



Positive Energy Districts

Fact sheet

This fact sheet is in large parts based on, and citing, the **PED solution booklet** produced by the EU Smart Cities Information System and the SCC Lighthouse Projects Atelier, Sparcs, MakingCity and +CityxChange (2020).

PEDs often result to be complex urban projects, involving many different actors and stakeholders. PEDs also necessarily address a multitude of aspects ranging from different energy technologies and their meaningful integration, over citizen engagement and social justice up to creating composite business models and solving legal questions. The PED solution booklet and its derived fact sheet are intended for the main actors setting up a PED project: local authorities, citizens, investors, technology providers.

In the PED solution booklet, more in-depth information as well as many more examples and references can be found:

<https://smart-cities-marketplace.ec.europa.eu/insights/solutions/solution-booklet-positive-energy-districts>

Apart from the PED solution booklet itself, which is intended as an umbrella document, SCIS has edited a series of solution booklets that analyse into more detail relevant technologies, development concepts and process setups. These booklets can be consulted at <https://smart-cities-marketplace.ec.europa.eu/insights/solutions>

1. Introduction: definition

In the framework of the EU's SET Plan Action 3.2, [JPI Urban Europe](#) and the [EERA Joint Programme on Smart Cities](#) have set out to detail an operational definition of PEDs. This initial definition is used as the working basis for the present fact sheet. It states:

“Positive Energy Districts are energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy.

They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while securing the energy supply and a good life for all in line with social, economic and environmental sustainability”.

(www.jpi-urbaneurope.eu/ped)

2. General information

The big picture: how do PEDs contribute to overall sustainability and clean energy goals?

The energy/carbon perspective

One could try to make a city energy positive and climate neutral by bringing every single building separately to the near-zero energy building (NZEB) standard. Yet, such a city with separate NZEBs would miss many opportunities for technical and financial optimisation, for scale advantages, the use



of district energy systems, energy flexibility services and collective energy production and storage. In a similar vein and from the non-technical point of view, a city is neither a mere accumulation of buildings. The goal of integrated urban functioning is of utmost importance, regardless of the chosen perspective.

PEDs are thus the next logical evolutionary step following NZEBs. Once a city has buildings that start to generate surplus energy part time or all the time, a step change occurs and these buildings can be integrated in a different way into the energy system – in the case of plus-energy buildings, the surplus energy has to be shared with others. They can then not only be treated as local generation but lead the path towards upgrades of larger neighbourhoods.

PEDs may both regard newbuilt, urban retrofit, or a mix of the two. Hereby new buildings may more easily acquire the plus-energy status, and thus be in a position to help filling the energy balance of existing or retrofitted buildings in the neighbourhood, where the latter often lack the possibilities to fully upgrade to energy sufficiency.

The scale of integration can be progressively extended, but an overall strategy working in the opposite direction is also necessary.

Solving the urban clean energy puzzle is indeed best done in a combined bottom-up and top-down approach. In fact, the regional sustainable and renewable energy potentials (within the urban texture as well as in the surrounding hinterland) define the overall envelope of possibilities to realise a fully decarbonised system.



Figure: Energy from district to regional integration and beyond. Scheme adapted from the Whitepaper Transformation Swiss Energy System – Swiss Competence Centre of Energy Research, Future Energy Efficient Buildings & Districts

Beyond energy: integrated sustainability

A PED is not only about energy. It will preferably be a **vibrant urban district** where people wish to reside, work and recreate. **Mixed functions** will hereby not only serve the quality of life, but also the energy balancing between buildings of different usage. Mixity can be a catalyser for urban regeneration. A PED can help to fight energy poverty and provide more local green employment. Embedding the energy concept of a PED in a broader framework of integrated sustainability has been intentionally adopted in the PED definition – ultimately, it is about securing the **good life for all**.



