment sub types: as built
3. As-built and in-use (based on commissioning, testing and metering)	✓ Construction quality testing: air tightness and building fabric integrity ✓ Commissioning: functional performance testing and seasonal testing. ✓ Measured EPB assessment sub types: climate corrected, use corrected or standard

The unit of measurement

The common unit of measurement for total primary energy demand in the use stage of a building is **kilowatt hours per square metre per year (kWh/ m^2 / yr).**

The performance is assessed for the total useful floor area of the building, which is recorded in the Level(s) building description. National rules may in addition define zones of a building that are to be included or excluded from the reporting.

System boundary

The assessment boundary is the building. Energy can be imported or exported from/to the building from on-site, nearby and distant energy generators. Inside the assessment boundary, primary energy factors shall apply to all forms of energy generation that supply the delivered energy needs of the building, as well as any exports[5].

Scope

The minimum scope of the indicator reflects those energy needs defined by the Energy Performance of Building Directive - heating, cooling, ventilation, domestic hot water and (built-in) lighting and other technical building systems. In a life cycle approach, these energy needs are referred to as 'operational energy consumption' and are reported under Module B6 in EN 15978.

The design principles and calculations shall also take into account thermal performance characteristics of the building included in thermal modelling according to the local climatic conditions – including insulation, thermal bridging, passive solar gain and thermal capacity – and the benefits of daylighting.

Calculation method and reference standards

The calculation method is the national or regional calculation method for energy performance laid down in the Member State where the building is located. If other calculation methods are used, they must be compliant with the EN ISO 52000-1 series. The calculation method and assessment type (as defined by the EN ISO series) shall be reported in all cases.

[5] Primary energy factors are, in most cases, provided in each national calculation method as defined by Member Stated. If not, default factors can be found in the reference EN standards series.

Instructions on how to use the indicator at each level

Instructions for Level 1

L1.1 The purpose of this level

This level is for those users who would like to:

- Understand the energy needs associated with the type of building they are working on, and
- Where they can focus attention in order to reduce the total primary energy use associated with the building's delivered energy needs during the use stage.

L1.2 Step-by-step instructions

These instructions should be read in conjunction with the accompanying technical guidance and supporting information.

1. Make sure to have completed the Level(s) building description, as some of the information may be needed to check the relevance of design concepts
2. Consult the checklist under L1.4 of energy design concepts and read the related sections of the Level 1 technical guidance
3. Within the design team, review and identify how the energy design concepts can be introduced into the design process.
4. Once the design concept is finalised with the client, record the energy design concepts that were taken into account using the L1 reporting format.

L1.3 Who should be involved and when

Actors involved at the conceptual design stage, led by the concept architect and engineers. The energy design concepts can be further explored once professionals such as service engineers, energy auditors, energy/sustainability consultants and quantity surveyors become involved in the project.

L1.4 Checklist of energy design concepts

The following energy design concepts have been identified from best practice and literature reviewed by the Joint Research Centre as proxies for achieving better performance. Although all new buildings in the EU are required to comply with minimum energy performance requirements and there are also requirements on existing buildings or building components (depending on Member State), the checklist can still be used to inform design concepts and to improve performance without necessarily having to make more advanced assessments of the building's energy requirements.

Table 1. Energy design concepts checklist

1. Minimum energy performance requirements and Near Zero-Energy Building (NZEB) design	• Minimise the heating, cooling and lighting needs of the building by: - *For new buildings*, designing and specifying a high performance and air tight building fabric. - Designing and specifying high performance heating, ventilation, cooling and (fixed) lighting systems - Using renewable energy technologies to, as far as possible, supply the remaining energy needs of the building - *For major renovations*, detailing and specifying high performance improvements to the existing building fabric - Designing and specifying high performance heating, ventilation, cooling and (fixed) lighting systems • Using renewable energy technologies to, as far as possible, supply the remaining energy needs of the building.

2. Site specific design	In designing a new building or a major renovation of existing building, take into account:
	• the climatic conditions of the site in order to minimise heating, cooling, domestic hot water, ventilation and lighting needs and to inform the specification of non-combustion renewable energy technologies. Steps that can be taken include:
	  - Reference to local weather data in order to understand the distinct seasonal, monthly, weekly and daily conditions
	  - Reference to information about any localised microclimate conditions, such as prevailing winds, the urban heat island effect and air pollution levels.
	
