PED-ID

Holistic assessment and innovative stakeholder involvement process
for identification of Positive-Energy-Districts

D4.1 Criteria catalogue for Positive-Energy-Districts

Deliverable No.	D4.1
Deliverable Name	Criteria catalogue for Positive-Energy-Districts
Version	V5
Release date	15/04/2022
Dissemination level	Public
Status	Final
Authors	Camilla Rampinelli (e7) Gerhard Hofer (e7)

Document history:

Version	Date of issue	Content and changes	Edited by
V1	02/03/2022	First version	Gerhard Hofer
V2	18/03/2022	Second version	Gerhard Hofer
V3	21/03/2022	Third Version	Camilla Rampinelli
V4	04/04/2022	Final version	Gerhard Hofer
V5	15/04/2022	Format & text	Camilla Rampinelli

Peer reviewed by:

Partner	Reviewer
e7	Camilla Rampinelli
White	Keith Boxer
SEVEn	Jakub Kvasnica

This project has received funding from the JPI Urban Europe programme.

Table of contents

List of Figures

List of Tables

Acronyms table

A	Area
BRE	BRE is a profit-for-purpose organisation which develops standards for the built environment www.bregroup.com
BREDEM	BRE Domestic Energy Model
BREEAM	BRE Environmental Assessment Method
CCTV	Closed Circuit Television
CHP	Combined Heat and Power
CS	Credit Score
DENA	Deutsche Energie-Agentur
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen
DSM	Demand Side Management
EERA	European Energy Research Alliance
EPBD	Energy Performance of Buildings Directive
ESCO	Energy Service Company
EV	Electric Vehicles
Excl.	Exclusive
GHG	Greenhouse Gas
GHG-e	Greenhouse Gas Emissions
ICE	Institution of Civil Engineers
Incl.	inclusive
JPI	Joint Programme Initiative
KNQA	Klimaneutrale Quartiere/Areale
KPI	Climate-neutral Districts/Areas (German acronym)
kWe	Kilowatt electric
kWh	Kilowatt hour
kWth	Kilowatt thermal
LCA	Life Cycle Assessment
LCC	Life Cycle Costs
LZC	Local Zero Carbon
MCS	Microgeneration Scheme
MIV	Motorized Private Transport
MWh	Megawatt Hour
NCM	National Calculation Methodology
PE	Primary Energy
PEB	Primary Energy Demand (German acronym)
PEB ges.	Total Primary Energy Demand (German acronym)
PEBm	Primary Energy Demand including Mobility (German acronym)
PED	Positive Energy District
PV	Photovoltaics
ROC	Renewables Obligation Certificate
SBEM	Simplified Building Energy Model
SET Plan	European Strategic Energy Technology Plan
THG-e	Greenhouse Gas Emissions
UCTE	Union for the Co-ordination of Transmission of Electricity

UK	United Kingdom
VAWT	Vertical axis wind turbine
VTT	Technische Forschungszentrum Finnland https://www.vttresearch.com
WRAP	Waste & Resources Action Programme
ZQ	Future District (German acronym)

1 Executive Summary

Positive Energy Districts (PEDs) are an essential piece of the puzzle for climate neutrality in the upcoming years. PEDs contribute to the ambitious targets of the European Strategic Energy Technology Plan ('SET-Plan ACTION N°3.2' 2018). The goal is to deploy 100 Positive Energy Districts by 2025. The programme JPI Urban Europe supports this goal by funding research and implementation of projects focusing on PEDs ('JPI Urban Europe' 2021a).

The goal for Positive Energy Districts is thus already set. However, the definition of what PEDs is and how they are defined is not yet fixed. Currently, many projects as well as JPI Urban Europe and IEA Annex 83 "Positive Energy Districts" ('IEA EBC' 2021) work on definitions for Positive Energy Districts.

These definitions will be finalized and agreed in some months or years. In the meantime, it is important to ensure that even current districts that are moving towards plus-energy or CO_2-neutrality have options to be able to define the district.

Why do we need these definitions? Many urban development areas declare themselves as PED. But here is a lack of consistency among existing PED concepts that could lead to misinterpretations. Unfortunately, when assigning this term alone, it is not clear which requirements have been implemented and how high the energy demands are. This ranges from the delimitation of energy uses to the operating energy according to the requirements of the EPBD and the coverage of this demand with renewable energy resources on site, or also with district heating coming from outside, or also with other renewable energy sources coming from outside the neighbourhood (e.g., green electricity). On the other hand, Positive-Energy can also be covered with the total amount of energy in the neighbourhood: Operating energy in the building and in the neighbourhood, embedded energy of materials and disposal, and the energy for mobility). The energy supply is spatially exclusive in the quarter. This can apply up to a balance period for each moment, i.e., a completely self-sufficient district (island operation).

Stakeholders in the neighbourhood development, i.e., property developers or end users, should get an assessment of the value of the term Positive-Energy-District. Is this definition only achievable by very high technical efforts or easy to fulfil? This can also lead to the introduction of a rating system for this definition. In this way, end users can also easily determine how close a neighbourhood comes to Plus-Energy status or whether a neighbourhood already meets all requirements and goes beyond.

The aim of this report is to define viable options and definitions for Positive Energy Districts. Based on the possible definitions, district developers can decide for themselves how the definition should be agreed upon for their own district. These proposals are only valid until an international agreement on Positive Energy Districts comes into force.

Criteria for energy from existing sustainability catalogues from England, Germany and Austria were used as a basis. At the same time, individual preliminary work and papers on the topic of PEDs and climate-neutral districts were considered. Based on this, options and possibilities of delimitation for Positive Energy Districts were defined. The definition is based on the following criteria:

- Objective
- Indicator
- Temporal system boundaries, balancing period
- Spatial system boundaries

- → Energy uses

With these definitions, different demands of Positive Energy Districts can be compared with each other.

2 Introduction

2.1 Project PED-ID

PED-ID is an innovation project that aims to accelerate the decarbonisation of the urban environment by promoting the implementation of Positive-Energy-Districts (PED). PEDs are districts in urban areas that manage their resources to achieve net-zero energy balance (more energy is produced than consumed) and reduce greenhouse gas emissions. This project provides decision-makers with improved information about methods, tools and guidance for PEDs at an early stage of development, proposing a knowledge-based participation process. Stakeholders will be able to actively use these methods in the data-driven participation process to consolidate their options and make decisions based on data. This process will be tested using real Living Labs of potential PED projects. With the help of this method, the decision on sites will be accelerated to reach the goal of 100 PED sites in Europe.

2.2 Scope of this Document

This document begins with an overview of energy criteria specifications in individual existing criteria catalogues for districts and settlements, specifically the DGNB, BREEAM and klimaaktiv. Then unique specifications of districts are listed, specifically from DENA, the “Zukuftsquartier” (Future District) project and a paper from VTT.

Based on the specifications, a structure was defined that makes it possible to determine the boundaries of Positive Energy Districts. With this structure, a few options and possibilities have been left open, which are to be defined in the context of the preparation of a positive energy district.

Finally, the recommendations and the outlook deal with the ongoing developments and projects. From the multitude of developments currently underway, an agreement should be reached in a few years on how Positive Energy Districts can be defined and examined as part of the planning process. This should also lead to benchmarking so that different districts can be compared with each other.

3 Existing Requirements for PEDs

3.1 Overview

In the following chapters, requirements from the field of energy and renewable energy sources are collected from several European certification systems for sustainability and studies for Positive Energy Districts. This list is intended to provide an overview of possible specifications for energy-relevant criteria for PEDs.

The following sustainability catalogues and studies were selected:

- DGNB SYSTEM – Catalogue of Criteria Districts ('DGNB SYSTEM KRITERIENKATALOG QUARTIERE' 2020)
- BREEAM Communities ('BREEAM Communities Technical Manual' 2017)
- Path for the Realisation of Positive Energy Districts in Melk (Hofer et al., n.d.)
- "Zukunftsquartier" – Way to the Positive Energy District in Vienna (Schöfmann et al. 2019)
- dena Final Report – Climate-Neutral Districts and Areas ('Abschlussbericht, Klimaneutrale Quartiere und Areale' 2021)
- Positioning Positive Energy Districts in European Cities [(Lindholm, Rehman, and Reda 2021)]
- Towards a European PED definition ('Towards a European PED Definition, Draft' 2021)

In the next chapters, elements of these documents were directly excerpted and – if necessary – translated to English.

3.2 DGNB

3.2.1 Overview of Requirements

- ENV1.1 - Life Cycle Assessment
- TEC2.1 - Energy Infrastructure
- TEC2.4 - Smart Infrastructure
- TEC3.1 - Mobility infrastructure - Motorized Transportation
- TEC3.2 - Mobility infrastructure - Non-motorized traffic

3.2.2 Detailed Description of Requirements

This chapter describes the structure and content of energy-related requirements.

ENV1.1 - Life cycle assessment

Goal

The goal is to avoid and reduce emission-related environmental impacts over the entire life cycle of the district/site.

Benefit

Life cycle-oriented planning of districts and sites with the help of life cycle assessments (LCA) supports building owners and planners in making environmentally-oriented decisions based on comprehensive information. Solutions that are optimized concerning relevant environmental issues and different impact locations and impact times can be identified. The application of a consistent methodology supports reporting on relevant environmental indicators of the building, such as the CO_2 emissions or the energy demand over the entire life cycle.

This can result in the following benefits for businesses, municipalities and/or users:

- Contributing to the mitigation of global warming and the associated consequences on humans and nature (e.g. heat stress, extreme weather events)
- Contribution to the reduction of local smog pollution in the city
- Contribution to the reduction of the pH value of precipitation and the associated consequences (e.g. forest dieback)
- Contribution to reducing the over-fertilization of water bodies and open spaces and the associated consequences (e.g. algae in water bodies, fish mortality, input into food)
- Reduction of dependence on fossil fuels
- Long-term cost savings due to price increases of fossil fuels
- Avoidance of effects on the environment and humans caused by the degradation of fossil fuels (e.g. destruction of biotopes, the collapse of mines)
- Strengthening the local economy through the expansion of renewable energies

Contribution to overarching sustainability goals

3: Good health and well-being

6: Clean water and sanitation

7: Affordable and clean energy

8: Decent work and economic growth

12: Responsible consumption and production

14: Life below water

15: Life on land

Outlook

In the future, reference values will continue to tighten, matching increasing requirements for national climate protection, emission and resource targets for industry and the building sector. To encourage positive-impact measures within the scope of energy demand (not regulated by building energy legislation), work is underway to expand the system boundaries meaningfully.

In the future, the scope of LCA as a method for assessing life-cycle-based ecological effects should reflect additional environmental impacts. When quantification and characterization methods are available for which a broad consensus has been reached among experts and for which suitable data are available in LCA datasets, further environmental effects are to be calculated using LCA. Examples of this are ecotoxicity, use of natural space and biodiversity.

In the future, life cycle assessments will be easier to prepare thanks to better and networked tools, and decision-makers will have more evaluations on a reliable basis at their disposal to work out better districts more quickly. Thus, LCAs will also gain importance for life cycle optimization in all phases of district planning.

Indicators 1 and 2 are introduced as supporting incentives for an earlier and more consistent integration of LCA methods into districts' planning. In perspective, these indicators can be dropped again when LCA calculations are established as normal elements of building planning.

Evaluation

The criterion Life Cycle Assessment of the district is an exclusion criterion in the DGNB certification system for districts. A district that does not achieve the minimum requirement of 10 points in indicator 3 in the criterion cannot be certified.

It is recognized if LCA results are used early in the planning process and the energy consideration framework goes beyond the Energy Saving Ordinance (indicator 1). Furthermore, the implementation and use of variant comparisons with LCA calculations is positively evaluated (indicator 2). The results of a complete district life cycle assessment calculated according to specified conventions are evaluated using comparative values (indicator 3). If the target values of the LCA comparison calculation are exceeded, up to 20 additional points can be recognized here. A maximum of 100 points can be achieved in the criterion without bonuses, and a maximum of 130 points, including bonuses.

- 1 Life cycle assessment in planning
  - 1.1 Integration of life cycle assessment into the planning process
- 2 Life cycle assessment optimization
  - 2.1 Life cycle assessment optimization accompanying planning
- 3 Life cycle assessment comparative calculation
  - 3.1 Weighted environmental impacts: entire district
  - 3.2 Weighted environmental impacts: of the energy supply
  - 3.3 Weighted environmental impacts: buildings
- 4 Agenda 2030 Bonus - climate protection targets
  - 4.1 Ambition to achieve climate neutrality
  - 4.2 Halogenated hydrocarbons in refrigerants
- 5 Special constructions
  - 5.1 Valuation of special constructions
    - 5.1.1 Sustainable building/choice of building materials
    - 5.1.2 Health-relevant aspects of the construction
    - 5.1.3 Health-relevant aspects of interior design
    - 5.1.4 Specifications for the replacement of components
    - 5.1.5 Life cycle assessment study for special buildings
  - 5.2 Correction factor

TEC2.1 - Energy infrastructure

Goal

The objective is to create the technical conditions for the optimization (efficiency, effectiveness, generation) of energy demand, renewable energy and costs in the provision of energy in the district.

Benefits

This can result in the following benefits for companies, municipalities and/or users:

- Reduction of energy demand and the associated consequences for people and the environment (contribution to climate protection)
- Short- and long-term reduction of costs for energy supply
- Contribution to municipal economic power by using local resources and synergies
- Risk minimization by ensuring later adaptability in case of changes in external conditions

Contribution to overarching sustainability goals

7: Affordable and clean energy

8: Decent work and economic growth

9: Industry, innovation and infrastructure

Evaluation

- 1 Integral energy concept
  - 1.1 Energy demand
  - 1.2 Energy potential
  - 1.3 Energy balance
  - 1.4 Energy supply variants
  - 1.5 Investments and operating costs
- 2 Coherent supply structure
  - 2.1 Heating and cooling supply structure
- 3 Use of synergies
  - 3.1 Integral energy cycle
  - 3.2 Agenda 2030 Bonus – climate protection targets
- 4 Energy management and energy audits
  - 4.1 Introduction of energy management/audits
- 5 Load management
  - 5.1 Load management at the district level
- 6 Energy generation on roof surfaces
  - 6.1 Use of roof surfaces for energy generation
- 7 Energy efficiency
  - 7.1 Heat/Cold
  - 7.2 Room air technology
  - 7.3 Compressed air
  - 7.4 Drives
  - 7.5 Lighting

TEC2.4 - Smart infrastructure

Goal

The goal is to save resources and costs and increase user comfort through interconnected infrastructure systems.

Benefits

This can result in the following benefits for companies, municipalities and/or users:

- Saving resources such as electricity, heat, water, time and money
- Locational advantage over other districts; increased attractiveness for companies and investors that depend on corresponding infrastructures (e.g., broadband, Industry 4.0, Care of the Elderly 4.0)
- Opportunity to improve social participation of residents and users through information and communication
- Protection and safety of residents and users (e.g., early warning systems for environmental risks, detection of limit violations for air and water, ambient assisted living in buildings)
- Prerequisite for faster implementation of the energy transition (e.g., grid efficiency)

Contribution to overarching sustainability goals

7: Affordable and clean energy

Evaluation

- 1 Integration of the topic of digitalisation in district planning
  - 1.1 Integration of digitalisation in district planning
  - 1.2 Coordination on the topic of digitalisation with the city
- 2 Infrastructure data acquisition
  - 2.1 Sensors in buildings and structural infrastructures
  - 2.2 Sensors in the free space (see definition of system basics)
  - 2.3 Telecommunications infrastructure/distribution
  - 2.4 Free WIFI in public spaces
- 3 Infrastructure Data evaluation/information
  - 3.1 Continuous availability of information
- 4 Infrastructure control/optimisation
  - 4.1 Possibility of controlling and regulating buildings and structural infrastructures
  - 4.2 Possibility of controlling and regulating elements in the open space
  - 4.3 Control/rate models for buildings and open spaces
- 5 District-based digital offers
  - 5.1 Access to information
  - 5.2 Information on digital services in the district
  - 5.3 District-related online platform(s)

TEC3.1 - Mobility infrastructure - motorized transportation

Goal

The goal is to save resources, reduce transportation-related emissions, and increase user comfort through sustainable mobility infrastructure for motorized transportation.

Benefits

The following benefits can be achieved for companies, municipalities and/or users:

- Good accessibility for all, without restrictions to a specific means of transport
- Increasing the quality of the environment, i.e., reducing the negative environmental impact of individual motorized transport
- Higher quality of life

Contribution to overarching sustainability goals

3: Good health and well-being

9: Industry, innovation and infrastructure

11: Sustainable cities and communities

13: Climate action

Evaluation

In the criterion, more than 100 evaluation points can be obtained in the evaluation. A maximum of 100 evaluation points can be applied. An urban district that does not achieve the minimum requirement of 10 points in the criterion in the areas of environmental connectivity and public transport cannot be certified.

- 1 Traffic model
  - 1.1 Actuality traffic model
- 2 Modal split
  - 2.1 Environmental association
- 3 Promotion of alternative drive technologies
  - 3.1 Outdoor charging infrastructure
  - 3.2 Self-sufficiency of the charging infrastructure
- 4 Vehicle sharing
  - 4.1 Vehicle sharing offers
- 5 Public transport accessibility
  - 5.1 Public transport accessibility
  - 5.2 Offer bus and train lines
- 6 Intermodal platforms
  - 6.1 Accessibility of intermodal platforms from the district
- 7 Access to the nearest railway station
  - 7.1 Public transport
- 8 Public transport frequency
  - 8.1 Public transport frequency
- 9 Special measures to promote public transport
  - 9.1 Structural or operational measures
  - 9.2 Design of the public transport stops
- 10 Concepts of commercial transport
  - 10.1 Concept of commercial transport
  - 10.2 Agenda 2030 bonus – climate protection targets
- 11 Delivery times compatible with the district

- 11.1 Delivery times compatible with the district

TEC3.2 - Mobility infrastructure - non-motorized traffic

Goal

The goal is to save resources and increase user comfort through sustainable mobility infrastructure for non-motorized transportation.

Benefits

This can result in the following benefits for businesses, municipalities and/or users:

- Improved accessibility, especially for non-motorized and mobility-impaired road users
- Increase of the quality of stay in the street space

Contribution to overarching sustainability goals

3: Good health and well-being

9: Industry, innovation and infrastructure

11: Sustainable cities and communities

13: Climate action

Evaluation

In the criterion, more than 100 evaluation points can be obtained in the evaluation. A maximum of 100 evaluation points can be applied.