The energy system of a PED

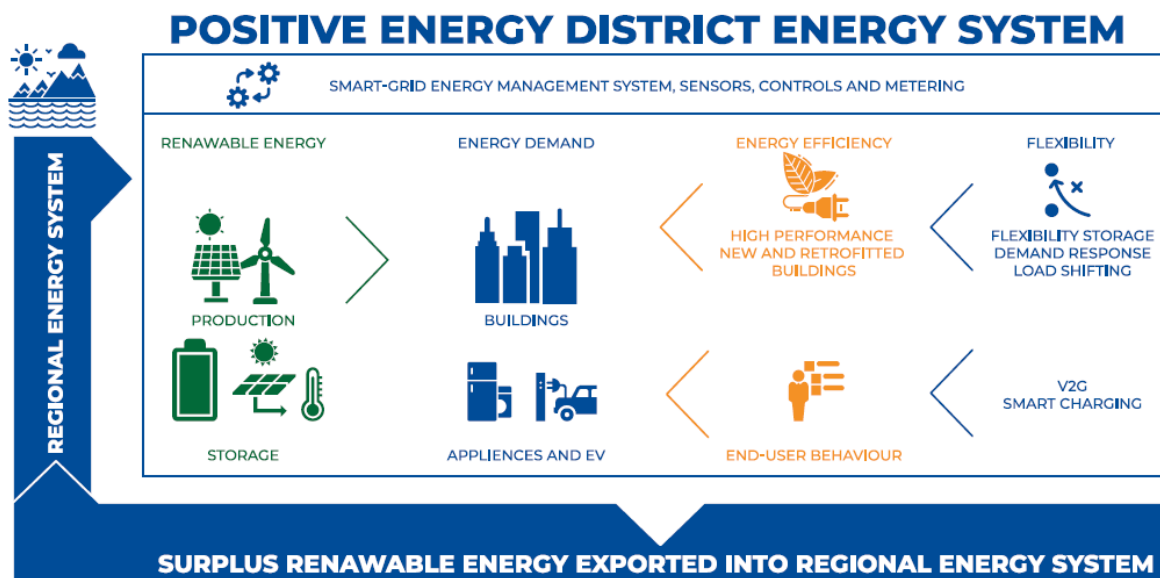


Figure: Simple graph energy system PED in wider context | Adapted from Amsterdam University of Applied Sciences

A PED is characterised by achieving a positive energy balance within a given boundary. Defining the boundaries to the PED energy system is not straightforward. Such a boundary can be geographical or virtual. In all cases, the energy system boundary will include a virtual component through connection to a smart grid.

The optimal design of a PED and the corresponding level of surplus energy can only be determined with a wider energy system context and within an upscaling strategy. Boundaries need to be set for the design of the smart grid and interconnections, as well as for evaluation of impact and performance. However, it should be considered that these boundaries are temporary and, to some extent, ambiguous. A strict focus on setting specific boundaries, within which the PED pilot must be energy positive at all costs, could even hinder upscaling.

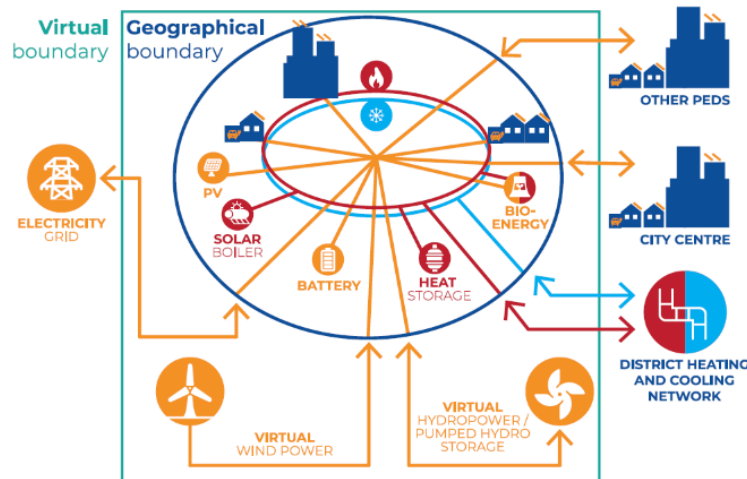


Figure: PED boundaries. | Adapted from VTT, SPARCS

Which steps are needed before implementation? What is the role of local authorities?

PEDs require interaction and integration between buildings, building users, local and regional energy systems, mobility and ICT systems, as well as an integrated approach including technology, spatial, regulatory, financial, legal, social and economic perspectives. PED energy systems should consider the wider context of regional and local energy systems to avoid the creation of tailor-made energy systems that limit opportunities for integration, scale-up and replication.

A novel, integrated approach to planning and implementation is needed, which considers not only the full lifecycle of planned investments in the built environment, but also the entire community influenced by them.

One challenge is that planning aspects like renewable energy production and decentralisation and digitalisation of the energy sector have previously not been a focus of urban planning. Until now, energy planning and urban planning have remained separate, even though the need for their integration has been identified. Hence, **integrated spatial, energy and community planning** – supporting climate protection and the energy transition with means of spatial planning – has become more important. In this sense, PEDs can offer an opportunity for a highly efficient and sustainable route to progress beyond the current urban planning traditions.