	In this way, the physical design, elevations and servicing can be designed to respond to the local climate, including the potential for passive heating/cooling, intelligent structures, high yield renewables and use of daylighting.
	
	This aspect has a strong interaction with indicators 4.2 and 4.3, which address thermal comfort and lighting respectively.

3. Renovation specific design	In seeking to renovate a building, use information gathered in a baseline survey to adapt the improvements to the performance and conditions of the existing building, taking into account: • The construction of the original building, including the building envelope and structure, • Existing technical services, including heating, cooling, domestic hot water, ventilation and lighting. • How the orientation and floor layout influences patterns of climatic exposure, daylighting and ventilation Information obtained from prior occupants may also yield useful information about the buildings performance.
4. High quality building fabric and services	Minimising the potential for gaps between design and actual performance by ensuring that the building fabric and technical services are designed, detailed, constructed and installed with the necessary attention to detail and quality. This could include a focus on: • The air tightness and thermal integrity of the building envelope, including the continuity of insulation and junctions with windows, doors and balconies. • The functional performance of HVAC systems, including the design of distribution systems and the setup of equipment.
5. Smart monitoring and control systems	Identify opportunities to install intelligent systems that can: • provide users and building managers with timely information about the buildings energy use whilst also learning how to meet occupier energy needs with less energy. • be used to maximise the potential for self-consumption of renewable energy generated by the building.

L1.5 Reporting format

To complete the reporting format for Level 1 you should answer yes or no for each of the design concepts that you have addressed and then provide brief descriptions of the measures or decisions taken for each one.

Energy design concept	**Addressed?** *(yes/no)*	**How has it been incorporated into the building design concept?** *(provide a brief description)*
1. Minimum energy performance requirements and Near Zero-Energy Building (NZEB) design		
2. Site specific design		
3. Renovation specific design		
4. High quality building fabric and services		
5. Smart monitoring and control systems		

Instructions for Level 2

L2.1 The purpose of this level

This level is for those users who are at the stage of needing to calculate the energy needs and primary energy use of a building for the purpose of design comparisons, building permitting or tendering.

L2.2 Step-by-step instructions

These instructions should be read in conjunction with the accompanying guidance and supporting information which can be found from page 11 onwards.

1. Identify the type of energy performance assessment that is required, the calculation method to be used and the software tools that will be used.
2. Complete the reporting table with the type of energy performance assessment, the calculation method and the scope of energy needs addressed by the method.
3. Identify and gather the input data that will be required to make the calculation. This may need to be obtained from different members of the design team - for example, building material insulation values, heating and cooling systems' design performance values.
4. Obtain calculated values for the contribution of on-site or off-site low carbon or renewable energy generation technologies to the building's energy needs.
5. *For renovation projects,* ensure that the baseline building survey will provide the necessary information about the existing building structure and fabric.
6. Use the input data to calculate the energy needs of the building.

7. *Optional step:* where the national calculation method used does not provide a calculation route for estimating other occupier energy needs, estimates may be made at this point.
8. Apply primary energy factors to the energy carriers used for the calculated energy needs in order to obtain the total primary energy.
9. Continue with design iterations and improvements until the final design that will be used for building permitting or the tendering process has been obtained.

10. *Optional step:* If the intention in the Level(s) project plan is to report on the performance of the completed building, the monitoring and metering strategy should be developed.
11. Develop specifications and designs for the energy monitoring systems and metering that will be used to obtain data on the energy needs of the completed and occupied building.
12. Complete the supporting information table on energy needs, entering the figures obtained for each fuel or energy carrier.
13. Complete the main reporting table with the total primary energy figure obtained. Estimates for occupier primary energy needs shall be entered separately.

L2.3 What do you need to make an assessment?

The main items needed are as follows:

- a completed Level(s) building description,
- An appropriate calculation software tool that is compliant with the national or regional calculation method for the relevant Member State
- A building design sufficiently advanced to provide the input data required to make the calculations using the compliant calculation software tool.
- Estimations of occupier related energy needs, in the case that a method for their estimation is not provided within the national calculation method.

L2.4 Who should be involved and when?

Those actors involved at the detailed design stage, led by the architect and engineers. Input data may be obtained from, amongst others, the architect, energy auditors, service engineers and quantity surveyor. Simulations may be carried out by the service engineers or energy/sustainability consultants.