- 1 Mobility elements for cyclists and pedestrians
  - 1.1 Mobility elements promoting cycling/pedestrian traffic
- 2 Mobility infrastructure for cycling
  - 2.1 Prioritisation of cycling in the district
  - 2.2 Prioritisation of cycling at the site
  - 2.3 Degree of fulfilment of the quantitative requirements
- 3 Quality of the bicycle parking facilities
  - 3.1 Quality of the parking facilities
- 4 Signposting systems for cycling
  - 4.1 Signposting systems
- 5 Footpath network
  - 5.1 Footpath infrastructure
- 6 Location of crossing facilities for pedestrians
  - 6.1 Crossing the paths
- 7 Signposting systems for pedestrians
  - 7.1 Signposting systems

3.3 BREEAM

3.3.1 Overview of Criteria

- RE 01 – Energy Strategy
- RE 02 – Existing Buildings and Infrastructure
- TM 01 – Transport Assessment
- TM 02 – Safe and Appealing Streets
- TM 03 – Cycling Network
- TM 04 – Access to Public Transport
- RE 04 – Sustainable Buildings
- RE 05 – Low Impact Materials
- RE 06 – Resource Efficiency
- RE 07 – Transport Carbon Emissions
- TM 05 – Cycling Facilities
- TM 06 – Public Transport Facilities

3.3.2 Detailed Description of Criteria

RE 01 – Energy strategy

Table 1 Energy strategy overview

Step	Category	Mandatory standards	No. of credits available
1	Resources and energy	Yes (criterion 1)	11

Aim

To recognize and encourage developments designed to minimize operational energy demand, consumption and CO_2 emissions.

Assessment criteria

The following is required to demonstrate compliance:

Mandatory requirements

1. An energy strategy has been written for the proposed development by an energy specialist.

One to ten credits

2. Criterion 1 is achieved.
3. The developer commits to implementing recommendations in the energy strategy that will reduce carbon dioxide emissions associated with baseline energy demand. Credits are available for the following percentage reductions:

Table 2 Credits and related percentage reduction of CO_2 emissions

Credits	Reduction in CO_2 emissions
1	3.6%
2	9.9%
3	17.7%
4	26.7%
5	36.9%
6	47.9%
7	59.8%
8	72.5%
9	85.9%
10	100%

Eleven credits

4. Criterion 1 is achieved, and the development is 'carbon neutral' (receiving 10 credits above).
5. The developer commits to implementing recommendations in the energy strategy that will result in a 'carbon negative' development (see Additional Information section).

Compliance notes

The following table gives a detailed description of relevant compliance notes:

Table 3 Energy strategy compliance notes

Ref	Terms	Description
CN1	Energy strategy. See criterion 1	The energy strategy should include the following as a minimum: 1. a prediction of the baseline energy demand and associated emissions for a Local Building Regulation compliant development calculated using approved Building Regulations compliant energy modelling software and other modelling to cover site-wide consumption. This should include: • a breakdown of the site-wide heating, cooling and electricity demand • emissions for both regulated and unregulated energy use • emissions associated with street lighting and other electrically powered street furniture 2. recommendations for reducing energy use and associated emissions beyond baseline levels

Ref	Terms	Description
		through the implementation of energy-efficient measures, including: • site layout • use of topography • shading • solar orientation • use of daylighting • wind management • use of natural ventilation. 3. opportunities to further reduce emissions through the use of decentralized energy, including: • connection to existing or future heat distribution networks • installation of site-wide communal heating and cooling networks • utilization of combined heat and power (CHP) systems, including any opportunities to extend beyond the site boundary • proposed decentralized energy networks • reasons for excluding other technologies 4. opportunities to further reduce emissions through the installation of local (on-site or near-site) low or zero carbon (LZC) energy sources, including details of the following: • energy generated from LZC energy source • payback • land use • local planning criteria • noise • feasibility of exporting heat/electricity from the system • life cycle cost/lifecycle impact of the potential specification in terms of carbon emissions • all technologies appropriate to the site and energy demand of the development • how any proposed LZC sources will be integrated with and complement any proposed decentralised energy networks • reasons for excluding other technologies 5. Summary of the carbon dioxide savings resulting from energy-efficient design measures, the use of

Ref	Terms	Description
		decentralised energy and the installation of LZC energy sources.
CN2	Energy specialist. See criterion 1	An individual who: • has acquired substantial expertise or a recognized qualification for undertaking assessments, designs and installations of low or zero-carbon solutions; • is not professionally connected to any low or zero-carbon technology or manufacturer.
CN3	Approved building energy calculation software. See criterion 1	Software approved to demonstrate compliance with the building regulations' energy efficiency and carbon emission requirements (and, in turn, compliance with the Energy Performance of Buildings Directive (EPBD) recast 2012. In countries with an existing National Calculation Methodology (NCM), the tools approved under the NCM can automatically be approved as building energy modelling software. BRE will confirm these as part of the Approved standards list process. Where the design team wishes to use an alternative modelling software package to assess this BREEAM issue, please request the Approval for Energy Software from BRE Global to determine whether the software package meets the minimum requirements in terms of the minimum capabilities, features and testing results. Where those minimum requirements are met, approval from BRE Global will be required (via the Approved standards list process) before the package can be used for the purposes of demonstrating compliance with RE 01.
CN4	Baseline Energy Demand. See criterion 1	The predicted baseline energy demand should take into account the following energy uses: 1. Regulated energy demand for buildings: energy demand covered by building regulations and the EU Energy Performance of Buildings Directive, i.e. the energy demand associated with all fixed building services that provide heating, hot water, cooling, ventilation, and lighting.

Ref	Terms	Description
		2. Unregulated energy demand for buildings: energy demand not covered by buildings regulations, i.e. energy used for cooking and home appliances in dwelling, computers and printers, etc., in an office. 3. Site wide energy demand: energy demand for street lighting and other electrically powered street furniture within the public realm. 4. To determine the baseline energy demand across these 3 different types of energy uses, it may be necessary to use several different calculation methods. a. Calculating baseline regulated energy demand for buildings; where a country has a National Calculation methodology (NCM) following the EU Energy Performance of Buildings Directive, it would be necessary to use energy modelling software compliant with the NCM to generate the baseline regulated energy use for buildings. b. This should be calculated using up to date benchmarks for standard practice performance. In the UK, acceptable sources of information for unregulated energy would typically be benchmarks for energy use in different building types published by the Chartered Institute of Building Services Engineers. It would be acceptable to use hand calculations or calculations spread sheets to generate the total unregulated energy use based on the acceptable benchmarks and estimated respective floor areas for the different building types. It would also be possible for some building types to use other appropriate calculation methodologies to calculate unregulated energy demand instead of using benchmarks. For example, the Building Research establishment Domestic Energy Model (BREDEM)

Ref	Terms	Description
		could calculate unregulated energy demand for dwellings. c. Calculating baseline site-wide energy demand; Hand calculations would be acceptable for estimating the site-wide demand for street lighting and other electrically powered street furniture within the public realm, based on reasonable assumptions, i.e. using an indicative number of street lights and figures for typical energy consumption, hours of use etc. the energy specialist is expected to be capable of making suitable assumptions or justification for calculating unregulated 'site wide' and building energy use as they might be expected to do for a normal energy strategy which would support a planning application.
CN5	Renewable and low carbon installations. See criterion 1	Where included as part of the development, the installation of low or zero-carbon technologies can be used to offset emissions arising from regulated and unregulated energy consumption. The LZC technology can be installed on-site, near-site (which includes dedicated renewable energy generated near to the site that is provided for all or part of the community)., e.g. decentralised energy generation linked to a community heat network or renewables connected via a private wire arrangement or off-site via the provision of accredited external renewables (see CN6).
CN6	Accredited external renewables. See criterion 1	For the purpose of this BREEAM issue, accredited external renewables are renewable energy schemes located off-site but within the country in which the development is being assessed, which: 1. Create new installed generation capacity, designed to meet loads of the development (i.e. not just units of carbon), 2. Are additional to capacity already required under pre-existing commitments.

Ref	Terms	Description
		At the time of writing, BRE Global are not aware of a mechanism for accrediting off-site renewables and consequently any renewable energy schemes that meet the above definition, although some ESCOs may achieve these criteria.
CN7	Recognised 'local' LZC technologies. See criterion 1	Technologies eligible to contribute to achieving the requirements of this issue must produce energy from renewable sources as defined by Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (www.eur-lex.europa.eu). All other ancillary requirements set out in the EU Directive also apply. The following requirements must also be met: 1. There must be a Private wire arrangement to supply energy produced to the building under assessment. 2. Where the country of assessment has an independent national certification scheme for installers of small-scale renewable energy or Combined Heat and Power systems, these technologies must be certified following the national plan. 3. The accreditation scheme must align with the Directives listed above or an equivalent country or regional directive or standard. 4. Air source heat pumps can only be considered a renewable technology when used in heating mode. Refer to Annex VI of Directive 2009/28/EC for more detail on energy accounting from heat pumps. 5. Where independent accreditation schemes do not exist in the country, the design team must demonstrate they have investigated the competence of the installer selected to install the LZC technology and that they are confident the installers have the skill and competence to install the technology appropriately. In the UK, the following schemes apply:

Ref	Terms	Description
		• Where covered by the Microgeneration Scheme (MCS), technologies under 50kWe or 45kWth must be MCS (or equivalent) certified products installed by MCS (or equivalent) certified installers. • Combined Heat and Power (CHP) schemes above 50kWe must be certified under the CHPQA standard.
CN8	Waste heat from a building-related operational process. See criterion 1	Waste heat from a process within the assessed site, for the purpose of this BREEAM issue, can be considered 'Low Carbon'.
CN9	Waste Incineration. See criterion 1	Waste heat from an incineration plant can only be considered as low carbon for the purpose of this BREEAM issue under the following circumstances: • All other LZC technologies have been considered and discounted in the feasibility study and EITHER • The local authority in which the incineration plant is located is demonstrably meeting its annual waste reuse or recycling targets OR • A near or on-site facility is connected to the development via a private wire arrangement, demonstrably removing reusable and recyclable materials to prevent incineration.
CN10	Biofuels. See criterion 1	Given the current uncertainty over their impact on biodiversity, global food production and greenhouse gas savings, plus the ease of interchangeability between fossil fuels, BREEAM does not recognise or reward building systems fuelled by first-generation biofuels manufactured from feedstocks, e.g. biofuels manufactured from sugars, seeds, grain, animal fats etc. BREEAM will recognise systems using second-generation biofuels (biofuels from lignocellulosic biomass feedstock using advanced technical processes) or biofuels manufactured from biodegradable waste materials, e.g. biogas, or locally and sustainably sourced solid biofuels, e.g. woodchip, wood pellets

Ref	Terms	Description
		where these are not interchangeable with fossil fuels or first-generation biofuels.

Evidence

Table 4 lists the necessary evidence regarding the relevant criteria:

Table 4 Evidence for the respective criteria

Criteria No.	Interim assessment	Final assessment
1	A copy of the energy strategy and confirmation this was undertaken by an energy specialist.	None
3-5	None.	A copy of the energy strategy.

Additional information

Relevant definitions

Building regulations

Building regulations set standards for the design and construction of buildings to ensure the safety and health of people in or about those buildings. They also include requirements to ensure that fuel and power are conserved and facilities are provided for people, including those with disabilities, to access and move around inside buildings.
Please refer to the country-specific reference sheet in the BREEAM Communities Approved Standards list to locate the appropriate building regulations in the country of assessment. Alternatively, please demonstrate applicability as follows:

- The minimum requirements as set out in the approved standards list are covered by the proposed documents and are submitted to BRE Global for approval; OR
- The minimum requirements as set out in the approved standards list are covered by the proposed documents and are submitted to BRE Global for approval; OR

Carbon negative

A site that generates a surplus to its own energy demand, an excess renewable or carbon-neutral energy, exports that surplus via the national or local distribution grid to meet other off-site energy demands, i.e., the site is a net exporter of zero-carbon energy. The excess in this respect means that the site generates more energy via renewable or carbon-neutral sources than it needs to meet its own regulated and unregulated energy needs. This definition of carbon-negative focuses only on energy and carbon dioxide emissions resulting from the operational stage of the site. It does not consider the embodied carbon in terms of carbon fixing or emissions resulting from the manufacture or disposal of building materials and components (these impacts and benefits are dealt with in BREEAM New Construction issue Mat 01 Life Cycle Impacts).

Carbon neutral

Carbon neutral means that 'through a transparent process of calculating emissions, reducing those emissions and offsetting residual emissions, net carbon emissions equal zero' (Source: Department of Energy and Climate Change, Oct 2009). See also the zero net CO_2 emissions definition below.

Regulated emissions

Emissions from building energy consumption resulting from the specification of a 'controlled', 'fixed building service'.

Renewables Obligation Certificate (ROC)

A green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. One ROC is issued for each megawatt-hour (MWh) of eligible renewable output generated (Source www.ofgem.gov.uk).

Unregulated emissions

Emissions from building energy consumption resulting from a system or process that is not 'controlled', i.e. energy consumption from systems in the building on which the Building Regulations do not impose a requirement. This also covers most energy use outside the buildings.

Zero net carbon dioxide emissions

The annual building or site CO_2 emissions ($kgCO_2/m^2/year$) arising as a result of energy consumption from fixed building services, i.e. space heating and cooling, water heating, ventilation and lighting, also referred to as a controlled service or fitting as a result of requirements imposed on such systems by the Building Regulations. In aiming to achieve a zero-carbon status, the building energy modelling can take account of contributions of energy generation from on-site, near-site and accredited external renewable and low carbon installations. Energy generated and supplied from off-site renewable and low carbon installations that are not accredited cannot be used to meet this definition.

RE 02 – Existing buildings and infrastructure

Table 5 Existing buildings and infrastructure overview

Step	Category	Mandatory standards	No. of credits available
1	Resources and energy	Yes (criteria 1 and 2)	2

Aim

To take account of the embodied carbon in existing buildings and infrastructure and promote their re-use where possible.

Assessment criteria

The following is required to demonstrate compliance:

Mandatory requirements

1. Any existing buildings and infrastructure assessment is carried out to determine what can be refurbished, re-used, recycled or maintained and those of significant value. The assessment considers the following:
   - heritage and local identity
   - the location and condition of buildings and infrastructure
   - the embodied carbon in existing materials
   - potential uses of buildings and infrastructure
   - possible use of materials (on or off-site)
   - community and local authority knowledge and opinion (see GO 01 – Consultation plan).
   - local or regional authority; best practice guidance, policies or strategies (where they exist)
2. A decision is made and justified with evidence regarding the use and/or demolition of all existing buildings and infrastructure on-site.

One credit

3. Criteria 1 and 2 are achieved.
4. The developer commits to reusing or recycling building and/or infrastructure materials on the development site.

Two credits

5. Criteria 1 to 4 are achieved.
6. The developer commits to refurbishing any existing buildings and/or infrastructure that have been identified in the assessment (criterion 1).
7. The developer commits to refurbishing any existing buildings and/or infrastructure that have been identified in the assessment as being of significant value to the local community or for sustainability reasons.

Compliance notes

Table 6 outlines the relevant compliance notes:

Table 6 Existing buildings and infrastructure compliance notes

Ref	Terms	Description
CN1	No existing buildings or infrastructure	Where the assessed site does not contain any existing buildings or infrastructure, then the credits for this issue are not available by default. This issue aims not to encourage development on previously undeveloped sites. In order for sites with no existing buildings and infrastructure to achieve the mandatory elements of this assessment issue, site plans must be provided as evidence to demonstrate that there are no existing buildings or infrastructure on site.

CN2	Embodied carbon in existing materials: See Criterion 1	A full life cycle analysis is not required for the purposes of this issue. A high-level assessment on the materials used from the existing buildings and infrastructure should be conducted, identifying the types and estimates of the volume of different materials. For example buildings or infrastructure with high volumes of steel or concrete, which have a relatively high embodied carbon, should be targeted for reuse and refurbishment where possible.
CN3	Reuse of material: See criterion 4	Where it is not possible to reuse materials on site it is still possible to gain credits by re-using materials within a 30km radius of the site.

Evidence

An overview is given below of the evidence needed for the different criteria:

Table 7 Evidence for the respective criteria

Criteria No.	Interim assessment	Final assessment
1	A copy of the assessment.	None.
2	Documentary evidence.	None.
4-7	None.	Written commitment from the developer.

Additional information

This issue relates to criterion 1 in RE 06 – Resource efficiency, where a pre-demolition audit of any existing building, structure or hard surfaces is completed to determine if refurbishment/re-use of materials is possible.

Relevant definition

Embodied carbon

> The amount of carbon released from material extraction processing, transport, manufacturing, and related activities; from the cradle to the grave [1].

TM 01 – Transport assessment

[1] Sustains definition of embodied carbon can be found at - http://www.sustain.co.uk/embodied-carbon/

Table 8 Transport assessment overview

Step	Category	Mandatory standards	No. of credits available
1	Transport and movement	Yes (criteria 1 to 2)	2

Aim

To ensure transport and movement strategies reduce the impact of the development upon the existing transport infrastructure and improve environmental and social sustainability through transport.

Assessment criteria

The following is required to demonstrate compliance:

Mandatory requirements

1. A transport assessment or transport statement is developed following scoping discussions with the local authority and local, national and regional authorities (where applicable) responsible for roads and other transport networks.
2. A travel plans is developed by a travel plan coordinator for the site outlining the design methods used to encourage and implement sustainable transport and movement.

One credit

3. Criteria 1 to 2 are achieved.
4. The transport assessment or statement and travel plans positively influence the environmental sustainability of the development and wellbeing of future residents. This is achieved through recommendations or plans to:
    1. reduce the need for travel (especially by car)
    2. reduce the length of trips
    3. promote multi-purpose or linked trips
    4. promote a more sustainable pattern of development
    5. reduce the physical separation of key land uses and landmasses
    6. reduce distances from buildings to public transport nodes
    7. improve sustainable transport choices through actions such as increased or improved walking or cycling and public transport infrastructure and facilities
    8. ensure safe and easy access to jobs, shopping, leisure facilities and services by walking, cycling and public transport.
    9. consider transport capacity to ensure there is sufficient provision

Two credits

5. Criteria 1 to 4 are achieved.
6. The transport assessment or statement confirms that there is spare capacity to meet the demands of the proposed development. OR
7. Where development is phased, public transport services will be subsidised by the developer of the local municipality to ensure residents occupying the early phases of development can use these services from the outset.