Further reading on integrated urban planning and design for PEDs

The **Smart City Guidance Package** helps to plan and implement smart city and low energy district projects in an integrated way by describing common situations and giving real-life examples. Available are a summary guide (<https://smart-cities-marketplace.ec.europa.eu/insights/solutions/smart-cities-guidance-package-summary>) and the full package (<https://smart-cities-marketplace.ec.europa.eu/insights/solutions/smart-cities-guidance-package-full-document>).



The four pillars of PED energy systems

A high level of **energy efficiency** and **renewable energy production** are obvious pillars of the PED design.

Furthermore, **energy flexibility** aims to allow a higher level of integration of renewables in urban areas.

In those cities with plans to expand **e-mobility**, the charging infrastructure and charging demand as well as e-mobility services can also be integrated in the energy system. As this will be the case in most cities that are considering PEDs, e-mobility is emerging as the fourth pillar of a PED.

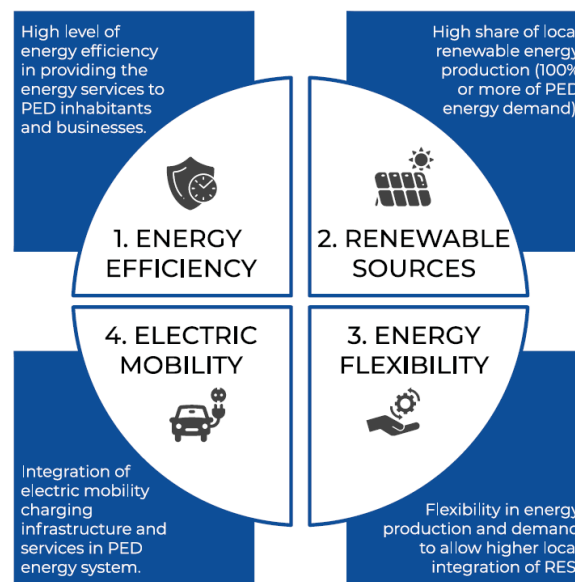


Figure: the 4 PED energy pillars

These 4 pillars are explained with more detail in the PED solution booklet.

3. Societal & User aspects

The success of implementing PEDs will not only depend on the availability of technical solutions but also on social, political and business commitment. The energy transition is a multi-level phenomenon, involving cultural and societal aspects next to planning and finance, for example. In order to achieve a truly sustainable and 'smart' energy system, that is secure and affordable for all citizens, the **social dimension needs to be addressed upfront and throughout.**

Citizen and stakeholder engagement is an important means through which to achieve this. Putting the goals and aims of the engagements first, different methods, tools and forms of participation can be suitable and effective. From activating awareness through events, to co-creation interventions and citizen science projects.

Considering a citizen and stakeholder engagement approach in PED projects, the following considerations are especially relevant:



- **Working in a setting of new and existing buildings** over large parts of neighbourhoods makes it important to build good connections to citizens and stakeholders, to include their ideas, concerns, and contributions, and to make them **partners in the transition**;
- To improve **energy-conscious inclusive citizen services**, it is required to **take measures such as shifting their energy consumption to periods with surplus renewables or using shared e-mobility** instead of private cars. This calls for extensive and innovative citizen engagement and co-creation methods, resulting in citizens who understand, trust, use and feel **ownership** of the integrated energy and mobility solutions offered in their district;
- **Citizens in a PED may even become energy prosumers**. What does that mean for them? What do they need to live and work in a PED? What does it mean to have a form of ownership of your energy consumption and market?
- Can we, also beyond the individual PED demonstrators, engage more citizens in the energy transition: **increasing citizens' knowledge level and motivation** and growing support for, and informed appreciation of, energy transition measures?

4. Regulations and policies

Traditionally, the energy generation and distribution systems as well as the legislation and regulation framework around them, have assumed a centralised, hierarchical system.

This is an obstacle for the energy transition. Decentralisation efforts and the necessary feed-in of renewables cause a paradigm shift. Large installations are treated as power plants, but small installations on or close to buildings need a local distribution grid capable of two-way power flow.

At the EU level, this is handled by directives like the Electricity Directive, and within the EU member states, through grid regulation and general or specific renewable energy feed-in rules and tariffs.

PEDs go one step further and strongly include local and decentralised energy generation, distribution, and storage; within a local part of the grid, but at the same time in connection to the wider grid.

Even if the **EU's Clean Energy for all Europeans Package** is now coming into application through 'recast' directives, most of the current energy regulation in Europe is still geared towards the traditional centralised generation and distribution system. Decentralisation is an ongoing topic and many grids are already partially enabled for two-way energy flow.