L2.5 Ensuring the comparability of results

Comparative performance assessments shall be made on the basis of:

- The assessment type: This will be identified within national or national calculation method with respect to whether the assessment is for building permitting and/or an Energy Performance Certificate.
- Primary energy factors: The primary energy factors associated with extraction/generation and transport of the energy carried to the building.
- Weather data: The design winter and summer years for the local area or region, following the method in EN 52000-1.
- Standard input data: Data provided at national level as part of national or regional calculation methods or the default data provided in Annex G of EN ISO 13790 shall be used. This shall include the use of standard occupancy data (see Annex G.8).
- Calculation time step: The choice of a quasi-steady state or hourly dynamic method as described in EN ISO 13790.

The conditions of use will have been fixed according to national/regional requirements. It is recommended that special attention is paid to the quality and compliance of third party input data, in relation to which further guidance is provided in this section.

L2.6 Going a step further – Optimisation steps to improve the assessment and building performance

The following steps can be taken in order to optimise the energy simulations carried out in order to design a high performance NZEB building. This represents a 'tailored' calculation that is representative of the site conditions and occupier energy needs:

- Representative input data: The use of input data that is representative of:
  - the conditions of use and occupancy patterns associated with the building.
  - the certified performance of construction products and energy systems.
  - In the case of major renovations, the actual construction details of the existing building. This could include existing EPCs or other studies that have been used to demonsrate compliance with minimum energy performance requirements.
- Site specific weather data: The use of weather files that are as representative as possible of the location of the building.
- Dynamic simulation: The use of a 'dynamic' method of simulating the energy performance of a building, meaning that it has an hourly time interval.

L2.7 Format for reporting the results of an assessment

Supporting information

Level 2 reporting item	**Information to provide** **(select/delete as appropriate)**
Type of assessment	*Building permit, as-built (calculated) EPC or tailored assessment*
	Specify the Member State and the method used

Calculation method	*The time step for the weather data used by the method e.g. monthly, daily, hourly*
Scope of energy needs assessed	*The energy needs included in the scope of the calculation method*
Unregulated energy needs assessed	*The unregulated energy needs assessed in addition to those included in the calculation method*

Delivered energy needs assessment

Energy needs	***Fuel or energy carrier [1]***	***kWh/yr***
Heating		
Cooling		
Ventilation		
Hot water		
Lighting		
Other (please specify)		

Notes:

1. Select from: electricity, natural gas, district heating, district cooling, biomass, other (to be specified)

Energy performance assessment results

	kWh/m²/yr
Total primary energy	*Cells L2.1 + L2.2*
L2.1 Regulated total primary energy	
L2.2 Unregulated total primary energy	

Instructions for Level 3

L3.1 The purpose of this level

This level is for those users who would like to:

- Collect metered data in order to understand the energy needs associated with the building they are working on, and
- Carry out testing of the building in use in order to identify any performance issues with the fabric and technical services.

L3.2 Step-by-step instructions

These instructions should be read in conjunction with the accompanying technical guidance and supporting information.

<u>Building fabric and technical services testing</u>

1. Prior to handover of the building, the testing for air tightness and thermal integrity shall take place.
2. Prior to handover of the building, functional performance testing (i.e. commissioning) of the HVAC as well as low or zero carbon energy systems shall take place.
3. The reports obtained from the tests undertaken shall be reviewed to identify any remedial actions that can be undertaken by the construction contractors.

<u>Monitoring and metering strategy</u>

4. Prior to handover, the setting up of monitoring metering systems shall be completed. This shall include the correct calibration of meters and the reconciliation of sub-meter readings (if installed) with the main meters and the logs of Building Automation and Control Systems and/or Building Energy Management Systems (if installed).
5. Following handover and prior to occupation, responsibility shall be assigned for obtaining and compiling the data provided by the installed meters and systems.

6. Data shall be collected after the minimum period of occupation time following completion of the building and for the minimum duration of time.
7. If the data is to be used to compare performance with other buildings, the performance shall be corrected in relation to the conditions of use and the test reference year for the local area or region, following the method in the national calculation method or EN ISO 52000-1.
8. Complete the supporting information table on energy needs, entering the metered figures obtained for each fuel or energy carrier.
9. To obtain the total primary energy use, apply the primary energy factors stipulated in the national calculation method to the figures obtained for each fuel or energy carrier.
10. Complete the main reporting table with the total primary energy figure obtained. If they can be disaggregated, occupier primary energy needs shall be entered separately.
11. Optional step: Identify and attempt to diagnose the reason for any significant deviations from the calculated figures reported at Level 2.