Compliance notes

In Table 9 the respective compliance notes are described in detail:

Table 9 Transport assessment compliance notes

Ref	Terms	Description
CN1	Transport statement. See criterion 1	A transport statement is suitable when the proposed development is expected to generate relatively small numbers of trips or traffic flows, with minor transport impacts. As a minimum a transport statement should include[2]: • existing site information including existing uses and issues and plans for the site • baseline transport data including existing site travel characteristics, public transport provision, description and functional classification of the highway network in the vicinity of the site, analysis of the injury accident records in the vicinity of the site • plans for the proposed site layout, scale of development and proposed land uses, major features of the development, person-trip generation of the proposed development, distribution of trips across modes and a description (based on recent site observations) of the travel characteristics of the proposed development.
CN2	Transport assessment. See criterion 1	A transport assessment will be required where a proposed development is likely to have significant transport and related environmental impacts. The study area for a transport assessment related to a proposed development should be determined in discussion between the developer and appropriate authorities. In addition to the points listed above for a transport statement, a full transport assessment should contain the following:

[2] Department for Transport publication 'Guidance on Transport Assessment' available at http://www.dft.gov.uk/publications/guidance-on-transport-assessment/

Ref	Terms	Description
		• Baseline transport data, including: parking facilities available in the vicinity of the site, current traffic flows at links or junctions, identification of critical links or junctions and capacity testing, a summary of planned transport improvements, identification of current peak periods on the adjacent road network, levels for air quality and noise for the highway network at the site entrance and any other locations where statutory limits might be breached by additional development traffic, and baseline carbon emissions data for the site, broken down by mode. • Public transport assessment, including: the total person trip generation for all travel modes, the likely modal split for the public transport network (buses, rail and tram), the public transport services relevant to the proposed development, the existing capacity of the bus, rail or tram service, the current level of patronage or usage on the public transport network, the estimated spare capacity on the public transport network, and measures to address any shortfall in capacity. • Walking or cycling assessment, including: the capacity of the existing cycleway and rights of way network and required enhancements. • Road network, traffic data and safety, including: the available vehicular capacity on the road network, the impacts from the development and any mitigation measures that may be required, the viable parking facilities in the vicinity of the site, the impact that development could have upon them, recent counts for peak period turning movements at the critical junctions (other counts such as queue length, journey time, freight counts etc. may also be required) and any significant highway safety issues and recent accident history of the area. • Proposed development plans, including site area and development phasing, proposed access arrangements, method of linking to

Ref	Terms	Description
		existing infrastructure, servicing arrangements, hours of operation. The transport assessment should ensure that the impacts of the proposed development are considered in the context of two scenarios 'With' and 'Without' the development. As a minimum the impacts assessed should include: • accessibility • safety • economy • environment • integration.
CN3	Travel plan coordinator. See criterion 2	The role of the travel plan coordinator will depend on the scale of the development. The following responsibilities are normally included: • development and implementation of travel plans appropriate to the site • promote the travel plan and raise awareness of sustainable transport options • review the success of the travel plan. The travel plan coordinator can be a member of the design team.
CN4	Travel Plans. See criterion 2	Travel plans are a valuable tool in the delivery of sustainable outcomes. A travel plan comprises site-specific initiatives to improve the availability and choice of travel modes to and from development. Together with a transport assessment, travel plans are the mechanism for assessing and managing access to sites, improving accessibility and promoting practices or policies that reduce the need for travel.

Evidence

Which kind of evidence is needed for the criteria can be found below:

Table 10 Evidence for the respective criteria

Criteria No.	Interim assessment	Final assessment
1	A copy of the transport assessment or statement.	None.
2	A copy of the travel plan.	None.
4	None.	A copy of the travel plan and confirmation this was undertaken by a travel plan coordinator.
6	None.	A copy of the transport assessment or statement.
7	None.	A written commitment from the developer or the municipality.

Additional information

The design and layout of streets is covered in issue TM 02 – Safe and appealing streets.

Relevant definitions

Existing transport corridor

Any route served by a regular transport service.

Public transport corridor

Any route served by bus, train, tram or other form of public transport.

Transport capacity

The maximum number of people that can be transported via a public transport service. ALL potential users of the development must be able to access the transport facility within the defined boundaries.

TM 02 – Safe and appealing streets

Table 11 Safe and appealing streets overview

Step	Category	Mandatory standards	No. of credits available
2	Transport and movement	No	4

Aim

To create safe and appealing spaces that encourage human interaction and a positive sense of place.

Assessment criteria

The following is required to demonstrate compliance:

One credit

1. The transport assessment or statement and travel plans are used to inform the objectives for the design of the streetscape.
2. A context appraisal is carried out to determine the appropriate streetscape layout concerning the existing or planned buildings and/or open space.
3. A movement framework is developed to determine the layout and design of the streetscape that will promote sustainable modes of movement and transport through travel plans.
4. Street layouts and the design of pedestrian and cycle routes are safe and secure by incorporating the following:
   - in residential areas, all streets and open spaces will be overlooked
   - all access points and routes through the site will be well lit, direct and overlooked
   - pedestrian crossings are designed to ensure safety for all users
   - a clear distinction is made between public, semi-public and private external spaces.
5. Design measures are incorporated into the masterplan to ensure safety with regard to large vehicles, pedestrian and cyclist movement. As a minimum, vehicle delivery areas are not accessed through parking areas and do not share pedestrian and cyclist routes.

Two credits

6. Criteria 1 to 5 are achieved.
7. The landscape design covers pedestrian routes through design and the provision of attractive landscaping.

8. Pedestrian routes allow easy navigation around the development using key features and existing districts to aid navigation. As a minimum, the following is achieved:
   - new routes into the development are a continuation of existing routes from the surrounding area
   - routes connect residential areas to, and between, community focal points in the development and surrounding area.

Three credits

9. Criteria 1 to 8 are achieved.
10. Within the development's traffic management plan, targets have been set to reduce road traffic accidents and these targets have been agreed and informed by the authorities responsible for monitoring and reporting road traffic accidents.
11. Potential noise, visual and vibration disturbance from heavy vehicles has been mitigated through road layout, building orientation and buffer zones.

Four credits

12. Criteria 1 to 11 are achieved.
13. A maintenance contract will be in place for external areas that are not covered by the local authority for at least the first five years from the time the development is occupied.

Compliance notes

The following table gives an overview of the relevant compliance notes:

Table 12 Safe and appealing streets compliance notes

Ref	Terms	Description
CN1	Context appraisal. See criterion 2	The context appraisal will identify how an area has developed in terms of form, scale, the pattern and character of streets and how a site or existing street relates to existing buildings or open space. This will involve analysing the following: • local character and distinctiveness • how existing streets sit within the area • the relationship between streets, buildings and the public realm • the use of links to important destinations • the need to remedy existing poor-quality connections and identify opportunities for new connections • the importance of existing or planned buildings and public spaces • key destinations such as transport nodes, educational facilities, offices, and retail areas • movement via pedestrians, cyclists, public transport users, specialist vehicles (including large and heavy goods vehicles) and other motor traffic. The context appraisal can form part of the transport assessment or transport statement and does not have to be a standalone document.
CN2	Movement framework. See criterion 3	The framework should include consideration of: • a hierarchy of sustainable transport (pedestrians, cyclists, public transport users, specialist vehicles and other motor traffic) • the form of the surrounding environment (buildings, landscape and activities)

Ref	Terms	Description
		• connection and permeability of street networks. The movement framework can form part of the transport assessment or transport statement and does not have to be a standalone document.
CN3	Design measures for street safety and large vehicles. See criterion 5	The following design measures could be used to address the impact of large vehicles: • parking and turning areas allow for simple manoeuvring of large vehicle type, thus avoiding the risk of minor collisions • there are separate parking areas for waiting goods vehicles, away from the manoeuvring areas and staff/visitor car parking • there are dedicated space(s) to store refuse skips/pallets away from delivery vehicle manoeuvring areas and car parking.
CN4	Insufficient information on traffic incident: See criterion 10	Where there is insufficient information to set targets to reduce road traffic accidents, the credit may be awarded where the developer commits to monitoring the level of road traffic accidents and over a suitable timescale will form reduction targets based on this monitoring.

Evidence

Table 13 specifies what kind of evidence is necessary with regard to each criterion:

Table 13 Evidence for the respective criteria

Criteria No.	Final Assessment
2	A copy of the context appraisal or transport assessment or statement.
3	A copy of the movement framework or transport assessment or statement.
4, 5, 8 & 11	Documentary evidence, design specifications, and/or a copy of the masterplan or relevant site plans.
7	Design specifications.
10	A copy of the traffic management plan.
13	A written commitment from the developer.

Additional information

Relevant definitions

Semi-public

Those areas often adjacent to buildings or private areas that, whilst not enclosed or demarcated as private, are not expected to be accessed by users of the public areas. This could include buffer zones between public rights of way and private boundary finishes.

Private

Areas often within buildings or surrounded by boundary finishes such as fencing and hedges that create a sense of exclusion from the public realm. These areas are for the use of the building (or area) occupants only.

Community focal points

Facilities, amenities or other valuable community assets situated within the development or within the surrounding area. This may include: Commercial or educational centres, Sports or recreation facilities, dedicated open spaces, community meeting areas or key transport facilities.

TM 03 – Cycling network

Table 14 Cycling network overview

Step	Category	Mandatory standards	No. of credits available
2	Transport and movement	No	1

Aim

Promoting cycling as a leisure activity and an alternative to vehicle use by providing a safe and efficient cycle network.

Assessment criteria

The following is required to demonstrate compliance:

One credit

1. The movement framework or similar (developed for TM 02 – Safe and appealing streets) covers items A – G below.

Table 15 Cycling network assessment criteria

Item	Description
A	Cycle routes within the development connect to, or are a continuation of existing routes from the surrounding area.
B	Cycle routes connect residential areas to community focal points in the development and surrounding area.
C	Cycle routes are direct and safe (well lit, safe road crossings etc.).
D	Cycle routes are segregated from vehicles and pedestrians as appropriate: • on low-speed streets, below 20mph (30km/h), cyclists can be integrated with vehicles • on busy streets or where there are higher traffic speeds there should be clearly defined cycle lanes • separate cycle tracks should be introduced where space allows, in particular where the traffic speeds exceed 30mph (50km/h) • pedestrians and cyclists can share the same space, but steps must be taken to segregate the two, for example, a raised kerb or clear markings. Where pedestrians and cyclists share the same space, but segregation is not possible, a minimum width of 3 metres should be provided.
E	Adequate signage detailing directions and route information is provided to guide cyclist navigation around the development and surrounding area.

Item	Description
F	Special provision is provided at junctions (including roundabouts) for cyclists. Junctions are designed to ensure that cyclists can see and be seen by other road users. Cyclists are given priority at interchanges with other infrastructure networks, for example, through the phasing of lights, priority crossing points and advanced stop lines.
G	Cycle routes are attractive and designed to be enjoyable in order to encourage cycling and discourage the use of vehicles.

Compliance notes

The following table gives a detailed description of the respective compliance notes:

Table 16 Cycling network compliance notes

Ref	Terms	Description
CN1	Cycle lane dimensions	One-way cycle lanes should be ≥ 1.25m wide. Two-way cycle lanes should be ≥ 2.5m wide.

Evidence

Which kind of evidence is needed for the criteria can be found below:

Table 17 Evidence for the respective criteria

Criteria No.	Final Assessment
All	A copy of the movement framework (or similar).

Additional information

Further information on Cycle Infrastructure Design can be found in the Department for Transport Local Transport Note 2/08.

TM 04 – Access to public transport

Table 18 Access to public transport overview

Step	Category	Mandatory standards	No. of credits available
2	Transport and movement	No	4

Aim

To ensure the availability of frequent and convenient public transport links to fixed public transport nodes (train, bus, tram or tube) and local centres.

Assessment criteria

The following is required to demonstrate compliance:

One to four credits

1. The distance from each building entrance to a compliant transport node must be via a safe and convenient pedestrian route and between the following distances:

Table 19 Access to public transport assessment criteria

Credits	Distances (urban)	Distances (rural)
1	≤ 650m	≤ 1300m
2	≤ 550m	≤ 1100m
3	≤ 450m	≤ 900m
4	≤ 350m	≤ 700m

2. Public transport provision for the compliant transport nodes is agreed upon with the local authority and as a minimum considers of:
   - public transport routes and stops
   - frequency of services at peak and off-peak times.

Compliance notes

Table 20 gives an overview of the relevant compliance notes:

Table 20 Access to public transport compliance notes

Ref	Terms	Description
CN1	Compliant transport node	In order to be compliant, the transport node must provide a regular or frequent service. The node must have a service at least every 10/15 (peak/off-peak) minutes in urban

Ref	Terms	Description
		areas and every 30 minutes/1 hour (peak/off peak) in rural areas. The services should run to a local centre or a key services centre.
CN2	Proximity to buildings	The public transport nodes' proximity and frequency should be assessed for each building separately. The resulting 'credits' should be averaged to obtain the 'credits' awarded to the whole development. Where building types are unknown, notional entrance points must be marked on the masterplan and measurement taken from this point.
CN3	Measuring distance	Distance should not be measured 'as the crow flies' and must be measured via a safe pedestrian route (see CN6) from the main building entrance to the nearest compliant transport node.
CN4	Multiple services at a transport node	Where a transport node is served by more than one service going to a local urban centre, the frequency between services can be used as the frequency for assessment. For example, where there are three services, each with a 30-minute frequency but each follows on 10 minutes after the other, and then the frequency used for assessment purposes would be 10 minutes.
CN5	Multiple transport nodes	Where there is more than one transport node, but it serves different proximities of the buildings, units or plots, e.g., one node at 400m and another at 600m then each node should be assessed separately and the 'credits' awarded for the best performing node.
CN6	Safe and convenient pedestrian route	See compliance notes for SE 06 – Delivery of services, facilities and amenities
CN7	Phased developments	In the case of a large development where new transport facilities will be provided at a later stage than the phase being assessed, a commitment to provide the transport facilities should be demonstrated either within the General Contract Specification or in a binding undertaking such as a Section 106 Agreement.

Evidence

Table 21 specifies the evidence needed:

Table 21 Evidence for the respective criteria

Criteria No.	Final Assessment
1	Design specifications or a copy of the masterplan or relevant site plans
2	Written confirmation from the local authority

Additional information

Relevant definitions

Local centre

A local centre is defined as any community focal point. This includes local shops, community facilities, a major transport node, (i.e., a railway, bus station) or another type of significant non-leisure related meeting place.

Definitions for peak and off-peak hours as follows:

Peak hours: between 07:00–10:00 and 16:00–19:00.

Off peak hours: between 10:00–16:00 and 19:00–01:00

Note: Where these timings differ to those for the country where the assessment is being undertaken, it is possible to use an equivalent to the BREEAM requirements stated; however, this must be approved by BRE Global. The BREEAM Communities Approved standards list can be used to check for previously approved standards or to propose a new national or local standard.

RE 04 – Sustainable buildings

Table 22 Sustainable buildings overview

Step	Category	Mandatory standards	No. of credits available
3	Resources and energy	No	6

Aim

To increase the sustainability of all buildings within the development.

Assessment criteria

The following is required to demonstrate compliance:

One credit

1. The developer and design team have committed to designing new or refurbished buildings on site to comply with recognised industry best-practice standards in

sustainable design for one or more of the following key sustainability areas: energy, water, and waste, embodied impacts of materials, and occupant health and well-being.

2. The commitment is confirmed through a planning condition (or other binding mechanism, such as a planning obligation) by the local authority.

Two credits

3. The developer and design team have committed to designing new or refurbished buildings on site to comply with recognised industry best practice standards in sustainable design for all of the following key sustainability areas: energy, water, and waste, embodied impacts of materials, and occupant health and wellbeing.
4. The commitment is confirmed through a planning condition (or other binding mechanism, such as a planning obligation) by the local authority.

Three to six credits

5. The developer and design team have committed to using an accredited third-party assessment scheme, to measure the level of sustainable design, construction and refurbishment of all buildings on the site. Credits are available based on the following performance:

Table 23 Sustainable buildings assessment criteria, credits three to six

Credits	Overall building performance for the full range of key sustainability areas (see compliance notes)
3	Buildings performing in the top 50%
4	Buildings performing in the top 25%
5	Buildings performing in the top 10%
6	Buildings performing in the top 1%

6. The commitment is confirmed through a planning condition (or other binding mechanism, such as a planning obligation) by the local authority.

Compliance notes

The following table gives a detailed description of the respective compliance notes:

Table 24 Sustainable buildings compliance notes

Ref	Terms	Description
CN1	Code for Sustainable Homes and BREEAM (or equivalent). See criterion 5	Where a developer wishes to use an equivalent accredited third-party assessment scheme for sustainable buildings, this arrangement should be agreed with BRE

Ref	Terms	Description
		Global by the assessor. Please contact the BREEAM at breeam@bre.co.uk.
CN2	Calculating credits for mixed-use developments. See criterion 5.	When assessing a development with a number of building types, the following applies. Determine the number of credits available and proposed floor area for each building type. The assessor should calculate the number of credits to be awarded as follows (credits should be rounded down to the nearest whole number): $Credits\ achieved = \frac{(A_1 \times CS_1)+(A_2 \times CS_2)+\ldots+(A_n \times CS_n)}{(A_1+A_2+\ldots+A_n)}$ Where: 1. A = Gross floor area (m^2) 2. CS = Credit score 3. 1 - n = Building types
CN3	Maintaining existing development or buildings	Where existing development or buildings on site do not require refurbishment (as established within RE 02 – Existing buildings and infrastructure) then a BREEAM (or equivalent) assessment is not required.
CN4	Key sustainability areas	The key sustainability areas that an accredited assessment scheme must address: • Improving energy performance through demand and fabric efficiency • Reducing water consumption • Minimizing construction and operational waste • Reducing the embodied impact of materials • Designing for resilience through flood prevention and tackling climate change • Sources of pollution are prevention or mitigation • Ensuring access to sustainable means of transport for building users. • Consider occupants health and wellbeing • Take into account the ecological impact of development. Overall performance is based on appropriate minimum standards against fundamental environmental issues combined with a balanced scorecard approach to allow a degree of flexibility in response to local needs. Furthermore, each of the key sustainability areas should

Ref	Terms	Description
		be weighted to reflect their importance or impact in the local context.
CN5	Other binding mechanism. See criteria 2 and 4	The commitments are confirmed through one or more of the following: - for buildings where the end owner is known, then a legal commitment/contract/purchase agreement should be set up between the developer and the future owner to demonstrate a commitment achieve a specific level of BREEAM certification - where the end user is not known, a legally binding commitment to deliver the service, facility or amenity should be in place, such as a planning condition, obligation or permit to deliver a specific level of BREEAM certification.

Evidence

Which kind of evidence is necessary in regard to each criterion is described below:

Table 25 Evidence for the respective criteria

Criteria No.	Final Assessment
All	Documentary evidence and a copy of the planning condition (or other binding mechanism, e.g., planning obligation)
Criterion 2	Copy of the relevant legal commitment and conformation that the contracts will align with the planning of urban zone requirements.

Additional information

Accredited third party assessment schemes

The table below outlines how The Code for Sustainable Homes, Home Quality Mark and the wider family of BREEAM schemes and their associated ratings relate to the credits available within RE 04 Sustainable buildings.