The flow between buildings and local assets, either directly between neighbours, or through a local community grid operator role, is thus not yet part of current regulations. New regulatory principles on this topic have been formulated in the Clean Energy Package. Subsequently, the EU's recast directives in the field of energy are now expected to gradually mainstream such new regulations suitable for PEDs, including price incentive schemes towards a green shift. EU Member States have one to two years to transpose the new directives into national law. Market mechanisms for PED trading will be part of the electricity market transition.



5. Business models and finance

From business model to value chain

Setting up a PED is a complex process. It involves many stakeholders, each with their own interests, constraints and (investment) agendas. Managing this requires a high degree of coordination.

This is why the large-scale deployment of PEDs requires the inclusion of sustainable business models that consider the whole process of building, operating and maintaining PEDs.

There is no predefined single business model for the successful development of a PED. Instead, **a combination of different business models has to be found for each stakeholder involved. This applies to each of the pillars of the PED energy system** (energy efficiency, renewable energy production, energy system flexibility and electric mobility). For each stakeholder involved (cities, real estate developers, building owners, providers of innovative technologies, energy infrastructure operators, inhabitants...), the PED has to bring a value proposition that meets the stakeholders' needs and wishes.

Therefore, an important step in the development of business models for PEDs is the **identification and mapping of stakeholders involved** in PEDs, their individual interests and their interactions, representing the PEDs' complex ecosystem.

Apart from **energy trading, the trading of flexibility and its management** could be a major success factor for PEDs, as it allows the operator to manage capacity and reduce peaks. The potential of flexibility however depends on the local configuration of the distribution grid and whether the latter presents bottlenecks or not, see also a related SCIS policy paper on the impact of the EU's changing electricity market design on the development of smart and sustainable cities and energy communities (<https://smart-cities-marketplace.ec.europa.eu/insights/publications/impact-eus-changing-electricity-market-design-development-smart-and>).

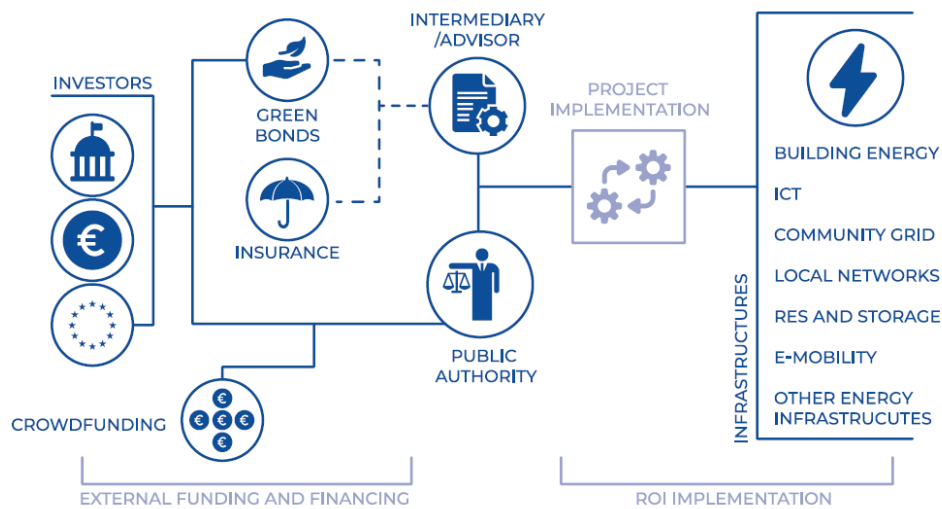


Figure: PEV Implementation and Operation through Business and Investment Models Innovation. Adapted from: +CityxChange D2.4: Report on bankability of the demonstrated innovations; cityxchange.eu/knowledge-base/report-on-bankability-of-the-demonstrated-innovations.

Suitable business models have to be identified for each involved actor. Typical business models that are relevant for the four pillars of PED energy systems are listed below. Most of these business models already exist in practice: the challenge and the innovation for PEDs is to combine several of them.

For energy efficiency: The energy renovation of buildings can benefit from several business models, adapted to different types of buildings and the needs of their owners:

- Within a **one-stop-shop business model**;
- Within the **Energy Performance Contracting (EPC) model**;
- There are many more ways urban (energy) renovation projects can be financed. Local authorities can hereby take a leading role in **setting up innovative investment schemes**. A summary overview of concrete financing solutions can be found in SCIS's policy paper on urban energy retrofit (<https://smart-cities-marketplace.ec.europa.eu/insights/publications/upscaling-urban-residential-retrofit-eus-low-carbon-future-challenges-and>) and in the renovation hub 'Stunning' overview of business models (<https://renovation-hub.eu/business-models/>).