L3.3 What do you need to make an assessment?

The main items needed are as follows:

- a completed Level(s) building description,
- Certifications and results from air tightness, thermal integrity and functional performance testing.
- Measured data obtained from meters and sub-meters, or from a building management system.

L3.4 Who should be involved and when?

Those actors involved in handover of the building and in subsequent facilities management. Analysis may be carried out by the same service engineers, energy auditors or energy/sustainability consultants who made the design assessment, or by consultants appointed by the building owner/operator.

L3.5 Format for reporting the results of an assessment

Supporting information

Level 3 reporting item	**Information to provide** **(select/delete as appropriate)**
Type of assessment	*Measured EPC or other type of corrected (measured) assessment*
Sampling period	*How long after completion of the building and for how many years*
Corrections applied	*Please detail any corrections applied to the data and according to which standard.*
Primary energy factors	*Please identify the calculation method from which the factors used are taken*

Measured delivered energy needs

Energy needs	***Fuel or energy carrier [1]***	***kWh/yr***
Heating		
Cooling		
Ventilation		
Hot water		
Lighting		
Other (please specify)		

Notes:

1. Select from: electricity, natural gas, district heating, district cooling, biomass, other (to be specified)

Energy performance assessment results

	kWh/m²/yr
Total primary energy	*Cells L2.1 + L2.2*
L2.1 Regulated total primary energy	
L2.2 Unregulated total primary energy	

Guidance and further information for using the indicator

Instructions for using level 1

In this section of the guidance, additional background guidance and explanations are provided for two key concepts introduced in the Level 1 energy design concept checklist, namely:

- L1.4 Checklist: Understanding the energy needs associated with a building,
- L1.4 Checklist: The minimum energy performanceand the requirements for Nearly Zero-Energy Building (NZEB), according to the national/regional building codes.

L1.4 Checklist: Understanding the energy needs associated with a building

Directive 2010/31/EU on the energy performance of buildings (hereafter referred to as 'the EPBD') as amended by Directive (EU) 2018/844 states that reporting on the energy performance of a building shall include 'an energy performance indicator and a numeric indicator of primary energy use'. Moreover, the calculation methodology should follow the national annexes of the overarching standards, namely EN ISO 52000-1, 52003-1, 52010-1, 52016-1, and 52018-1.

Annex I of the Directive lays down a common framework for calculation of a building's energy performance. This describes the minimum scope for the performance aspects to be modelled within a national or regional calculation method, as indicated in Table 1. These equates to heating, hot water, cooling, ventilation and built-in lighting. Passive and internal heat gains, for example from appliances and heating pipes, shall also be taken into account.

Table 2 Common general framework for calculation of a building's energy performance as laid down by the EPBD (recast)

Type of performance aspect	**Performance aspects**
Minimum aspects of thermal characteristics to take into consideration	(a) the following actual thermal characteristics of the building including its internal partitions: (i) thermal capacity; (ii) insulation; (iii) passive heating; (iv) cooling elements; and (v) thermal bridges; (b) heating installation and hot water supply, including their insulation characteristics (c) air-conditioning installations (d) natural and mechanical ventilation which may include air-tightness (e) built-in lighting installation (mainly in the non-residential sector) (f) the design, positioning and orientation of the building, including outdoor climate (g) passive solar systems and solar protection (h) indoor climatic conditions, including the designed indoor climate (i) internal loads

Aspects whose 'positive influence' shall be taken into account	(a) local solar exposure conditions, active solar systems and other heating and electricity systems based on energy from renewable sources; (b) electricity produced by cogeneration; (c) district or block heating and cooling systems; (d) natural lighting.

Source: European Commission (2010)

L1.4 Checklist: The concept of a Nearly Zero Energy Building (NZEB)

Under the EPBD, Member States must ensure that all new buildings are 'nearly zero-energy' (NZEB) from the 31st December 2020 – meaning that an NZEB building effectively becomes the minimum energy performance requirement for new buildings from that date onwards. According to Article 2(2) of the EPBD, an NZEB '…means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby'.

This definition does not differentiate between new and existing buildings. However, action is encourage across the EU to *facilitate the cost-effective transformation of existing buildings into nearly zero- energy buildings*, meaning a depth of refurbishment that allows energy performance requirements of an NZEB level to be met.