Table 26 Different schemes and ratings related to the credits within RE 04 Sustainable buildings

Credits	Home Quality Mark star rating	Code for Sustainable Homes rating	BREEAM rating
3	2 stars	Level 3	Good
4	3 stars	Level 4	Very Good
5	4 stars	Level 5	Excellent

Credits	Home Quality Mark star rating	Code for Sustainable Homes rating	BREEAM rating
6	5 stars	Level 6	Outstanding

Depending on the location, building types and building uses on site any of the following BREEAM schemes may be applicable:

- BREEAM International New Construction
- BREEAM New Construction UK
- BREEAM Domestic Refurbishment
- BREEAM International Refurbishment and Fit-Out
- BREEAM UK Refurbishment and Fit-Out
- BREEAM NSO schemes covering the design and construction life cycle stage

The Code for Sustainable Homes can be used to assess all new single occupancy dwellings. All new non-domestic and multi-residential buildings can be assessed under BREEAM New Construction. The refurbishment of existing buildings can be assessed under BREEAM Domestic Refurbishment for single occupancy dwellings and BREEAM Non-Domestic Refurbishment for all non-domestic buildings.

RE 05 – Low impact materials

Table 27 Low impact materials overview

Step	Category	Mandatory standards	No. of credits available
3	Resources and energy	No	6

Aim

To reduce the environmental impact of construction through the use of low impact materials in the public realm.

Assessment criteria

The following is required to demonstrate compliance:

Sustainable materials

<u>One to three credits</u>

1. Contractors and sub-contractors have environmental management policies and procedures, such as EMAS/ISO14001, in place to ensure the sustainable management and supply of materials used in the public realm.
2. Credits are awarded based upon the percentage of materials (used in the public realm) that achieve an A+ to B rating, as defined in the Green Guide to Specification:

Table 28 Sustainable materials assessment criteria

Credits	Percentage of materials in the public realm (by volume or weight)
1	Between 40 - 60%
2	Greater than 60%
3	Greater than 80%

Road construction materials

One to three credits

3. Credits are awarded based upon the percentage of road or path construction material that is locally reclaimed or constituted from recycled material. The table below gives an overview of the relevant percentages:

Table 29 Road construction materials assessment criteria

Credits	Percentage of road or path (by volume or weight)
1	Greater than 15%
2	Between 25% - 30%
3	Greater than 30%

Compliance notes

Respective compliance notes are described in the following table:

Table 30 Low impact materials compliance notes

Ref	Terms	Description
CN1	Green Guide ratings. See criterion 2.	Green Guide ratings for the specification(s) of each element can be found online at: www.thegreenguide.org.uk
CN2	Matching specifications to those in the Green Guide. See criterion 2.	Exact matches for material specifications are not always found in the Green Guide. But it should be possible to identify a similar specification and use its rating for the purposes of assessment. Where no similar specification can be found, seek guidance from the BRE Global (breeam@bre.co.uk) for the appropriate rating.

Ref	Terms	Description
CN3	Sustainable materials. See criterion 1 & 2.	The 'sustainable materials' section of this assessment issue relates only to materials used in the public realm but excludes roads. This issue does not cover the use of materials in the buildings themselves. All material identified for use, must be used on site and materials identified for re-use must be sourced from the site. See the additional information section in SE 07 – Public realm for a definition of public realm.
CN4	Reused materials. See criterion 2.	The Green Guide gives a default A rating to all materials that are being reused on the site. Reused materials are those that can be extracted from the waste stream and used again without further processing, or with only minor processing, which does not alter the nature of the material (e.g., cleaning, cutting, fixing to other materials). This includes reused materials from the development site and/or from the local area, assuming that the reasons for sourcing these materials locally can be justified as a sustainable solution by the assessor.
CN5	No new materials	The maximum available credits for the 'Sustainable materials' and 'Road/paths construction materials' sections can be awarded automatically when no new material is being used on the development (possibly for refurbishment projects).
CN6	Locally reclaimed. See criterion 3	It is possible to source materials from within a radius of 30km to demonstrate compliance.

Evidence

Table 31 defines the evidence needed for each criterion:

Table 31 Evidence for the respective criteria

Criteria No.	Final assessment
1	A copy of the environmental management policies and procedures
2 & 3	Design specifications

Additional information

Please refer to best practice guidance on incorporating recycled content in roads from AggRegain WRAP[3].

RE 06 – Resource efficiency

Table 32 Resource efficiency overview

Step	Category	Mandatory standards	No. of credits available
3	Resources and energy	No	4

Aim

To promote resource efficiency by reducing waste during construction and throughout the life cycle of the development.

Assessment criteria

The following is required to demonstrate compliance:

One credit

1. Where existing buildings and infrastructures on the site have been identified in RE 02 – Existing buildings and infrastructure for refurbishment, reuse or demolition, an audit of any existing buildings, structures or hard surfaces is completed to maximize the recovery of material from demolition or refurbishment for subsequent high-grade applications. The audit must be referenced in the waste management strategy or plan and cover:
   - identification and quantification of the key refurbishment or demolition materials.
   - potential applications and any related issues for the reuse and recycling of the key refurbishment and demolition materials.
2. Where the works are likely to produce excavation waste (soils and stones), the following is assessed and referenced within the waste management strategy or plan:
   - an estimate of the amount of excavation waste generated
   - how to maximize reuse of excavation waste on site if feasible, and if not, how to maximize the recovery of material.
3. The design team has embedded resource efficiency within the overall scheme design with specific reference to best practice guidance principles for Designing out Waste principles for any civil engineering works being undertaken on-site and at the building level.
4. A waste management strategy or plan has been completed to confirm the estimated amount and types of construction, demolition, and excavation waste from the site development, including infrastructure development and landscaping.

[3] http://aggregain.wrap.org.uk/recycled_roads.html

Two credits

5. Criteria 1 to 4 are achieved.
6. Landscape designs have been informed by and refer to the waste management strategy or plan, with specific aims to retain construction, demolition and excavation materials and waste on site.
7. Where design work has already started at the building level, designs refer to best practice guidance principles for Designing out Waste principles and are informed by the waste management strategy or plan. Where plot or building level developer agreements are not yet in place this must be a requirement of the development project.
8. Where individual plots are developed independent to the entire site, the developer has provided a written commitment to reduce and recover waste during the construction phase and put in place contractual agreements with the main contractor or waste management contractor.

Three to Four credits

9. Criteria 1 to 8 are achieved.
10. The developer has provided a written commitment that an agreement will be in place at the start of construction to divert non-hazardous construction and non-hazardous demolition waste from landfills (based on the estimate from criterion 2):

Table 33 Resource efficiency assessment criteria, three to four credits

Credits	Type of waste	Volume	Tonnage
3	Non-hazardous construction	70%	80%
	Non-hazardous demolition	80%	90%
4	Non-hazardous construction	85%	90%
	Non-hazardous demolition	85%	95%

Compliance notes

The following table gives a detailed description of the respective compliance notes:

Table 34 Resource efficiency compliance notes

Ref	Terms	Description
CN1	Pre-demolition audit. See criterion 1	A pre-demolition audit should be conducted using an appropriate methodology. The Institution of Civil Engineers (ICE) has produced guidance on pre-demolition audits, including 'The Demolition Protocol' and the Waste Resources Action Programme (WRAP – http://www.wrap.org.uk) also provides guidance. This may be consulted if there are no national references available.
CN2	High-grade application. See criterion 1	Crushed material used as fill material on site is not considered to be a high-grade application. This practice is now commonplace on construction sites.
CN3	Best practice guidance principles for Designing out Waste. See criterion 3	Please refer to the country-specific reference sheet in the BREEAM Communities Approved Standards list to locate the appropriate equivalent LCA tool in the country of assessment. Alternatively, please demonstrate applicability as follows: The minimum requirements as set out in the approved standards list are covered by the proposed documents and are submitted to BRE Global for approval; OR where appropriate alternative standards do not exist for a country, the design team should demonstrate compliance with the UK or European standards as listed in each relevant country reference sheet.
CN4	Waste management strategy or plan. See criteria 2 and 4	A waste management strategy is one that defines: • a target benchmark for resource efficiency, e.g., m^3 or tones of non-hazardous construction waste per $100m^2$ • procedures and commitments for minimizing non-hazardous construction waste in line with the benchmark • procedures for minimizing hazardous waste • estimated amounts and types of refurbishments or demolition, excavation waste and construction waste, where applicable • procedures for monitoring, measuring and reporting hazardous and non-hazardous construction, demolition and excavation waste, where applicable • procedures for sorting, reusing and recycling construction and demolition waste, where applicable, into defined waste groups (see Additional

Ref	Terms	Description
		Information section 'Best practice waste management strategy or plan'), either on-site or through a licensed external contractor • procedures for sorting or reusing on-site, where feasible, and recycling excavation waste, where applicable • the name or job title of the individual responsible for implementing the above.
CN5	Diversion from landfill. See criterion 10	Diversion from landfill includes: reusing the material on-site (in-situ or for new applications), reusing the material on other sites, salvaging or reclaiming the material for reuse, returning material to the supplier via a 'take-back' scheme, recovery of the material from site by an approved waste management contractor to be recycled or sent for energy recovery

Evidence

The necessary evidence in regard to each criterion is outlined below:

Table 35 Evidence for the respective criteria

Criteria No.	Final Assessment
1	A copy of the pre-demolition audit
2 & 4	A copy of the waste management strategy or plan
3 & 6	Design specifications
7	Design specifications or a written commitment from the developer
8 & 10	Written commitment from the developer

Additional information

Relevant definitions:

Waste management strategy or plan

Aims to promote resource efficiency and prevent illegal waste activities. Resource efficiency includes minimizing waste at the source and ensuring that clients, designers and principal contractors assess the use, reuse and recycling of materials and products on and off the site.

Pre-demolition audits

These provide detailed information on materials that can be reclaimed and recycled, so reducing the cost and environmental impact of waste disposal, bringing savings from re-using existing materials and earnings from selling those that are not needed.

Best practice waste management strategy or plan

A best practice is a combination of commitments to:

1. Design out waste
2. Reduce waste generated on-site
3. Develop and implement procedures to sort and reuse/recycle construction, demolition and excavation waste on and off-site (as applicable).
4. National or regional guidance from governmental departments or independent bodies in the field of waste management. Please refer to the country-specific reference sheet in the BREEAM Communities Approved Standards list to locate the appropriate equivalent LCA tool in the country of assessment. Alternatively, please demonstrate applicability as follows:

The minimum requirements as set out in the approved standards list are covered by the proposed documents and are submitted to BRE Global for approval; OR
Where appropriate alternative standards do not exist for a country, the design team should demonstrate compliance with the UK or European standards as listed in each relevant country reference sheet.

The following guidance may be consulted if there are no national references available from:

- Defra (Department for Environment, Food and Rural Affairs)
- BRE
- WRAP (Waste & Resources Action Programme)
- CL:AIRE (Contaminated Land: Applications in Real Environments).
- BRE's SMARTWaste Plan (www.smartwaste.co.uk) can be used to prepare, implement and review a waste management strategy including measuring waste. As part of the SMARTWaste Membership scheme, energy and water consumption and the procurement of certified timber can also be monitored. Other tools are available from WRAP.

RE 07 – Transport carbon emissions

Table 36 Transport carbon emissions overview

Step	Category	Mandatory standards	No. of credits available
3	Resources and energy	No	1

Aim

To reduce pollution associated with car use and provide viable alternatives to car ownership.

Assessment criteria

The following is required to demonstrate compliance:

One credit

1. A feasibility study/desk-based assessment is undertaken using the information from the transport assessment or transport statement (see TM 01 – Transport assessment) to establish appropriate alternative transport options for the development.
2. Travel plans (see TM 01 – Transport assessment) for the development set out the appropriate alternative transport options, on the basis of:
    - occupancy of the development
    - potential reduction in greenhouse gas emissions from different solutions
    - costs involved in different solutions
    - existing alternative transport facilities within the community
    - possibility of external funding
    - potential for community management of solutions.
3. At least one alternative means of sustainable transport has been established/incorporated into the development.
4. The sustainable transport options are advertised in order to ensure all residents and users of the community are aware of the options available.
5. Management plans are in place to monitor use and ensure facilities are well maintained.

Compliance notes

Table 37 gives an overview of the relevant compliance notes:

Table 37 Transport carbon emissions compliance notes

Ref	Terms	Description
CN1	Alternative sustainable transport. See criterion 1	Compliant alternative transport options are methods of transport that reduce the pollution associated with private car ownership/use within the community. These do not include traditional public transport systems such as trams, trains, buses or cycling/pedestrian rights of way. These may include, but are not limited to: • car pools/clubs • cycle hire schemes • lift sharing clubs • community electric vehicle hire • community work/office space – to avoid the need to commute to offices.
CN2	Management Plan. See criterion 5	The management plan and funding must be based on the findings of the feasibility study.

Evidence

Table 38 specifies which kind of evidence is necessary with regard to criterion One to Five:

Table 38 Evidence for the respective criteria

Criteria No.	Final Assessment
1	A copy of the feasibility study
2	A copy of the travel plan(s)
3	Documentary evidence
4	Written confirmation from the developer or service provider
5	A copy of the management plan

Additional information

Relevant definitions

Carpool or club

A car club or carpool offers a means of hiring or using a car as part of a club, in which a number of cars are shared amongst a larger group of individuals. This provides access to a car when required but removes the need for each member to have their own private car, reducing the use of private transport for necessary journeys.

Lift sharing clubs

A lift sharing club or scheme aims to encourage and facilitate the sharing of cars to reduce single person journeys.

TM 05 – Cycling facilities

Table 39 Cycling facilities overview

Step	Category	Mandatory standards	No. of credits available
3	Transport and movement	No	2

Aim

To promote cycling by ensuring the adequate provision of cyclist facilities.

Assessment criteria

The following is required to demonstrate compliance:

One credit

1. Consultation has taken place between the local authority, developer, community representatives and other stakeholders to establish the likely facility requirements. The consultation considers all expected users of the development (residents and non-residents), existing cycling facilities, potential location of facilities and expected demand.
2. The consultation results have been analysed and an appropriate level of cycle facilities to promote cycling for the development has been agreed.
3. A commitment is made to provide adequate space for cycle storage to accommodate the minimum standards shown below (See TM 05 – Cycling facilities):

Table 40 Minimum standards for cycle storage

Building type	Storage requirements
Residential	Requirements: • Studios/1-bedroom dwellings - storage for 1 cycle for every two dwellings • 2/3-bedroom dwellings - storage for 1 cycle • 4 + bedrooms - storage for 2 cycles
Non-residential	Requirements: • The first 500 users - 1 space per 10 users • Between 501 – 1000 users - 1 space per 15 users • Above 1001 + users - 1 space per 20 users

4. A legal agreement, contract or permit is in place to ensure non-residential plot developers provide an appropriate number of showers, changing facilities and lockers, and space for drying wet clothes.

Two credits

5. Criteria 1 to 4 are achieved.
6. The local authority and developer have agreed a maintenance strategy for the cyclist facilities and dedicated funds are allocated for the maintenance and adjustment of the cyclist facilities in communal locations.

Compliance notes

Below are outlined the relevant compliance notes with a detailed description:

Table 41 Cycling facilities compliance notes

Ref	Terms	Description
CN1	Compliant cycle storage (non-residential). See criterion 3	Compliant cycle storage facilities are those that meet the following: Where the calculated number of required cycle storage spaces is less than 4 total provisions should be based on the lower of the following: • a minimum of four compliant storage spaces must be provided (unless otherwise stated) OR • one space per user (staff and where appropriate other user groups). The space is secure, well-lit and covered overhead to protect from the weather. The covered area and the cycle racks are set in or fixed to a permanent structure (building or hardstanding). Alternatively, the cycle storage may be located in a locked structure fixed to or part of a

Ref	Terms	Description
		permanent structure with CCTV surveillance. The distance between each cycle rack, and cycle racks and other obstructions e.g., a wall, allows for appropriate access to the cycle storage space, to enable bikes to be easily stored and accessed. The facilities are in a prominent site location that is in view/overlooked from either an occupied building or the main access to a building. The majority of the cycle racks are within 100m of a building entrance (ideally within 50m).
CN2	Compliant cycle storage (residential). See criterion 3	Compliant cycle storage facilities are those that meet the following: The minimum storage area required to store cycles on the floor: • 1 cycle: 2 m long × 0.75 m wide • 2 cycles: 2 m long × 1.5 m wide • 4 cycles: 2 m long × 2.5 m wide Where proprietary storage or hanging systems are provided, the space requirements are flexible, but the system must allow each cycle to be removed independently. Where cycle storage is provided in a shed, a minimum of 1 m2 is required for garden tools (in addition to the above dimensions). The shed must be set on a concrete foundation and secure fixing must be provided. Where cycle storage is provided in a garage, adequate space must be provided to store both the bicycle(s) and the car(s) simultaneously. Easy and direct access from/to the dwelling(s) and from/to the cycle store to a public right of way. Access from the store to a public right of way through the dwelling is not acceptable, e.g., where cycles are stored in a shed in the back garden of a mid-terraced home and there is no direct access from the garden to a public right of way. Communal stores must be located within 100m of the front door or the main entrance to a block of flats.
CN3	Calculating the number of compliant cyclist spaces required (non-residential). See criterion 3	Calculating the number of cyclist spaces needed for non-residential development should be undertaken according to the following example. A non-residential development with 1800 users would be required to provide the following number of cycle storage spaces: 1-500 users @ 1 space per 10 users = 50 spaces 501-1000 users @ 1 space per 15 users = 34 spaces (rounded up from 33.26) 1001-1800 users @ 1 space per 20 users = 40 spaces (rounded up from 39.95) Total compliant cycle storage spaces required = 124 spaces

Ref	Terms	Description
CN4	Funding for maintenance & adjustment. See criterion 6	Guidance should be sought from the local authority as to how much maintenance and adjustment costs typically are. An amount need not be set by the local authority and matched by the developer but should be used to indicate the levels of financial resources required.
CN5	Number of building users in non-residential building types. See criterion 3	Where the end occupier is unknown, the number of building occupants in an existing development of similar type and size can be used (the assessor needs to justify or validate the number used in their certification report).