For renewable energy production: The development of local, renewable energy production within a PED can equally be based on different business models. Some examples apart from the single-owned asset:

- Within a **roof, building integrated PV (BIPV) or land renting model**;
- With the **leasing of renewable energy equipment**;



- An **energy cooperative** is a non-profit entity for green energy production and consumption, which performs the same activities as any other retailer or energy producer company;
- The deployment of a **district energy system**, which can be combined with local heat and cold production. The majority of business models for district energy involve the public sector to some degree, whether as a local policymaker, planner, regulator or consumer, or more directly through **partial or full ownership of projects**.

For energy system flexibility: Energy flexibility, consisting in adjusting energy consumption (and possibly production), to the needs of the energy system, can be combined with other pillars of PED energy systems, in particular energy production and electric mobility. The following business models illustrate the concept of energy flexibility:

- **Demand response** consists in reducing or increasing the load level of consumers for some time when the price of electricity reaches a high/low enough level;
- **Tariff structures** also play a role. As far as capacity is going to be charged rather than the quantity of electricity purchased, the viability of offering flexibility may increase (e.g. BE, CZ);
- Also, **thermal flexibility services** in district heating are bringing new advantages;
- These activities may take place under the umbrella of **Renewable Energy Communities (REC) or Citizen Energy Communities (CEC)** as recently defined by the EC.

For electric mobility: Electric mobility can nicely complement the other pillars of the PED energy system:

- Through offering **Mobility as a Service (MaaS)**;
- When electric vehicles are well spread and technology allows for it, **smart charging (SC)** or **vehicle-to-grid (V2G)** can complement demand response from buildings by adjusting the charging load or even discharging the car battery depending on the energy system needs;
- By rolling out **urban freight logistics (UFL)**.

Further reading on smart city business models (provided through the SCC Lighthouse Projects)

- **Smarter Together handbook on Smart City Business Model innovation:** <http://smarter-together.eu/deliverables/handbook-smart-city-business-model-innovation>;
- **SmartEnCity Regeneration Strategy**, New business models, procurement schemes and financing mechanisms for smart city projects: http://smartencity.eu/news/detail/?rx_call=107;
- **IRIS Smart City Business Model Canvas:** <http://irissmartcities.eu/content/smart-city-business-model-canvas>;
- **Replicate City Model Canvas:** <https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5b318b5b8&appId=PPGMS>;



6. Governance

“A PED is a process, not a product”

PEDs are still novel systems but will always involve multiple building blocks and a large number of stakeholders and contributors, which will each have their own ambitions, agendas, interests and constraints. The PED process and projects are therefore complex and require a high degree of coordination.

The stakeholders usually include municipalities, real estate developers, building owners, tenants, energy providers for electricity and heating, research institutes and universities, mobility providers, energy system providers, ICT companies, industry, SMEs, non-profits or NGOs, politicians, and last but not least citizens and citizen organisations.

PEDs are evolving

Changing the - historically grown - energy infrastructure at the district or urban scale is more disruptive than transforming individual building installations.

Most PEDs will moreover involve urban renewal and retrofit to complement the energy system upgrades and to achieve the necessary demand reduction. Given this complex context, it will therefore not be possible to realise a PED overnight. Managing the corresponding urban transformation process will require a well-conceived governance structure.

PEDs versus local energy communities

PEDs may, in the near future, revert to Local Energy Communities (LECs) for operationalizing their energy systems and markets. The EU regulatory frameworks provide two definitions embodying the same principle, yet with slight differences: [Renewable Energy Communities](#) (RECs – under the Renewable Energy Directive) and [Citizen Energy Communities](#) (CECs – under the Electricity Directive). See the [RESCOOP platform](#) for a discussion: <https://www.rescoop.eu/toolbox/q-a-what-are-citizen-and-renewable-energy-communities>.

RECs and CECs are an outcome of the implementation of the [EU Clean Energy for all Europeans Package](#). Subsequently, the EU’s recast directives in the field of energy are now expected to gradually mainstream such new regulations suitable for PEDs. https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en

7. PED(-like) projects in practice

JPI Urban Europe has compiled an overview of already built or planned PED-related or PED-like projects, which is available at https://jpi-urbaneurope.eu/wp-content/uploads/2020/06/PED-Booklet-Update-Feb-2020_2.pdf