The exact definition of an NZEB in terms of primary energy use varies between Member States. However, the Commission published in 2016 [6] possible benchmarks by climate zone for an NZEB performance (see table 2). The climate zones referred to in table 2 can be cross-referenced to the heat and cooling degree days reference table included in the supporting guidance to the building description (see the Level(s) user manual 2)

Table 3 Indicative numeric benchmarks for the performance of an NZEB

Climate zone	***Office buildings***		***Single family house***	
	Total primary energy (kWh/m^2)	***On-site renewable energy contribution (kWh/m^2)***	***Total primary energy (kWh/m^2)***	***On-site renewable energy contribution (kWh/m^2)***
Mediterranean	*80-90*	*60*	*50-65*	*50*
Oceanic	*85-100*	*45*	*50-65*	*35*
Continental	*85-100*	*45*	*50-70*	*30*
Nordic	*85-100*	*30*	*65-90*	*25*

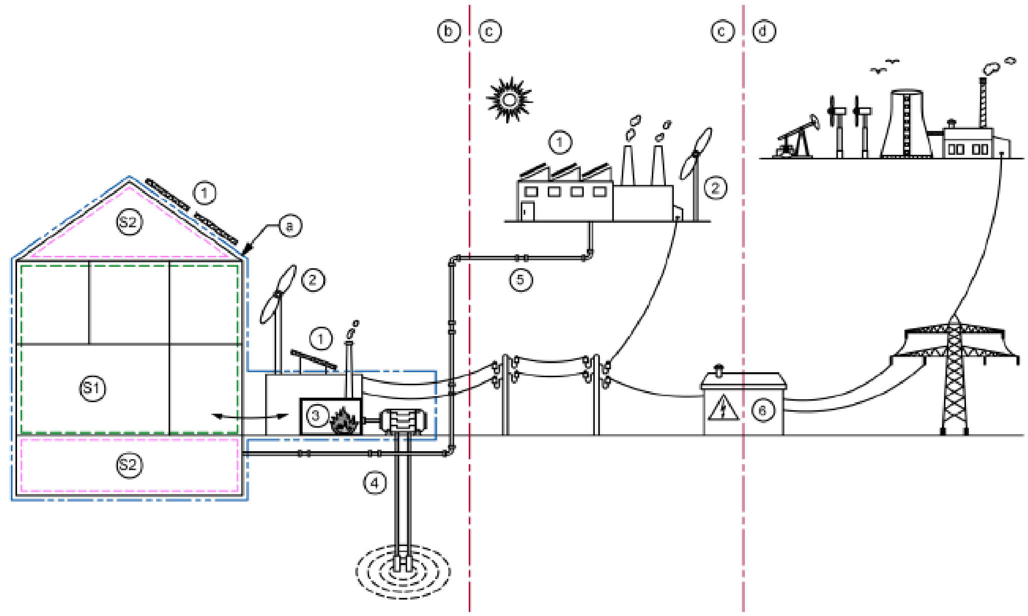
Source: European Commission (2016)

The first part of the definition establishes energy performance as the defining element that makes a building an 'NZEB'. This energy performance should be achieved by minimising energy needs and by focussing on the performance concepts identified in table 1, which focus on the building envelope and technical building systems.

[6] Commission Recommendation (EU) 2016/1318 of 29 July 2016 on guidelines for the promotion of nearly zero-energy buildings and best practices to ensure that, by 2020, all new buildings are nearly zero-energy buildings C/2016/4392

The second part of the definition provides guiding principles to achieve this very high performance by covering the resulting low amount of energy to a very significant extent by energy from renewable sources, on or off site.

The concept of NZEB reflects the fact that renewable energy and efficiency measures work together. When placed on a building, renewable energy technologies such as solar photovoltaic modules will reduce net delivered energy. Figure 1 illustrates the assessment boundaries for calculating primary energy according to EN 52001-1. In many cases, on-site renewable energy will not be sufficient to bring energy needs close to zero, at least without further energy efficiency measures. In these cases renewable energy sources located nearby can contribute towards meeting a buildings' energy needs.