Evidence

The evidence needed in regard to each criterion is described as follows:

Table 42 Evidence for the respective criteria

Criteria No.	Final assessment
1	Documentary evidence of consultation
2	Summary of the analysis and written confirmation from the developer
3	Written commitment from the developer
4	A copy of the legal agreement
6	A copy of the maintenance strategy and written confirmation from the developer and local authority

Additional information

Relevant definition

Community focal point

See TM 02 – Safe and appealing streets

Other information

Further information regarding default occupancy rates by building type can be found below:

Table 43 Default occupancy rates by building type

Building type and function area	Occupant density	Building type and function area	Occupant density
Business		**Secure residential institution**	
Office area (including reception areas)	0.111	Cell	0.190
Food preparation area (staffed)	0.108	Reception	0.121
Small workshop/category lab space	0.068	Hall/lecture theatre/assembly area	0.183
Industrial		Eating/drinking area	0.141
Food preparation area	0.213	Workshop - small-scale	0.048
Industrial process area	0.022	Laundry	0.086
Laboratory	0.107	Classroom	0.183
Reception	0.110	Office and consulting areas	0.093
Warehouse storage	0.009	Food preparation area	0.111
Generic Office Area	0.108	**Libraries, museums, galleries**	
Hospitals, care homes		Reception	0.095
Reception	0.152	Food preparation area	0.176
Post-mortem Facility	0.050	Hall/lecture theatre/assembly area	0.150
Food preparation area	0.161	Laboratory	0.098
Physiotherapy Studio	0.200	Workshop - small-scale	0.062
Bedroom Unit	0.105	Display and Public areas	0.150
Laundry	0.117	Generic Office Area	0.099
24-hours consulting/treatment areas	0.000	**General assembly and leisure, clubs, theatres**	

Building type and function area	Occupant density	Building type and function area	Occupant density
Assembly areas/halls	1.000	Dry sports hall	0.047
Hydrotherapy pool hall	0.100	Fitness Studio	0.132
Industrial process area	0.124	Fitness suite/gym	0.170
Laboratory	0.080	Food preparation area	0.131
Operating theatre	0.125	Hall/lecture theatre/assembly area	0.175
Classroom	1.000	Auditoria	0.341
Diagnostic Imaging	0.100	Ice rink	0.225
Generic Ward	0.175	Performance area (stage)	0.049
Office and consulting areas	0.195	Public circulation areas	0.241
Primary healthcare		Reception	0.126
Reception	0.11	Sales area - general	0.102
Office and consulting areas	0.082	Swimming pool	0.163
Further and higher education		Workshop - small-scale	0.067
Residents Bedroom	0.120	Generic Office Area	0.116
Classroom	0.203	Display area	0.001
Food preparation area	0.096	**Community/day centres**	
Hall/lecture theatre/assembly area	0.202	Reception	0.108
Computer laboratory	0.231	Dry sports hall	0.047
Laboratory	0.106	Food preparation area	0.143
Laundry	0.105	Workshop - small scale	0.064
Reception	0.112	Hall/lecture theatre/assembly area	0.169

Building type and function area	Occupant density	Building type and function area	Occupant density
Workshop - small scale	0.068	Office and consulting areas	0.106
Office and consulting areas	0.098	**Other spaces/buildings**	
Hotels		Data Centre	0.096
Bedroom	0.094	Server Room	0.096
Food preparation area	0.108	Heavy Plant Room	0.096
Reception	0.105		
Generic Office Area	0.106		

Notes for Table 43 of default occupancy rates:

1. The net floor area for each function must be multiplied by the equivalent occupant density to determine an overall occupancy for the function area.
2. Not all potential building areas are listed, only those required to reflect estimated building occupancy for the building type. For example, an office building may have a canteen, but it will be the staff that predominantly uses the canteen. The office staff numbers will be estimated using the default occupancy rate for the office area; therefore, including the canteen would double-count occupancy.
3. If a building type is not listed, occupancy rates for a similar building type or function area may be used.
4. The above occupancy rates have been sourced from the activity database of the Simplified Building Energy Model (SBEM).

TM 06 – Public transport facilities

Table 44 Public transport facilities overview

Step	Category	Mandatory standards	No. of credits available
3	Transport and movement	No	2

Aim

To encourage frequent use of public transport throughout the year by providing safe and comfortable transport facilities.

Assessment criteria

The following is required to demonstrate compliance:

One credit

1. Consultation has taken place between the local authority, developer, community representatives and public transport providers to establish the likely facility requirements. As a minimum, the consultation considers the following:
   - occupants and potential visitors and their accessibility needs (the needs of occupants are informed by the demographic profile completed for 'SE 02 – Demographic needs and priorities')
   - expected number of users at each public transport stop
   - existing facilities
   - provision of facilities and amenities.
2. The results of the consultation have been analysed and appropriate facilities are designed to encourage the use of public transport.
3. Shelters will be provided at public transport stops.
4. Shelters will be of adequate size to accommodate potential users of varying ages and disabilities.
5. Shelters within the development will be compliant with items A – H (below).

Two credits

6. Criteria 1 to 5 are achieved.
7. Shelters within the development will be compliant with items I – L (below)

Table 45 Public transport facilities assessment criteria

Item	Description
A	Shelters will be designed and sited to provide protection from weather conditions taking into consideration prevailing wind direction, splashes from passing vehicles and protection from the sun, rain and snow (where applicable).
B	Shelters will provide a safe and comfortable waiting area for users, in particular shelters will be well lit and allow sufficient ventilation to avoid overheating.
C	Shelters will be visible to the surrounding environment and community.
D	Shelters will not obstruct other area users such as pedestrians and cyclists and allow sufficient room for wheelchair users and those with prams/buggies to pass with ease.
E	Shelters will have up-to-date time tabling information prominently on display in the shelter.
F	Shelters will provide sufficient seating for the users of the development for all ages and disabilities, as judged through consultation with service providers and the local authority.

Item	Description
G	Street furniture will not be positioned where boarding/alighting is expected. Street furniture (apart from seating) should not be situated within the waiting area.
H	Secure cycle parking structures are provided near the public transport shelters/facilities to allow for transfer between modes of transport. The number of cycle spaces accommodated should be determined by the likely users identified in the transport assessment.
I	Litter bins will be provided by each shelter, positioned to avoid any interference with the use of the shelter. Regular refuse collection is negotiated with the local authority.
J	Shelters will have real-time timetable information feeds.
K	Where the consultation identifies a significant risk of vandalism, CCTV that covers the shelter and surrounding area should be installed and the shelter should be constructed of vandal resistant materials. Where CCTV is not legally permitted the shelter should be overlooked by surrounding buildings.
L	A renewable energy supply (with a storage capacity to work after dark) will be used to help power the shelters lighting and real-time timetabling displays.

Compliance notes

Table 46 outlines detailed descriptions of respective compliance notes:

Table 46 Public transport facilities compliance notes

Ref	Terms	Description
CN1	Shelter dimensions. See criterion 4	The dimensions for shelters are location specific and should be decided through consultation with representatives of the local authority, who in turn should relate their decision to the size of the development and the expected usage of
CN2	Seating. See item F	Where seats are provided, they should be in bright, “warm” materials with a non-slip surface, which is strong, easy to clean and quick to dry.
CN3	Pavement obstruction. See criterion 4	Public transport shelters should provide minimum obstruction to the pavement and a recommended width of 1.8m should be allowed for passing pedestrians.
CN4	Shelter from the elements/out of the weather. See criterion 5	Protection from precipitation and prevailing winds. Although this is location dependent, and will be judged by local authorities, it is generally expected that this will comprise a roof, and walls on at least three sides.

Evidence

The necessary evidence for the criteria is described as follows:

Table 47 Evidence for the respective criteria

Criteria No.	Final assessment
1	Documentary evidence of consultation
2	Summary of the analysis and design specifications
3, 4, 5 & 7	Design specifications and/or a copy of the masterplan and relevant site plans

Additional information

Public transport facilities, such as bus stop shelters, can be used to generate electricity for real-time bus arrival information through the use of photovoltaic cells. Green roofs can be used to slow surface water run-off and provide habitat to enhance the site's ecological value.

3.4 DENA

In the context of the "Climate-neutral districts and areas" project, climate neutrality means that the districts do not emit any greenhouse gases. The term "climate-neutral districts and areas" is to be understood as a short form for "districts and areas with a climate-neutral energy supply", whereby the climate neutrality goal is considered to have been achieved if the energy supply is made entirely from renewable energies or waste heat. In further descriptions, climate-neutral districts/areas are abbreviated as KNQA.

As shown in this chapter, a clear definition requires the specification of boundary conditions for which minimum and maximum requirements are named. The project investigated to what extent the analysed districts examples fulfil the minimum criteria. It was shown that the data required for this were often not collected or not collected in full, and therefore a corresponding project analysis is difficult to implement. Nevertheless, some examples could be quantitatively evaluated, and the implementation status could be presented in typical KNQAs.

Since the term "climate-neutral district/area" has not yet been officially defined, the boundary conditions must be defined to compare district projects.

Table 48 lists the boundary conditions and their minimum and maximum requirements. Due to the limited data availability, the listed minimum requirements were used favouring the comparability of the investigated district projects.

Table 48 Relevant boundary conditions and their minimum and maximum requirements for the comparative assessment of climate-neutral districts and areas

Dimensions	Minimum requirements	Maximum requirements
Energy consumption sectors covered	Electricity, heat (possibly cooling)	Electricity, heat, cooling, mobility
Spatial delimitation of the energy demand considered	Energy demand that exists within the area of the district/area (territorial principle, for mobility: only the travel distances within the district/area).	Energy demand of the residents and users of the district/area (polluter-pays principle, for mobility: all journeys made by residents and goods used)
Spatial delimitation of the energy production considered	The energy sources to supply the district/area can be located within its area or in a region to be defined around the area.	The district/area covers its energy needs entirely with energy sources located within its territory.
Temporal resolution of the energy balance	The energy demand of a year is covered by the climate-neutral energy production of the year. The energy demand of one year is covered by the climate-neutral energy production of the year ("net zero", temporary import is compensated by export at other times).	The energy demand is covered in every hour of the year by climate-neutral energy production ("gross zero": no import of climate-neutral energy necessary).
Energy sectors covered	Energy demand for the operation of the district/area	Energy demand for the entire life cycle of the buildings and facilities of the district (construction, operation and deconstruction)

Target image of the climate-neutral district/area in the project

In the following, a district or area is considered climate-neutral if:

- its energy supply is entirely from renewable energy or waste heat and at least the minimum requirements from
- Table 48 are met.
- the transformation of the central infrastructures has been included as a development corridor (it must not be assumed today that there will be an energy system without greenhouse gas emissions in the future).
- it contributes to reducing the burden on the overarching energy supply system (system compatibility).

3.5 klimaaktiv

3.5.1 Overview of the criteria for plus-energy

Based on the klima**aktiv** criteria catalogue for settlements and districts (Mair am Tinkhof et al. 2020), the following criteria are used for a plus-energy assessment:

- Category A Management
  - A.4 Install monitoring
- Category C Urban design
  - C.1 Building density
- Category D Buildings
  - D.2 Building standard
- Category E Supply
  - E.1 Degree of self-sufficiency
  - E.2 Quality of energy supply
- Category F Mobility

3.5.2 Criteria for plus-energy

The following criteria and descriptions were taken from the klima**aktiv** criteria catalogue for settlements and districts (Mair am Tinkhof et al. 2020) and from the manual for this criteria catalogue (Mair am Tinkhof, Schuster, and Trebut 2020). Partly, the explanations were taken directly from these documents.

Category A Management - A.4 Install Monitoring

Explanation

Monitoring means to record systematically, measure, observe or supervise a process and therefore forms the basis for project and success control. Successful monitoring is characterized by the fact that the key data of the monitoring concept are known at the earliest possible stage (e.g., objectives, scope, responsibilities). Accordingly, this set of measures asks both whether a monitoring concept exists and whether it has been implemented (Mair am Tinkhof et al. 2020).

Monitoring for districts is not a requirement that must be met to realize a Positive Energy District. However, monitoring should help to regularly check the fulfilment of the set requirements so that a realization of Positive Energy Districts is successful. This is because if individual buildings do not reach the target values, other buildings must compensate for the missing share to achieve a plus-energy balance.

Requirement

Monitoring in districts is divided into the following areas: Tenant and owner surveys, monitoring for operating energy, water consumption, waste quantities, and mobility. Regarding the requirement for plus-energy, the parts for operating energy and mobility are to be installed.

Category C Urban design - C.1 Building density

Explanation

Quality (post-)densification has still unknown positive effects for many people, only non-involved people see green and open spaces, playgrounds and views threatened. Important ecological aspects are more efficient land use, material use and energy use. Further economic and socio-cultural advantages, which are rather unknown but benefit the people, are for example the variety of uses, especially on the ground floor, better organization within the apartments and the urban space.

The quality of life must be increased through building densification, as already realized national and international examples show.

It is evaluated whether and how the project group has dealt with the topic of social and structural density and, of course, the planned number of stores in itself.

Requirement

The requirements for Positive Energy Districts correspond to those of the klima**aktiv** criteria catalogue. It is important to push the building density in areas, therefore, a characteristic value for the number of floor areas should be kept. Therefore, the following requirements must be met:

- Examples of high-quality redensification are known and have been prepared for relevant target groups;
- the floor area ratio was optimized for the present building project in coordination with the local building authority;
- the floor area ratio is >= 0.5.

Category D Buildings - D.2 Building standard

Explanation

The steering group responsible for the respective Positive Energy Districts pursues the goal of realizing the best possible building standard. This extensive task concerns the overall energy requirements for construction, operation and mobility, as well as other aspects of sustainable construction. Proof in this regard must be provided by means of test reports or certificates issued on this basis.

It will be evaluated whether, and in how many cases, building qualities are externally quality-assured by means of building labels.

In principle, the goal is to comply with the klima**aktiv** gold standard in order also to fulfil a plus-energy balance. With a high number of points in the energy and supply section, a very high number of points in the klima**aktiv** criteria catalogue can be achieved.

The requirements apply in particular to buildings with maximum construction class IV. These are, therefore, rather smaller buildings. Due to their lower compactness, these cannot easily reach the 900-point threshold and a klimaaktiv gold standard. For the requirements in the field of energy (heating demand, primary energy demand), compactness does not play a role in the maximum number of

points. Therefore, the requirement level is set lower in order to include buildings with lower compactness in this concept.

Requirement

A plus-energy building should meet the requirements of class Gold of the klima**aktiv** criteria catalogue. To better include fewer compact buildings, the minimum number of points of 65 is required. This corresponds to about 850 points in the klima**aktiv** criteria catalogue.

Category E Supply - E.1 Degree of self-sufficiency

Explanation

By optimizing loads concerning the use of energy-efficient devices and switch-on and switch-off times, as well as through intermediate storage of energy and the inclusion of the immediate environment, the potential of locally available energy sources should be utilized on the one hand and the degree of self-sufficiency maximized on the other. Ideally, the required energy, namely heat and electricity, should come from renewable energy sources on-site and be used.

The share of heat, general electricity and user electricity from on-site renewable energy sources is evaluated.

Requirement

This is the key point in plus-energy balancing. The total amount of energy required for the Positive Energy District is to be produced on-site or, in the case of local heat or waste heat, adjacent to the site (see E.2).

Category E Supply - E.2 Quality of energy supply

Explanation

Energy required from outside the district should come from renewable energy sources if possible, so that energy that cannot be provided on-site from renewable energy sources is also sustainable. It must be possible to prove this by means of certificates.

The share of heat, general electricity and user electricity from on-site and off-site renewable energy sources is evaluated, including consideration of surcharge points for biomass from the region, electricity (including for heat pumps) from photovoltaic systems or from certified sustainable "green electricity".

Requirement

This is the pivotal point in the plus-energy balancing. The total amount of energy required for the Positive Energy District is to be produced on the site or, in the case of local heating or waste heat, adjacent to the site (See E.2).

Category F Mobility

Explanation

In the area of mobility, the multiple practical options and all criteria in the catalogue are to be used. The steering group is asked to promote bicycle as well as pedestrian traffic and the use of public transport on the one hand by minimizing the number of parking spaces for cars and on the other hand by establishing a sufficient number of bicycle parking spaces in optimal locations.

The evaluation is based on the three categories "Motorized private transport", "Walking and cycling" and "Public transport and alternative services".

Requirement

High demands are placed on the three criteria mentioned. The use of alternative forms of mobility reduces the amount of energy used in the area. The use of electric vehicles reduces CO_2 emissions. The minimum requirement for all three criteria is 180 points.

3.6 Future District

Goals and framework conditions for the "Future District" project

The aim of the system boundaries, indicators and their target values presented here is to be able to make a statement about the district's contribution to meeting the goal of an emission-free building sector in 2050. The system boundary definition aims to make urban districts' sustainability and climate compatibility in particular and building projects in general assessable. It draws on known plus-energy standards for buildings and districts and takes the following three key steps further to make the definition practical:

- Consideration of the necessary self-sufficiency of the building sector of a renewable Austrian energy system 2050 in the PE balance (Primary energy balance) of districts.
- PE-target values are not in principle greater than zero, but depend on the building density of the district
- Primary energy consideration of grid efficiency and peak shaving

The central motivation behind the analysis and definition of system boundaries in the Future District project was to make them applicable, interpretable, and comparable with less dense development, even for the very dense urban context. An attempt was made to establish a relationship between building density and energy and environmental target values that consider economic viability for the individual building project and the national economy as a whole. In this sense, fairness was the focus of consideration - in that every building in Austria, whether new construction or renovation, must contribute an equal share to achieving our 2050 climate and energy targets, measured against its potential. Thus, we refrained from definitions that would imply additional land consumption beyond the geographic district boundary (for example, off-site wind or PV plants on greenfield sites) and thus distort the assessment basis of land consumption. Another basic premise is.

"Equal land area must provide equal benefits".

Therefore, the Future District project tried to derive how different land outputs can be made comparable with each other in terms of energy using the usable area created. Briefly summarized: A district that creates less usable space per lot must provide more renewable energy in return. This leads to a move away from globally fixed target values to target values dependent on the area efficiency of a building and the Austria-wide supply by means of large-scale renewable power plants and the ability for energy flexibility through demand-side management.

Analyses and system boundaries are limited to Austria in this project, an application to other geographic complexes, or to supranational entities such as the European Union or UCTE is possible, but also changes the framework of the sub-entities.

System boundaries and indicators (overview)

The following is a brief summary of the definition of a Future District. If everyday fossil mobility is to be considered, the system boundary ZQ PEBm (Future District Primary Energy Demand including Mobility) is used. Otherwise, the system boundary ZQ PEB (Future District Primary Energy Demand) is used, in which only e-car sharing mobility is considered. Figure 1 shows the system boundaries, the energy services included, and the energy supply.

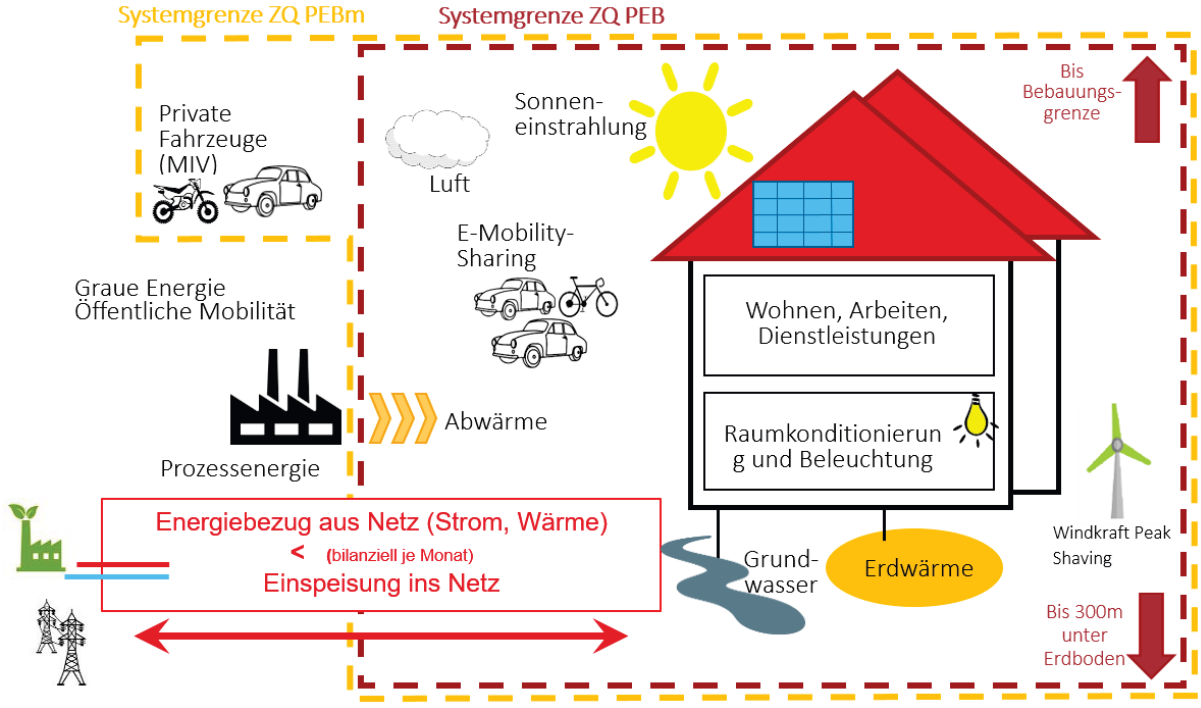

Figure 1: Future District system boundary ZQ PEBm with everyday mobility (orange) and ZQ PEB without everyday mobility (red) (Source: Zukunftsquartier).

The system boundaries of the Future District project are as shown in Table 49. A target value is pursued for the indicator total primary energy balance, but this depends on whether motorized private transport (MIV) or its reduction is also considered in the district concept and in the primary energy balance. If the MIV is included in the balance, the target value ZQ PEBm is to be used, if the balance is kept without consideration of the MIV, the target value ZQ PEB is to be used.

Table 49 System boundary definition Future District

Consideration	
Spatial balance boundary	Property or district boundary
Temporal balance boundary	Annual balance
Simulation period	Hourly
Life cycle phases	Energy consumption during operation

Energy services	Building operation Electricity demand of use
Reference value	Gross floor area (GFA)
Indicators	Total primary energy balance [kWh/m²a] Greenhouse gas emissions [kg/m²a] Life cycle differential costs [€/m²30a]
Target value ZQ PEB (without MIV)	$PE-Bilanz > 1{,}63\left(\frac{37}{GFZ+0{,}085}+9{,}2\right)-65{,}2\ \left[\frac{kWh}{m^2_{BGF}\,a}\right]$
Target value ZQ PEBm (incl. MIV)	$PE-Bilanz+1080\frac{kWh}{Pers}*Personen\ im\ Quartier > 1{,}63\left(\frac{37}{GFZ+0{,}085}+9{,}2\right)-65{,}2\ \left[\frac{kWh}{m^2_{BGF}\,a}\right]$

System boundaries and indicators in detail

The components of the system boundary definition are described in detail below.

Considered life cycle phases

ÖNORM EN 15804 divides the life cycle of buildings into the manufacturing, construction, utilization, and disposal phases, subdivided into further sub-phases. In the Future District project context, only phase B6 "Energy consumption during operation" is considered, as shown in Table 50.

Table 50 Life cycle phases of a building or group of buildings according to ÖNORM EN 15804

Life cycle phase	Designation		Consideration
Production phase	A1	Raw material procurement	
	A2	Transport	
	A3	Production	
Construction phase	A4	Transport	
	A5	Construction / Installation	
Use phase	B1	Use	
	B2	Maintenance	
	B3	Repair	
	B4	Replacement	

	B5	Modernisation	
	B6	**Energy consumption during operation**	**X**
	B7	Water consumption during operation	
Disposal phase	C1	Deconstruction / Demolition	
	C2	Transport	
	C3	Waste treatment	
	C4	Removal	
Credits and debits	D	Reuse, recovery, recycling potential	

Energy services considered

In a Future District, all energy services required for the district's daily operation are accounted for. Apart from energy for heating, cooling, ventilation and air-conditioning, dehumidification, and auxiliary and operating electricity, this also includes the energy requirements of all uses except process energy that can be allocated to production processes. Consideration of energy for everyday mobility is optional. This results in two different target values for the PEB (Primary Energy Demand). The following energy services are considered within the Future District system boundary:

Table 51 Energy services considered

Energy services		ZQ PEB (without everyday mobility)	ZQ PEBm (incl. everyday mobility)	Determination
Building operation	Heating demand	**x**	**x**	By means of dynamic building simulation methods or steady-state monthly methods according to ÖN B 8110-6 (2014)
	Cooling demand	**x**	**x**	
	Humidification/ dehumidification requirement	**x**	**x**	
	Ventilation	**x**	**x**	
	Auxiliary current of the HT system	**x**	**x**	
	General electricity & lift	**x**	**x**	

Energy services		ZQ PEB (without everyday mobility)	ZQ PEBm (incl. everyday mobility)	Determination
	Lighting	**x**	**x**	
Use	Process heat			
	Process cooling			
	Electricity demand for production processes			
	Electricity demand for general use (incl. services)	**x**	**x**	Hourly demand profiles
Mobility	MIV Source traffic electric		**x**	
	MIV Destination traffic electric		**x**	
	MIV Source traffic fossil		**x**	
	MIV destination traffic fossil		**x**	
	Public transport source traffic			
	ÖV destination traffic			
	Other mobility			

To cover the above energy services, the following energy sources are included in the Future District methodology with the specified primary energy conversion factors:

Table 52 Energy sources inside and outside the Future District system boundary

Energy sources	System boundary	Use	PE conversion factor in balancing
Environmental energy			
Air	Within up to the development boundary	Own cover, DSM	**0**
Geothermal energy			**0**
Groundwater			**0**
Waste heat			
Waste heat			
From process energy	Inside	Own cover, DSM	**0**
From wastewater			
Renewable generation			
Electricity from PV On-site	Inside	Own cover, DSM	0
Electricity from PV On-site	Inside	Grid feed-in	- f_{PE} electricity monthly according to OIB RL6 (draft 2018)
External energy sources			
Mains current	Outside	Own cover	+ f_{PE} electricity monthly according to OIB RL6 (draft 2018)
Electricity from off-site peak shaving (wind power surpluses)	Outside	Own Cover, DSM	0
Other	Outside	Own cover	Conversion factors according to OIB RL6 2019

Considered balance limits

Balance limit temporal: annual balance
Reason: Seasonal storage of renewable energy cannot and (especially in an urban context) should not be managed by buildings and districts alone, therefore a balance at any point in time is refrained from. On the other hand, the calculation is carried out in hourly steps or resolved higher in time.

Balance boundary spatially: property boundary, -300 m downward, and development boundary upward
Reason: Otherwise, the area efficiency cannot be considered. Crediting of regionally renewable energy is only permissible if it would otherwise not have been physically generated - i.e., it is additionally absorbed energy, as in the case of wind power peak shaving.

Indicators and target values used

For the system and balance boundary described above, the indicators shown in Table 53 are used, whereby only for the primary energy demand a target value, or more precisely a target function depending on the number of floor areas, is defined. The definition of a target value for the indicator GHG-e is in principle conceivable in analogy to the methodology for the total primary energy demand but was not conducted in the context of the exploratory project due to the insufficient data situation. In contrast to other approaches mentioned in the literature, the final energy demand does not appear as an indicator in the Future District model. The final energy balance allows a statement about the achievable degree of self-sufficiency of the district, but not about the value of the energy used and its efficient use in the national energy system.

Table 53 Indicators of the Future District method

	Indicator		Description	Target value
PEB ges.	$\frac{kWh}{m^2_{BGF}\,a}$	Total primary energy demand		PEB (Floor area ratio)
GHG-e	$\frac{kg\ CO_2äquiv.}{m^2_{BGF}\,a}$	Greenhouse gas emissions		
LCC	$\frac{€}{m^2_{BGF}\,a}$	Life cycle costs	Additional costs compared to minimum requirements of the building code over 30 years	

The target value of the primary energy demand is divided in the Future District method between the district without and with consideration of everyday mobility:

Table 54 Target value of the indicator Total Primary Energy

System boundary	Indicator	Credit	Target value
ZQ PEB (excl. everyday mobility)	PEB ges.		$> 1{,}63\left(\frac{37}{GFZ + 0{,}085} + 9{,}2\right) - 65{,}2 \quad \left[\frac{kWh}{m^2_{BGF}\,a}\right]$
ZQ PEBm (incl. everyday mobility)	PEB ges.	+ EE-credit	

3.7 VTT

A Positive Energy District generates more renewable energy than it consumes on a yearly basis (Laitinen and Lindholm 2020),('MakingCity' 2022). This is achieved by integrating renewable energy systems and energy storage and improving the district's energy efficiency by optimizing the energy flows between the energy consumers, producers and storage. As a part of the European Strategic Energy Technology Plan (SET Plan), PEDs are considered a building block for reducing cities' carbon emissions. Three frameworks were developed in a PED definition workshop organized by the European Energy Research Alliance (EERA) Joint Programme Smart Cities (Wyckmans et al. 2019):

- PED autonomous—a district with clear geographical boundaries that is completely self-sufficient energy-wise, meaning that the energy demand is covered by internally generated renewable energy. The district is thus not allowed to import any energy from the external electricity grid or district heating/gas network. The export of excess renewable energy is, however, allowed.
- PED dynamic—a district with clear geographical boundaries with an annual onsite renewable energy generation higher than its annual energy demand. The district can openly interact with other PEDs as well as the external electricity grid and district heating/gas network.
- PED virtual—a district that allows the implementation of virtual renewable energy systems and energy storage outside its geographical boundaries. However, the combined annual energy generation of the virtual renewable energy systems and the on-site renewable energy systems must be greater than the annual energy demand of the district.

Figures 2–4 show examples of how the three different PEDs could look. PED autonomous and PED dynamic are both constrained by geographical boundaries. PED autonomous is a completely self-sufficient energy system, which means that the energy demand is covered by internally generated renewable energy. PED dynamic allows the energy system to import externally generated energy, as long as the annual energy balance is positive. This means that PED dynamic must export more energy than it imports, on a yearly basis.

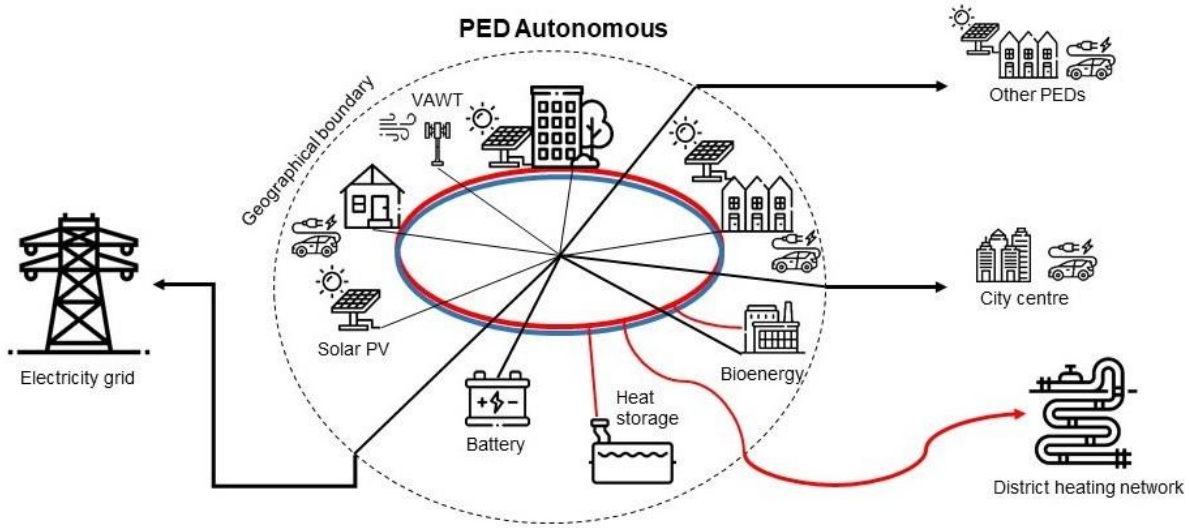

Figure 2: Graphical explanation of a PED autonomous. The PED autonomous is completely self-sufficient, which means that it covers the on-site energy demand with on-site renewable energy generation. It is, however, possible for the PED autonomous to export excess energy to other PEDs as well as the external electricity grid and district heating network. VAWT stands for vertical axis wind turbine.

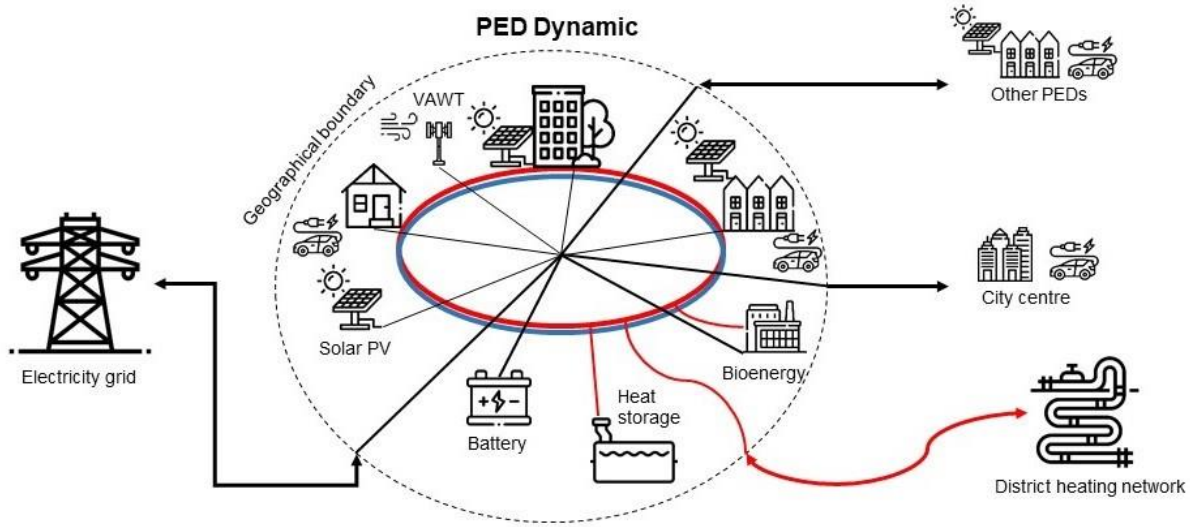

Figure 3: Graphical explanation of a PED dynamic. PED dynamic bidirectional energy trading with other PEDs and the external electricity grid and district heating network. VAWT stands for vertical axis wind turbine.

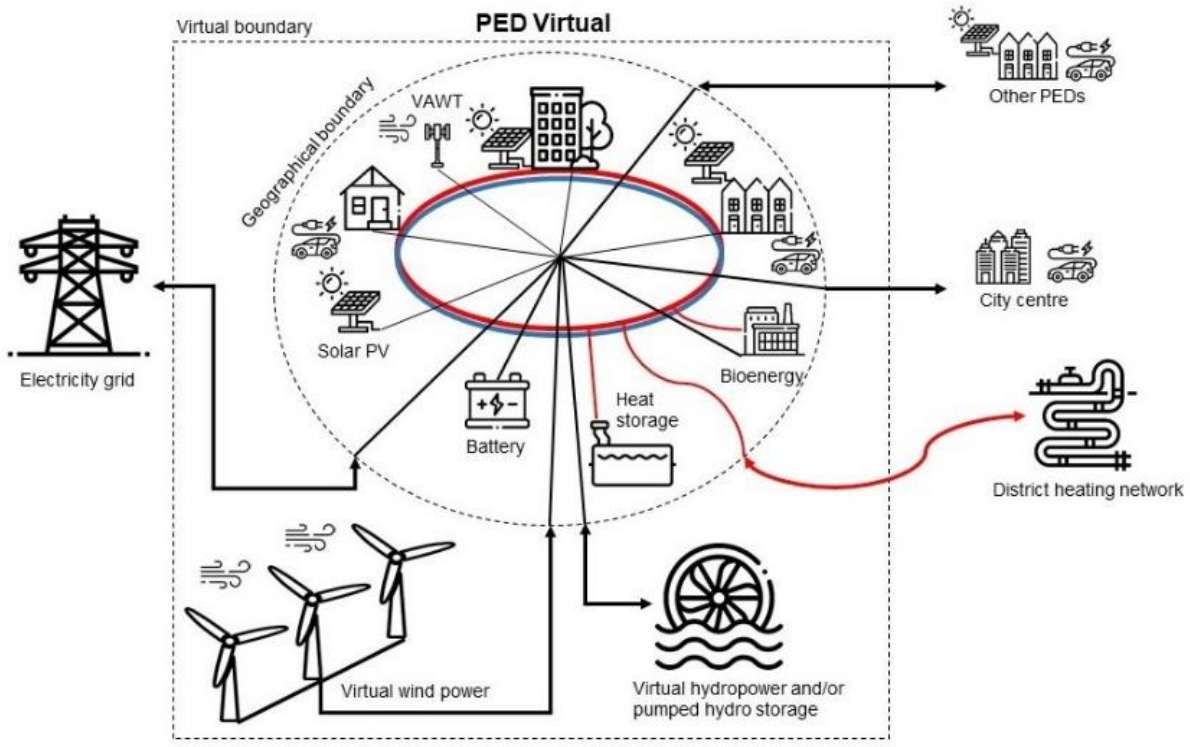

Figure 4: Graphical explanation of a PED virtual. PED virtual allows virtual renewable energy generation and energy storage operation outside the district's geographical boundaries. VAWT stands for vertical axis wind turbine.

The third definition, PED virtual, operates within virtual boundaries, which means that the energy system can operate outside the district's geographical boundaries and consequently utilize renewable energy sources or energy storage to greater extents. However, the part of the energy system that operates outside the district's borders must be an asset of the district to be classified as a PED virtual.

In European cities, transportation is one of the greatest polluters. Today, the transport and mobility sector contributes to 27% of the emissions in Europe ('Greenhouse Gas Emissions from Transport in Europe' n.d.). As emission reduction is one of the key objectives of PEDs, the use of electric vehicles (EVs) and other emission-free alternatives for transport and mobility in urban areas should be fostered.

At the moment, it is expected that by the year 2030, EV usage will increase to 44 million cars globally ('Global EV Outlook 2019' 2019). Many cities are thus already including the electrification of mobility in their city plans ('Kaupunkisuunnitteluviraston Esitteet' n.d.). Hence, all of the above-mentioned PED definitions should account for an increasing EV charging capacity and support for other emission-free transport and mobility.