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)

Figure 1. Building assessment boundary and energy balance locations

Source: CEN (2017)

Instructions for using level 2

In this part of the guidance, additional background guidance and explanations are provided to support the calculation of total primary energy at Level 2. The specific topics covered are as follows:

- L2.2 – Steps 1-2: The calculation methodology to be used,
- L2.2 – Steps 1-2: Accounting for unregulated energy needs,
- L2.2 – Step 3: Requirements for input data to the calculation method,
- L2.2 – Step 4: Ensuring the quality of the input data used,
- L2.2 – Step 3: The selection of weather data sets,
- L3.2 – Steps 1-2: Checking and testing the quality of construction and installation,
- L2.2 – Steps 10-11: Monitoring of occupied performance.

L2.2 – Steps 1-2: The calculation methodology to be used

The underlying calculation method for each component of a building's energy demand is provided by the EN ISO 52000-1 standards series developed in support of Directive 2010/31/EU for the Energy Performance of Buildings as amended by Directive (EU) 2018/844. However, Member States are not obliged to use this standard and they can apply their own calculation methodologies (which must comply with Annex I of the EPBD) according to national or regional circumstances. This means that national calculation methods that are required to be used in order to calculate the energy performance of buildings for the purpose of obtaining building permits or to issue Energy Performance Certificates (EPCs) shall be the main reference methods for reporting.

Learn more

Options for ensuring the consistency of the energy calculation method used

The majority of national or regional calculation methods are currently based on EN 15603 and its associated standards. It is anticipated that, over time, these methods will be updated to reflect the new EN ISO 52000-1 series. In any case, according to the EPBD Member States shall describe their national calculation methodology following the national annexes of the overarching standards, namely ISO 52000-1, 52003-1, 52010-1, 52016-1, and 52018-1, developed under mandate M/480 given to the European Committee for Standardisation (CEN). Compliant options available to users of the Level(s) framework across the EU include:

- Use of a national calculation method and associated software tools developed according to one of the reference CEN standard series;
- Use of independently developed and validated software tools developed according to one of the reference CEN standard series;
- Direct use of the calculation method laid down within one of the reference CEN standard series.

In each of these cases, it shall be indicated alongside the reporting on the indicator result whether a method developed according to a relevant CEN standard has been used. If a method is not available, the CEN standard itself (or its nationally adopted equivalent) can be used.

In addition to the calculation method, the exact type of energy assessment, according to the classification made by EN ISO 52000-1, shall be identified for the purposes of comparability. Table 4 classifies the assessment types available to users.

Table 4 Energy Performance of Building assessment types

Type	**Sub-type**	**Input data**			**Type of application**
		Use	**Climate**	**Building**	
Calculated (asset)	Design	Standard	Standard	Design	Building permit, certificate under conditions
	As built	Standard	Standard	Actual	Energy performance certificate, regulation
	Tailored	Depending on purpose			Optimisation, validation, retrofit planning, energy audit
Measured (operational)	Climate corrected	Actual	Corrected to standard	Actual	Monitoring, or energy audit
	Use corrected	Corrected to standard	Actual	Actual	Monitoring
	Standard	Corrected to standard	Corrected to standard	Actual	Energy performance certificate, regulation

Source: ISO organisation (2018)

The primary energy use of a building is derived from the calculation of the delivered energy needs of a building. There are therefore two main steps in the calculation routine that are important to understand at a general level:

1. Model the delivered final energy demand: Delivered energy is the energy delivered to the building in the form of electricity, heat and fuel in order to satisfy energy needs within the building (heating, cooling, ventilation, domestic hot water, lighting, appliances, etc.). The starting point for most energy calculation methods is on the thermal performance of the building envelope:
   - The building envelope (energy needs): This is the starting point for calculation methods developed according to EN ISO 13790 and EN ISO 52016. Orientation, control of solar gains and daylighting, thermal inertia and zoning are key factors to be considered in the method;
2. Derive the total primary energy demand: In order to derive the primary energy demand of a building, primary energy factors must be applied to the calculated or measured building final energy demand. These factors are provided within each national calculation method but default values can also be found in EN 52000-1. The primary energy factors represent 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. This energy use can then potentially be disaggregated into its non-renewable and renewable components;
   - Non-renewable primary energy demand: The primary energy demand of the building that is met by non-renewable sources, without accounting for any export of non-renewable energy generated on site (such as from CHP);
   - Renewable primary energy demand: The primary energy demand of the building that is met by renewable sources, without accounting for any export of renewable energy generated on site (such as from solar PV);

It is important to note that exported renewable energy is to be reported separately. This is because the Level(s) 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, under Module D.