3.8 JPI Draft: Proposal for an elaborated framework definition

This chapter is based on a draft document developed during the JPI Urban Europe initiative together with representatives of the first call of projects ('JPI Urban Europe' 2021b) and other European initiatives and projects in the field of Positive Energy Districts. This document has not been published so far. Parts of this definition are presented in ('Cities4PEDs' 2021).

A PED framework definition targets complex urban realities. Therefore, pinning down strict operational criteria for urban districts that fulfil a wide range of functions, while at the same time being deeply intertwined with their surrounding environment, is a daunting task.

In this context, a PED framework definition shall be sufficiently simple and unequivocal, yet flexible enough to accommodate for the varying contexts in which it will have to be applied.

In the proposed framework definition, this challenge is addressed by identifying quantitative versus qualitative criteria, mandatory versus optional requirements, and context factors to be taken into account for a given location. Criteria are result-oriented rather than means-oriented to allow for creative and technologically innovative responses to the PED requirements.

The different dimensions of the term 'positive' as an intrinsic attractor

From a narrowly quantitative viewpoint, the qualification 'positive' refers to the surplus production of sustainable, carbon-free energy attached to the urban district under scrutiny. On this level, it is possible and useful to ask what is "sufficiently positive" in a given municipal/regional/national context.

However, the term also refers to 'positive impacts' in a wider sense. Not only do PEDs positively support the wider energy system through their energy efficiency, production and flexibility functions [4,5]. The positive character also extends to the realm of the integrated sustainability they are expected to realize. In fact, the initiators of the term 'positive energy district' had in mind the multiple connotations it can harbour [6], and that idea has persisted throughout the PED definition development process.

Harnessing the complexity through impact categories and context factors

Starting from the current PED definition, one can identify a series of requirements to be fulfilled, varying in character from quantitative to qualitative.

The two main quantitative requirements, implying a mandatory character, are (1) the net-zero greenhouse gas emissions and (2) the annual local or regional surplus production of renewable energy.

Additional quantitative criteria to accomplish more generalized environmental sustainability can be regarded as desirable yet optional. These may first of all relate to material cycles and realizing the circular economy in particular. In a similar vein, economic sustainability can be quantitatively assessed

[4] The triple energy-related functions efficiency, production and flexibility have been adopted as main functional pillars in the JPI UE framework development, see the corresponding White Paper of 2020 - PED Framework version 2.0 (after national consultations), available at https://jpi-urbaneurope.eu/wp-content/uploads/2020/04/White-Paper-PED-Framework-Definition-2020323-final.pdf

[5] This is also reflected in an approach the COST Action PED-EU-NET has promoted (Gerhard Stryi-Hipp and Vicky Albert-Seifried, 2021)

[6] In 2015, as an outcome of the European project demonstrator Hikari at the Confluence district in Lyon (FR), the idea of a Positive Energy Block (PEB) was presented by Paul Cartuyvels (ECTP) for uptake in a new EIP SCC Marketplace Action Cluster initiative on PEBs. Subsequently the concept was promoted through the EIP SCC Marketplace as a way forward in scaling up zero or positive energy concepts from the building level to groups of buildings and, eventually, districts. In a next phase, and on the initiative of the programme responsible Jens Bartholmes (European Commission), the requirement to realise PEBs, and later on PEDs, was formally integrated into the EU Horizon 2020 Smart Cities and Communities Lighthouse Project Calls.

by inquiring, for example, the number of jobs created or the total cost of ownership for society. The proposed framework oversees these additional quantitative criteria as optional since the PED definition does not set specific standards for them.

The definition refers to three energy functions: efficiency, production and flexibility, but equally sets no standards for these. Therefore, they are adopted as qualitative criteria: one must consider all of these functions to ensure that a PED has optimally addressed the possibilities they offer. These functions shall also be mutually integrated, both within the district and within the wider urban or regional energy system in order to support the latter, implying the district will actively exchange energy streams with its hinterland [7].

Next come qualitative criteria that assure a good life for all. Apart from fulfilling quantifiable environmental, infrastructural and economical parameters, this good life will be assured by a range of stated qualities in the social, economic, cultural and governance domain. Here a knowledge theory, multimodal system analysis [8], is used to structure these qualitative requirements into a series of interlinked yet autonomous aspects of integrated sustainability, as referred to in the definition: … *in line with social, economic and environmental sustainability* [9].

The use of an extended methodological framework for qualitative assessments also allows better to connect PEDs to the New European Bauhaus initiative to create climate-neutral futures that are inclusive, sustainable and beautiful [10,11]. In particular, the multimodal system framework integrates good design (or beauty) into a logical sequence of interlinked aspects that contribute to overall quality.

An inherent tension between urban density and energy production requirements

When one considers the practical implications of applying the PED definition concept, an inherent tension between urban density and energy production requirements becomes clear. Low-density developments indeed allow for much more renewable energy production per building unit compared to high-density urban districts, while from the viewpoint of integrated sustainability, higher density urban textures provide clear benefits over their low-density counterparts. In many existing urban districts, reaching a net yearly positive energy balance will even not be feasible, economically or otherwise. But because such potentially sustainable urban districts should not be penalized for their dense set-up, a compensation mechanism could be thought of. In fact, the PED definition already hints

[7] This is thus also a main qualitative requirement in the COST Action PED-EU-NET framework proposal (Gerhard Stryi-Hipp and Vicky Albert-Seifried, 2021), stating the aspects energy efficiency, production, flexibility and the proper embedding in (or positive contribution to the balancing of) the wider, regional energy system. Reversely, this may also imply sustainable energy imports into the district.

[8] As e.g. brought forward in Lombardi, P., Brandon, P. (2007), The Multimodal System Approach to Sustainability Planning Evaluation, in: Deakin, M., Mitchell, G., Nijkamp, P., Vreeker, R. (Eds.), Sustainable Urban Development Volume 2: The Environmental Assessment Methods, Routledge.

[9] It can be argued that the qualification social, economic and environmental sustainability is in itself a partial, aspectual approach of sustainability and that a wider frame of reference is more instrumental in underpinning sustainability claims. See Vandevyvere, H. (2011), How to cut across the catch-all? A philosophical-cultural framework for assessing sustainability, International Journal of Innovation and Sustainable Development, Vol. 5, No. 4, p. 403-424.

[10] New European Bauhaus initiative, https://europa.eu/new-european-bauhaus/index_en

[11] As the European Commission is launching the New European Bauhaus to be a driver for all Missions and the Green Deal, it makes sense to (qualitatively) absorb its requirements in the EU PED framework definition.

to such approach while stating the annual local or regional surplus production of renewable energy, leaving space to harvest the energy from other areas than within the strict geographical limits of the urban district itself.

This leads to the use of context factors as a complement to quantitative and qualitative criteria.

In the case of urban density, the context factor will appropriately compensate for the situation where it is not reasonably possible or effective to satisfy the total yearly energy demand by onsite production, and allow for a certain share of that energy to be imported from outside the district. In other words, this means that a form of effort sharing is installed between the district (with limited RES potential) and its hinterland (with more ample RES potential).

Context factors

Context factors not only facilitate a fair handling of high-density urban areas, but equally account of other boundary conditions such as heritage value (implying buildings cannot be retrofitted to high energy efficiency standards), the local geography and climate or the specific situation of the district within its urban and national energy system context.

Context factors will thus functionally link to varying scale levels, ranging from the district scale over the urban, regional and national context, up to the EU level. They will provide a flexible framework, addressing different adjustment requirements of PEDs in different countries and contexts and thus aim at developing a measurable scheme for allocation of national/regional potential of renewable energy to local PEDs.

Context factors are typically proposed and developed by “front-runner” district projects, but it both an opportunity and responsibility of municipal, regional and national authorities to select the context factors appropriate for their respective climate goals and ensure appropriate calibration and scientific validation, while maintaining some form of comparability and uniformity on EU level.

PEDs and urban mobility

Although the PED definition instructs to consider the mobility system with its own share of energy needs, it does not set criteria for how much of its users’ mobility energy shall be produced by the PED. This gives an incentive to base the requirements for mobility energy on context factors as well [12].

Summary of PED framework strategy

The integration of the previously discussed building blocks into the PED framework definition can be summarized in a graphical scheme as follows:

[12] I.e. Mobility energy or emissions can be required to be included in the district energy balance on national, regional or municipal level with the appropriate target of mobility energy or emission budgets exists and can be included as a positive credit, being a normative context factor.

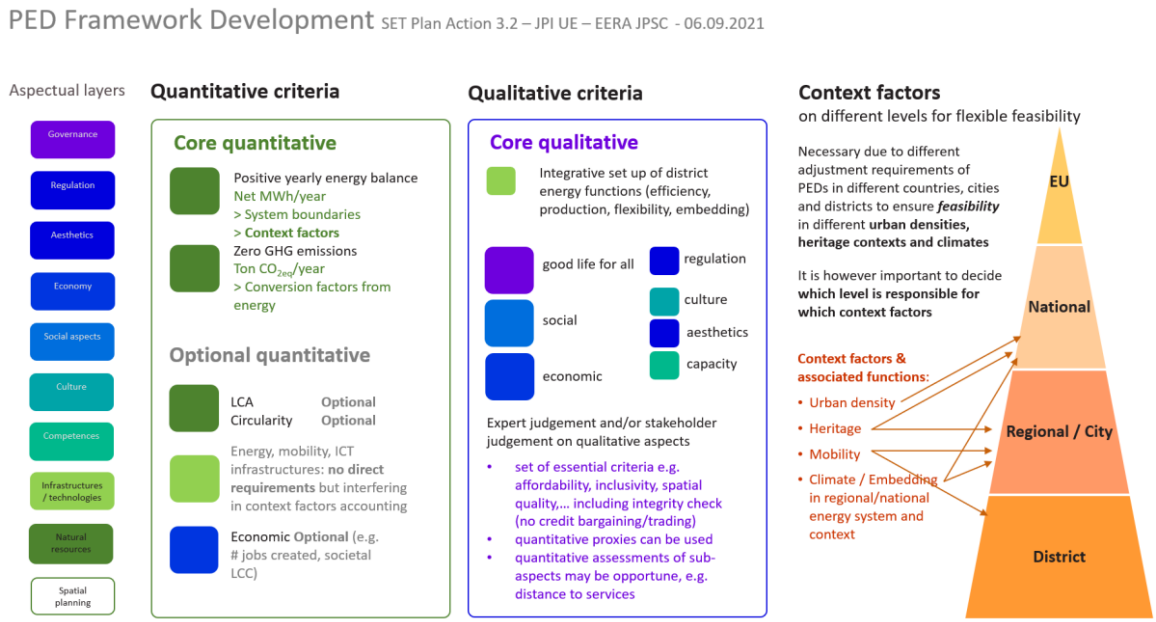

Figure 5: PED Framework Development Working proposal by Han Vandevyvere, Simon Schneider, Dirk Ahlers, Shima Goudarzi, Annemie Wyckmans - 07.07.2021, including contributions by Vicky Albert-Seifried, Gerhard Stryi-Hipp and the virtual board. Further updated 03.0

In what follows, specific criteria and context factors receive further methodological underpinning.

Energy and carbon accounting: methodological challenges and proposed solutions

Note: elaborate definitions of (sets of) indicators and context factors shall be reserved for annexes to the paper.

Yearly energy balance

The quantitative formula for calculating the district's energy balance on a yearly basis can be expressed as:

[Onsite Renewable Energy Generation] + [Climate-Neutral Energy Import] – [Energy Export]

= [District Energy Consumption]

Quantities are to be expressed as primary energy. Current and future primary energy and carbon emission conversion factors on an hourly basis (instead of annual constants) can best be used to assess this balance. In this case, the quantification of demand-side management and flexibility measures can be combined with the onsite RES and efficiency measures into a single metric.

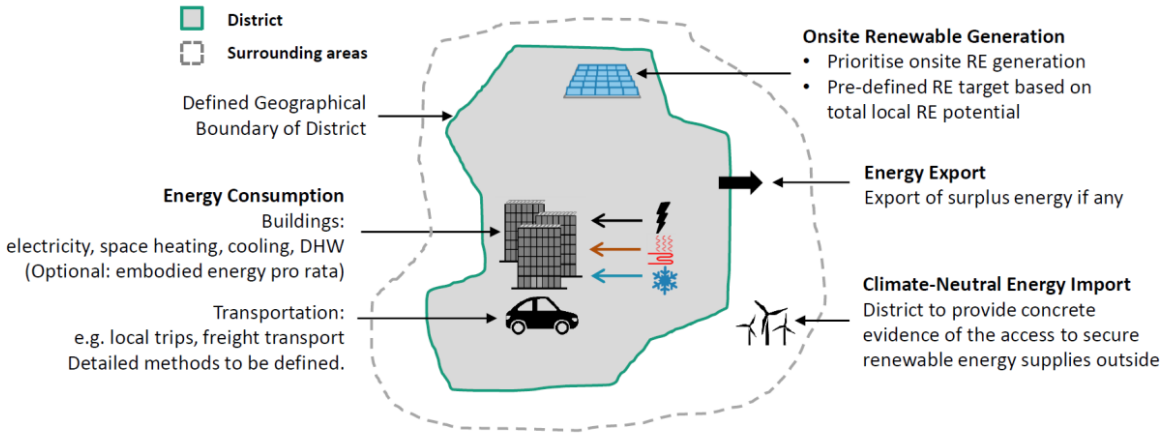

Figure 6: Schematic representation of the PED energy balance (graphic prepared by Gerhard Stryi-Hipp and Vicky Albert-Seifried, Fraunhofer ISE, 2021)

A context factor will be needed to define the amount of transport energy that needs to be provided by the district.

Carbon emissions

Preferably, carbon emission conversion factors applied to energy quantities shall be hourly-based rather than yearly based because of the dynamic exchanges of the PED with its hinterland and the varying carbon intensity of the electricity or heating/cooling grids over time.

4 Rating systems

Ratings systems are used to prepare the evaluation of criteria and framework conditions of products in a straightforward way for non-experts. In the field of energy, for example, there is the energy label for products, which allows a simple classification of products regarding their energy efficiency (e.g. class A to G) and to compare energy performance for the same product of the different manufacturers.

This section presents some examples of Rating Systems of buildings and neighbourhoods. They should serve as a basis for a possible evaluation of Positive Energy Districts.

4.1 Examples of Energy Performance Certificate

The Energy Performance of Buildings Directive (EPBD), which specifies energy performance certificates for buildings, has been in force for more than 15 years. The EPBD specifies the content of energy performance certificates. There is no specification about the design and layout of the energy certificate. Many energy performance certificates have been developed at the national and regional levels in recent years.

The main common feature of the energy performance certificates is the energy efficiency classes. These describe the energy performance of the building for one or more indicators. In most countries, this classification is from A to G using a grading chart (see examples in Figure 7)

Figure 7: Examples of Energy Performance Certificates (Source: Volt et al. 2020)

4.2 Examples Sustainability Certificates

Sustainability certificates also have classifications of the results. However, these are different in the different rating systems. Below are the examples of the sustainability certificates that have already been covered in the previous sections:

BREEAM

The BREEAM rating benchmark levels (see Fig) are defined in the following levels: outstanding, excellent, particularly good, good, pass and unclassified. The entire range of the possible number of points for the evaluation of a quarter is presented. Already from 30% degree of fulfilment, there is a positive classification.

BREEAM Rating	% score
OUTSTANDING	≥ 85
EXCELLENT	≥ 70
VERY GOOD	≥ 55
GOOD	≥ 45
PASS	≥ 30
UNCLASSIFIED	< 30

Figure 8: Rating System in BREAAM ('BREEAM Communities Technical Manual' 2017)

DGNB

In DGNB, the system of rating the quarters is similar to BREAAM. Here, the degree of fulfilment of the requirements is also covered. From an overall degree of fulfilment of 35%, there is a positive rating. The categories here are graded in platinum, gold, silver and bronze.

	DGNB PLATIN	DGNB GOLD	DGNB SILBER	DGNB BRONZE*
Gesamterfüllungsgrad	ab 80%	ab 65%	ab 50%	ab 35%
Mindesterfüllungsgrad	65%	50%	35%	— %

Figure 9: Rating System in DGBN ('DGNB SYSTEM KRITERIENKATALOG QUARTIERE' 2020)

klimaaktiv

In the Austrian sustainability certificate klimaaktiv, the fulfilment of the requirement is defined differently. On the one hand, there are individual criteria that are mandatory to implement. If these criteria are not met, then there is no certificate. If these criteria are met, the quality level bronze is reached.

If 75% of the maximum number of points of 1000 are reached, the quality level silver is reached. From 90% the quality level Gold is reached.

5 Proposal for Criteria to define Positive Energy Districts

In this section, individual aspects of a plus-energy definition are determined separately and summarised in conclusion. This provides a good overview of the limits of the definition.

5.1 PED core objective

Options and choice of setting

The options with regard to the selection of the objective(s) are outlined below:

Table 55 Selection options objective

Objective	Option 1	Option 2	Option 3
Plus-energy balance	•		•
Plus-emissions balance		•	•

Explanations

This determination is made with the district developer or the municipality. This concerns the objectives of the site development in terms of sustainability, energy use or climate impact. Depending on the priorities set, the objectives can be based solely on the energy balance, only on the emissions balance, or on both.

5.2 General indicators

Options and choice of setting

As shown in Table 56 there are various indicators to choose from in relation to Positive Energy Districts:

Table 56 Selection options indicator

Indicators	Options for the choice
Final energy	Option 1
Primary energy renewable	Option 2
Primary energy non-renewable	Option 3
Total primary energy	Option 4
GHG emissions	Option 5

Explanations

In many literature sources on the topic of Positive Energy Districts (e.g. (Schneider et al. 2019; European Commission. Joint Research Centre. 2020; Kourtzanidis et al. 2020; 'MakingCity' 2022), the indicator for the achievement of the target is the total primary energy demand. Internationally, however, carbon-neutral areas and cities are already being discussed. Here, the GHG emissions is usually used as an indicator. In areas where there is only one form of energy for supply (mainly electricity), the assessment can also be based on final energy.

5.3 Accounting Period

Options and choice of setting

It is also necessary to define the accounting period for which the specified target should be reached. The different options are shown in the following table:

Table 57 Selection options balance sheet period

Period accounting	Period under consideration/ temporal balance limit	Choice options
Life cycle	1 Year	Option 1
Annual	1 Year	Option 2
Monthly	1 Year	Option 3
Daily	1 Year	Option 4
Hourly	1 Year	Option 5
Immediate	1 Year	Option 6

Explanations

The accounting period defines the period for which the target is to be met. For example: With the objective "positive energy balance", a surplus of energy is to be provided in the accounting period "annually" over this period. This therefore does not take into account the seasonal imbalance, so that in summer there tends to be more energy in stock and in winter there tends to be an undersupply.

The shorter this period is, the more the balancing comes into the range of an "energy self-sufficient" district. In the "immediate" period, there must be a positive energy balance all the time. This condition corresponds to an energy self-sufficient district.