L2.2 – Steps 1-2; Accounting for unregulated (non-EPBD) energy needs

Electricity loads associated with occupier energy needs, such as, for example, appliances or computers that are plugged into power sockets, are not specifically covered in most national or regional calculation methods. This effectively means that they are unregulated energy needs. Depending on how they are treated, their omission from the calculations, or a separate calculation method or other assumptions if used, shall be noted in the reporting. The reference standard for lighting estimates shall be EN 15193.

L2.2 – Step 3: Requirements for input data to the calculation method

An important first step is to identify the input data that will be required. Table 5 summarises the main data items and potential sources. Each method will provide guidance on where real values can substitute default values. For a tailored assessment, real values shall be used as far as possible.

Table 5 Specification of the main data requirements and potential 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 [7]

[7] This may include reference to product characteristics laid down in Ecodesign Implementing Measures, Energy Labelling legislation or other relevant harmonised standards.

L2.2 – Step 4: Ensuring the quality and representativeness of the input data used

It is recommended that where third party input data is used, special attention be paid to its quality and compliance. For example, input data may also be available that has been checked and certified for use – for example, performance data for architectural details that can minimise thermal bridging.

Use of certified input data may be a requirement of a national calculation method in order to ensure comparability. Its use may therefore help ensuring that calculations are compliant with national calculation methods. The QUALICHeCK project provides further orientation on ensuring the quality and compliance of input data (see the box below).

> Learn more
>
> *Ensuring the quality and compliance of the input data used in an performance assessment*
>
> The Intelligent Energy Europe funded project QUALICHeCK has sought to identify how the quality and compliance of input data can be ensured[8]. Examples of sources of compliant input data can include:
>
> - Pre-calculated values for certain technologies/aspects;
> - Procedures for generating reliable data for innovative products;
> - Databases of product characteristics;
> - Rules for consistent declarations of product performance.
>
> These sources may also be subject to third party verification.

Although input data may comply with standards or calculation method requirements, it is important to note that it may not result in a more accurate simulation of the as-built performance, rather it will help ensure a comparable performance assessment.

Greater precision can be achieved by calculating or obtaining input data for the performance of specific building details or, in the case of building renovations, calculating or obtaining input data for the performance of specific construction details identified from condition surveys.

The performance of technologies such as renewable energy generation can be modelled separately in order to provide more representative input data.

It is also important to define in as a representative way as possible input data that is influenced by occupancy patterns. The starting point shall be predicted occupancy patterns and density for the building and the conditions of use with respect to how areas will be heated and cooled. This shall then be used as the basis for defining:

- Internal temperature set points
- Ventilation and infiltration rates
- Internal gains and heat flows

In the case of building renovations, surveys of the existing occupants of a building or a building stock can provide additional refinement of the understanding of occupancy patterns and user behaviour. It is important to consider user behaviour because evidence has shown that, particularly in residential building renovations, there can be a 'rebound effect' whereby the efficiency improvements are offset by greater energy use by occupants.

L2.2 – Step 3: The selection of weather data sets

It is recommended to use a test reference year derived from the medium term (20 or 30 year) time series of a standard local weather station should be used. The length of this time series will ensure that the reference year is

[8] QUALICHeCK (2016) *Compliant and Easily Accessible EPC Input Data,* http://qualicheck-platform.eu/results/reports/

representative of climatic variations in the short to medium term. If it is difficult to access hourly local weather files, the Joint Research Centre's open access weather file database may be used across the EU[9].

The Urban Heat Island (UHI) effect

It is important to take into account, where possible, the Urban Heat Island (UHI) effect, as this can have a significant effect on localised external temperature. In some EU towns and cities, work has been done to interpolate weather datasets to take into account the UHI effect. This is particularly important in major cities and locations where the urban design, commuting patterns and topography can exacerbate winter or summer conditions.

Learn more

Determining the extent of the urban heat island effect

The Urban Heat Island (UHI) effect is an additional factor to take into account when modelling the external air and radiative temperatures around a building. This is because the temperature in an urban area can be elevated compared to rural areas due to a combination of:

- vehicle exhaust,
- building air conditioning heat rejection,
- street canyon geometry,
- reduced evapotranspiration by vegetation and,
- absorption and re-radiation of heat by roads, paving and structures.

The effect can be generalised across an urban area or, where there are combinations of factors, it can be very localised within a district or at specific points.