Monthly balancing cannot represent energy self-sufficient operation, but it can take better account of the seasonal imbalance.

5.4 Spatial Boundaries

Options and choice of setting

There are diverse options regarding spatial delimitation, which are outlined as follows:

Table 58 Selection options spatial delimitation

Spatial delimitation	Choice
Development area of the building (e.g., PV on the roof)	●
Property of the building (e.g., PV on the property)	●
Property with energy resources from outside the property (e.g., biomass boiler)	●
Energy production outside the property, with direct supply (e.g., district heating)	●
Energy supply outside the property with exclusive use of surplus electricity for the use of flexibility in the district (e.g., wind energy).	Choice
Energy supply outside the property (e.g., green electricity)	Choice

Explanation

The spatial delimitation runs according to the definition of zero-energy buildings in (Knotzer et al. 2014). Starting with the building's built-up area, as well as the property of the building. Further boundaries are set for the supply with energy resources from outside the property as well as outside the property with direct supply. The last demarcation is the energy supply outside the property with renewable energy sources. This type of delimitation can also be used for neighbourhoods.

5.5 Energy Uses Boundaries

Options and choice of setting

The different options in relation to energy uses are listed in Table 59:

Table 59 Selection options energy uses

Category	Sector	Energy use	Minimum	Optimum
Operating energy	Building operation	Heating	●	●
		Cooling	●	●
		De-/Humidification	●	●
		Auxiliary energy	●	●
		Lighting	●	●
	User electricity	Household electricity	●	●
		Operating electricity	●	●
	Process energy	Process heating		●
		Process cooling		●
		Process current		●
	District	Lighting	●	●
		Supply	●	●
		Disposal	●	●
Embedded energy	Production	Raw material procurement		●
		Transport		●
		Production		●
	Construction	Transport		●
		Construction / Installation		●
	Use	Use		●
		Maintenance		●

		Repair		●
		Replacement		●
		Modernisation		●
	Disposal	Deconstruction / demolition		●
		Transport		●
		Waste treatment		●
		Removal		●
Mobility	Passenger mobility	Public Transport		●
		Sharing Mobility		●
		Motorised private transport	●	●
	Transport of goods	Transport of goods		●

Option 2 for embedded energy

Usually, the information about the materials, transport and installation in a building cannot be collected in detail. Instead, information about the entire product life cycle must be collected so that it can also be assessed in terms of energy expenditure.

Therefore, this section can also be divided differently: namely in the scope of the embedded energy components assessed. The following system boundaries are defined according to 'OI3-Berechnungsleitfaden V4.0' 2018:

- System Boundary 0 (BG0): constructions of the thermal building envelope; excl. roofing, damp proofing, ventilated façades; incl. intermediate ceilings.
- System Boundary 1 (BG1): constructions of the thermal building envelope (constructions complete) incl. intermediate ceilings
- System Boundary 2 (BG2): BG1 incl. interior walls (separating components, excl. door elements)
- System Boundary 3 (BG3): BG2 incl. internal walls (complete, excl. door elements), basement components (incl. basement partition walls, strip or point foundations), unheated buffer rooms (complete building structure); excl. open-access areas (staircases, arcades, loggias, balconies, etc.)
- System Boundary 4 (BG4): BG3 incl. open development areas
- System Boundary 5 (BG5): BG4 incl. building services

→ System Boundary 6 (BG6): BG5 incl. entire outdoor facilities (carport, bicycle parking, etc.), outbuildings

These system boundaries can be described as follows:

Table 60 Selection options embedded energy

Category	System boundary	Description	Minimum	Optimum
Embedded energy	BG0	Thermal building envelope		●
	BG1	Complete thermal building envelope		●
	BG2	BG1 incl. internal walls		●
	BG3	BG2 incl. internal walls, basement components, unheated buffer rooms		●
	BG4	BG3 incl. open development areas		●
	BG5	BG4 incl. building services		●
	BG6	BG5 incl. entire outdoor facilities		●

Explanation

The breakdown of energy is based on the 'EPBD' 2018 and 'ÖNORM EN 15643' 2021. The energy uses are divided into buildings and districts, embedded energy and mobility.

5.6 Example of a Summary of the Energy Requirements

The summary of the points results in an overview of the definition of the Positive Energy District (Table 61). At the same time, the plus-energy definition is shown graphically in Figure 10.

Table 61 Summary plus-energy definition

Dimensions of observation	Determination
Indicator energy service	Total primary energy
Target	Plus energy balance
Accounting period	Annual

Spatial boundaries	Heat: Energy production outside the property, with direct supply Electricity: Production on the property
Energy use boundaries	Operating energy: → Heating → Cooling → Humidification/dehumidification → Auxiliary energy → Lighting in the building → Lighting in the district Everyday mobility: → Motorised private transport
Remarks	Spatial delimitation: Production outside the properties in neighbouring areas will be examined in any case and considered if necessary.

This definition of the Positive Energy District is also shown graphically in Figure 10.

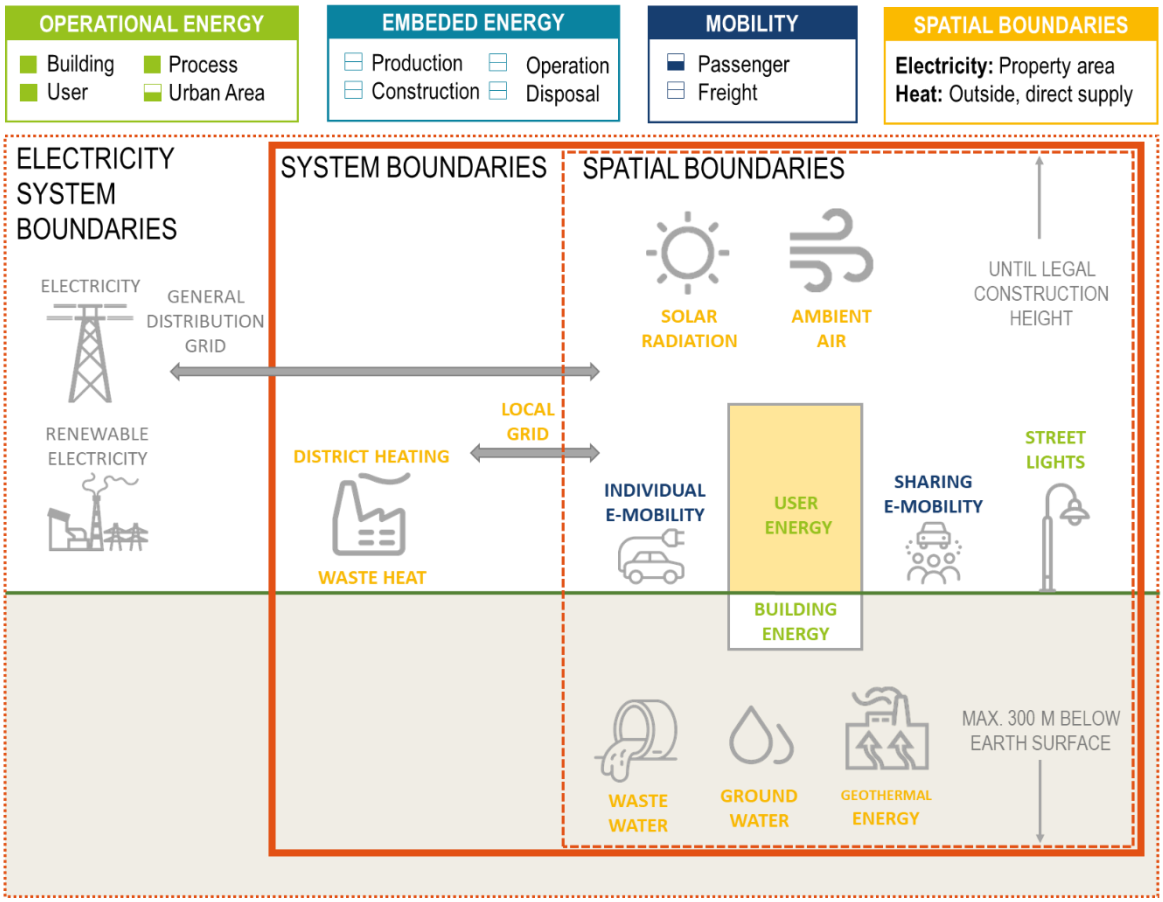

Figure 10: Plus-energy definition (source: own editing)

5.7 Rating system for PEDs

Just as with sustainability certificates, a rating system can be used to evaluate Positive Energy Neighbourhoods. Here, it is important to clarify how the various levels are defined.

A proposal for this is presented below (see Table 62). This proposal takes into account the aspects of energy use and indicators for defining the level of Plus-Energy quarters:

Table 62: Possible rating system for PEDs

Energy services	Indicator	Accounting Period	Rating
Operating Energy	Renewable primary energy	yearly	Level 1 Basic level
Operating Energy + either embedded energy or mobility	Total primary energy	yearly	Level 2
Operating Energy + embedded energy + mobility	Total primary energy + CO2 emission	monthly	Level 3
Operating Energy + embedded energy + mobility	Total primary energy + CO2 emission	hourly	Level 4
Operating Energy + embedded energy + mobility	Total primary energy + CO2 emission	currently	Level 5 Top Level

6 Conclusion and recommendation

The energy-relevant criteria of the sustainability criteria for settlements and districts are based on national specifications and are defined very country-specifically. Here, it is difficult to create a common consensus on criteria for plus-energy.

Instead of developing requirements for Positive Energy Districts, which are then often only based on individual national principles, the goal was changed to creating a clear declaration of Positive Energy Districts. The aim is to define the type of PED and then compare them with other quarters. For the time being, the focus is not on being able to compare different districts and their goals within the framework of benchmarking. First of all, the different ambitions of the districts should be presented. For example, it influences whether the balancing period is 1 year or 1 hour. And it also makes a difference whether only the energy for building operation is considered, or also grey energy and mobility.

Based on these principles, Positive Energy Districts are to be defined according to the following criteria:

- **Objective**: focus on energy or also include carbon
- **Indicator**: Final energy, distinct types of primary energy, CO_2 emission
- **Accounting period**: from 1 second to life cycle
- **Spatial boundaries**: from energy supply in buildings to energy supply from everywhere
- **Energy use boundaries**: from operational energy to also include embedded energy and mobility
- **Remarks**: additional remarks to define some specifications of the individual district, e.g., use of flexible elements

In addition to the boundaries in the definition of Positive Energy Districts, a rating system can also cover different levels of ambition. Based on different boundary conditions (energy services, indicators, counting period), various levels for Plus-Energy can be mapped.

This is the first step towards standardization. The next steps are already being started within the framework of the JPI Urban Europe Initiative or are being developed in IEA Annex 83. Here, general definitions for Positive Energy Districts are to be developed that can be applied by all.

7 References

'Abschlussbericht, Klimaneutrale Quartiere und Areale'. 2021. Deutsche Energie-Agentur (dena).

'BREEAM Communities Technical Manual'. 2017.

'Cities4PEDs'. 2021. Goals and Relevant Aspects of a Common PED Definition, Integrative Working Document as Part of Cities4PEDs WP2 | Nov. 10th, 2021.

'DGNB SYSTEM KRITERIENKATALOG QUARTIERE'. 2020. Deutsche Gesellschaft für Nachhaltiges Bauen – DGNB e.V.

'EPBD'. 2018. Directive 2018/844. Richtlinie (EU) 2018/844 Des Europäischen Parlaments Und Des Rates Vom 30. Mai 2018 Zur Änderung Der Richtlinie 2010/31/EU Über Die Gesamtenergieeffizienz von Gebäuden Und Der Richtlinie 2012/27/EU Über Energieeffizienz (Text von Bedeutung Für Den EWR). Brussels.

European Commission. Joint Research Centre. 2020. *Enabling Positive Energy Districts across Europe: Energy Efficiency Couples Renewable Energy.* LU: Publications Office. https://data.europa.eu/doi/10.2760/452028.

'Global EV Outlook 2019'. 2019. International Energy Agency. https://www.iea.org/reports/global-ev-outlook-2019.

'Greenhouse Gas Emissions from Transport in Europe'. n.d. Accessed 6 April 2020. https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12.

Hofer, G., M. Grim-Schlink, A. Stipsits, A. Bauer, and P. Hafner. n.d. 'Pfad für die Realisierung von Plus-Energie-Arealen in Melk'.

'IEA EBC'. 2021. IEA EBC Annex 83 Positive Energy District. 29 October 2021. https://annex83.iea-ebc.org/.

'JPI Urban Europe'. 2021a. JPI Urban Europe, Positive Energy Districts (PED). 2021. https://jpi-urbaneurope.eu/ped/.

'———'. 2021b. Announcement: Projects Awarded Funding in Positive Energy Districts (PEDs) Pilot Call. 29 October 2021. https://jpi-urbaneurope.eu/news/announcement-projects-selected-for-funding-in-the-first-pilot-call-on-positive-energy-districts-peds/.

'Kaupunkisuunnitteluviraston Esitteet'. n.d. Helsingin Kaupunki. Accessed 6 April 2020. https://www.hel.fi/kaupunkiymparisto/fi/julkaisut-ja-aineistot/julkaisuarkisto/kaupunkisuunnitteluviraston-esitteet.

Knotzer, Armin, Sonja Geier, Karl Höfler, David Venus, Werner Nussmüller, and Tobias Weiss. 2014. 'IEA Solares Heizen Und Kühlen Joint Project SHC Task 40/ EBC Annex 52: Internationale Definition von Nullenergiegebäuden'. Berichte aus Energie- und Umweltforschung 11/2014. Gleisdorf: AEE Intec.

Kourtzanidis, Konstantinos, Jinbubis abgekajigkiz, Paraskevi Giourka, Panagiotis Tsarchopoulos, Nikos Nikolopoulos, and Julia Kantorovich. 2020. 'EET-Centric KPIs Definition, with All Evaluation Metrics and Formulas Derived'. Deliverable D2.1. POCITYF.

Laitinen, A., and O. Lindholm. 2020. 'Energiaomavarainen Ei Pärjää Energiapositiiviselle'. *Tekniikka Talous*. https://www.tekniikkatalous.fi/uutiset/energiaomavarainen-ei-parjaa-energiapositiiviselle/7dc87e68-ba08-4976-ac2a-d4f5f30156d4.

Lindholm, Oscar, Hassam ur Rehman, and Francesco Reda. 2021. 'Positioning Positive Energy Districts in European Cities'. *Buildings*, no. 2021,11,19 (January).

Mair am Tinkhof, Oskar, Michael Cerveny, Markus Schuster, and Franziska Trebut. 2020. 'klimaaktiv Standard für Siedlungen und Quartiere'. Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie. https://www.klimaaktiv.at/service/publikationen/bauen-sanieren/kriterienkatalog-siedlungen.html.

Mair am Tinkhof, Oskar, Markus Schuster, and Franziska Trebut. 2020. 'Handbuch Kriterienkatalog Siedlungen Und Quartiere Neubau, Grundlagen Für Die Qualitative Bewertung von Klimaverträglichen Neubau, Siedlungen Und Quartiere in Der Entwicklungs-, Planungs- Und Umsetzungsphase'. Handbuch Kriterienkatalog. Wien: Bundesministerium für Klimaschutz, Umweld, Energie, Mobilität, Innovation und Technologie (BMK).

'MakingCity'. 2022. Project website. Making City – Energy Efficient Pathway for the City Transformation. 2 February 2022. https://makingcity.eu.

'OI3-Berechnungsleitfaden V4.0'. 2018. Version 4.0. Leitfaden zur Berechnung des Oekoindex OI3 für Bauteile und Gebäude. Wien: IBO – Österreichisches Institut für Bauen und Ökologie GmbH.

'ÖNORM EN 15643'. 2021. ÖNORM EN 15643:2021 Nachhaltigkeit von Bauwerken - Allgemeine Rahmenbedingungen Zur Bewertung von Gebäuden Und Ingenieurbauwerken. Austrian Standards.

Schneider, Simon, Nadja Barlmä, Jens Leibold, Petra Schöfmann, Momir Tabakovic, and Thomas Zelger. 2019. 'New Assessment Method for Buildings and Districts towards "Net Zero Energy Buildings" Compatible with the Energy Scenario 2050'. In *Proceedings*, 511–20. Karlsruhe. https://www.corp.at.

Schöfmann, Petra, Thomas Zelger, Nadja Bartlmä, Simon Schneider, Daniel Bell, and Jens Leibold. 2019. 'Zukunftsquartier, Weg zum Plus-Energie-Quartier in Wien'. Berichte aus der Energie- und Umweltforschung 11/2020. Stadt der Zukunft. Wien: Bundesministerium für Klimaschutz, Umweld, Energie, Mobilität, Innovation und Technologie (BMK). https://nachhaltigwirtschaften.at/de/sdz/projekte/zukunftsquartier.php.

'SET-Plan ACTION N°3.2'. 2018. SET-Plan ACTION N°3.2, Implementation Plan, Europe to Become a Global Role Model in Integrated, Innovative Solutions for the Planning, Deployment, and Replication of Positive Energy Districts. European Union.

'Towards a European PED Definition, Draft'. 2021. Alignment Core Group PED definition and integrated approach: EERA JPSC PED modules, SET Plan Action 3.2 PED Programme/DUT PED pillar, COST Action PED-EU-NET, IEA EBC Annex 83, UERA PED WG, PED-related SCC01 projects, H2020 SCC01 TG Replication, SCALE, Smart Cities Marketplace.

Volt, Jonathan, Sheikh Zuhaib, Senta Schmatzberger, and Zsolt Toth. 2020. 'Energy Performance Certificates, Assessing Their Status and Potential'. Deliverable D2.1. X-Tendo, EXTENDing the Energy Performance Assessment and Certification Schemes via a MOdular Approach. Brüssel: Buildings Performance Institute Europe (BPIE).

Wyckmans, A., K. Karatzoudi, D. Brigg, and D. Ahlers. 2019. 'D9.5:Report on Attendance at Eventsheld by Other SCC-01 Co-Ordinators 2, +CityxChangeWork Package 9 Task 9.2'. https://cityxchange.eu/wp-content/uploads/2019/11/D9.5_Report-on-Attendance-at-events-held-by-other-SCC-01-co-ordinators2.pdf.

PED-ID TEAM

Coordinator:

	e7 Energy Markt Analyse GmbH (e7)

Partners:

	Czech Technical University in Prague, Faculty of Civil Engineering (CVUT)
	SEVEn, Energy Efficiency Center, z.ú. (SEVEn)
	Sustainable Innovation AB (SUST)
	White Arkitekter AB (WHITE)

CONTACT

Project Coordinator:

e7 Energy Markt Analyse GmbH

Camilla Borges Rampinelli | camilla.rampinelli@e-sieben.at

This project has received funding from the European Union's Joint Programme Initiative Urban Europe programme.