Recognising the significance of this effect, a number of cities have put in place initiatives to support designers to better take it into account. Examples include London[10], Stuttgart[11] and Zaragoza[12].

L3.2 – Steps 1-2: Checking and testing the quality of construction and installation

Evidence shows that a commitment to carry out building envelope quality testing and the functional performance testing of HVAC systems for a completed building can ensure that performance more closely approximates to calculations by focussing the attention of design teams and contractors on:

- Design and in particular building envelope details,
- Construction quality, and
- The correct installation of services.

Performance targets and objectives can be laid down which can later be checked on site during completion of the building. For offices, this may be applied to the whole or a part of a building. For multi-unit residential building projects, these may be applied to a sample of properties. Reference test procedures that can be used are identified in the guidance note below.

[9] Joint Research Centre, Photovoltaic Geographical Information System (PVGIS) – TMY generator https://ec.europa.eu/jrc/en/PVGIS/tools/tmy

[10] London's urban heat island, https://data.london.gov.uk/dataset/london-s-urban-heat-island---average-summer

[11] Climate ADAPT case study of Stuttgart,http://climate-adapt.eea.europa.eu/metadata/case-studies/stuttgart-combating-the-heat-island-effect-and-poor-air-quality-with-green-ventilation-corridors

[12] José M. Cuadrat Prats, Sergio M. Vicente-Serrano y Miguel A. Saz Sánchez, *Los efectos de la urbanizacion en el clima de Zaragoza (España): La isla de calor y sus factores condictiontes*, Boletín de la A.G.E. N.º 40 - 2005, págs. 311-327

Learn more

Reference standards for checking and testing the as built and completed energy performance of a building

Quality and functional performance testing requirements can be specified with reference to specific tests, routines and standards:

- Testing of the quality and integrity of the building envelope, with reference standards to include:
  - Air tightness using a fan pressurisation test (EN ISO 9972)
  - Integrity by thermal imaging survey (EN 13187)
- Commissioning of Heating, Ventilation and Air Conditioning (HVAC) systems, with reference standards to include:
  - Functional performance testing of the system operating characteristics (EN 12599)
  - Checking of the integrity of ventilation duct work (EN 15727)
- Commissioning of low or zero carbon energy generation technologies, with reference to best practice for each technology.

The Intelligent Energy Europe funded project QUALICHeCK provides further guidance on ensuring the quality of works, including a range of case studies from across the EU [13].

L2.2 – Steps 10-11: Monitoring of occupied performance

A metering strategy is essential to ensure accurate measurement of a building's energy use. This is also important in buildings with supplies of heating, cooling and domestic hot water from a central source as the 2018 Energy Efficiency Directive [14] requires consumption data to be provided to energy consumers. Care should be taken to ensure meters are installed as specified, with due attention to calibration and placement, as well as to how the data will be collated and analysed, and by whom. Further guidance on the process is provided below.

Where installed, there is an important role for Building Automation and Control Systems or Building Energy Management Systems in monitoring performance. The revised Energy Performance of Buildings Directive requires that Member States lay down requirements that, where technically and economically feasible, non-residential buildings with an effective rated output for heating systems or systems for combined space heating and ventilation of over 290 kW are equipped with building automation and control systems by 2025.

Learn more

The role of metering in Building Performance Evaluation

The setting up of meters and monitoring systems should be addressed during the commissioning process for building services. This shall include the reconciliation of sub-meter readings with the main meters and the logs of the building energy management system (if installed).

All meters should be correctly set up to facilitate their use as a monitoring tool, either through the taking of direct readings or the collation of data from a building energy management system. The storage capacity of Building Energy Management Systems (BEMS's) can be a constraint, so the provision of sufficient data capacity to support ongoing monitoring should be checked.

[13] QUALICHeCK (2016) *Source book on Guidelines for better enforcement of quality of the works*, www.qualicheck-platform.eu

[14] Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency

Moreover, during building handover, the metering and building energy management system shall be fully documented, so that they can be correctly operated by the facilities manager and occupiers.

Smart meters can provide additional disaggregated consumption data that can be used to manage the energy use of a building. Such meters can also eliminate problems that may occur with the use of data obtained from estimated bills, which can lead to incorrect reporting. However, care should be taken to avoid over-complication of the sub-metering design, as this can lead to problems if they are incorrectly installed or commissioned.

Adapted from the Carbon Trust (2012), Innovate UK (2016)