oPEN Lab
TARTU PAMPLONA GENK
LEADING THE TRANSITION TO POSITIVE ENERGY NEIGHBOURHOODS

Towards a regulatory framework for positive energy neighbourhoods

Outline of the oPEN-Lab policy roadmap

TARTU

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Abbreviations and acronyms

Acronym	Description
CEC	Citizen energy community
CSC	Collective self-consumption
DSO	Distribution System Operator
EED	Energy Efficiency Directive
EMD	Electricity Market Design
EPBD	Energy Performance of Buildings Directive
EPC	Energy performance certificate
EV	Electric vehicle
GHG	Greenhouse gases
GPP	Green public procurement
LCA	Life-cycle assessment
IEA	International Energy Agency
MEPS	Minimum energy performance standards
NZEB	Nearly zero-energy building
PEN	Positive energy neighbourhood
PV	Photovoltaic
REC	Renewable energy community
RED	Renewable Energy Directive
TSO	Transmission System Operators

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Executive summary

The positive energy neighbourhood (PEN) approach can contribute to scaling up renovations while engaging local communities in the energy transition. A PEN is characterised by a group of buildings and public spaces with connected infrastructure, within a geographical area. A PEN aims for energy-efficient and energy-flexible groups of connected buildings and urban areas which produce net zero greenhouse gas emissions from energy use on an annual basis and actively manage an annual local or regional surplus production of renewable energy. This report includes an analysis of national implementation of the EU policies which underpin the PEN approach to building renovations.

oPEN Lab draws from the experience of Tartu oPEN Living Lab in Estonia, in which the PEN approach is being piloted. An analysis of regulatory barriers for energy performance, collective energy production and sharing, demand-side flexibility, and whole-life carbon and circularity have given insights as to where the current policy framework is hampering the roll-out of PEN. Despite not being explicitly encouraged by current policies, elements of the PEN approach are nevertheless already supported through various incentives and initiatives across these regions. These provide a base for the development of 'solution packages' in consecutive steps in close collaboration with Living Lab stakeholders.

Estonia's policy framework indirectly supports PENs through incentives aligned with broader energy efficiency and prefabrication strategies. The recent legal changes facilitating collective decision-making among housing associations are promising, yet challenges in CSC implementation and energy storage profitability due to double taxation reflect a need for further policy refinement.

While local initiatives and EU funding aid the integration of PENs, consistent challenges such as the complexity of energy sharing regulations, limited financial incentives for energy storage, and the need for enhanced expertise in sustainable building practices highlight the need for a unified EU-wide strategy to fully realise the potential of PENs. Policymakers are encouraged to address these barriers through integrated, clear and supportive regulations that align with the EU's climate-neutrality goals, fostering an environment where PENs can thrive as sustainable energy solutions.

Harmonised definitions and frameworks for PENs are necessary for assessing progress and ensuring consistency across Member States. More tailored financing solutions are required to protect vulnerable households and mitigate energy poverty, aligning with the directives' focus on social equity. Assessing the social and environmental co-benefits of PENs is critical for maximising their impact. By addressing these challenges and leveraging the opportunities presented by the ongoing implementation of the Energy Performance of Buildings Directive, Renewable Energy Directive III and Energy Efficiency Directive, PENs can emerge as a cornerstone of sustainable urban development within the EU, contributing significantly to energy efficiency, renewable energy deployment, and social goals.

Introduction

The decarbonisation of the EU building stock requires renovation at scale. The Renovation Wave aims to at least double renovation rates across EU Member States by 2030 in order to achieve a decarbonised building stock by 2050.

> 'The necessary decarbonisation of the Union building stock requires energy renovation at a large scale: almost 75% of that building stock is inefficient according to current building standards, and 85-95% of the buildings that exist today will still be standing in 2050. However, the weighted annual energy renovation rate is persistently low at around 1%. At the current pace, the decarbonisation of the building sector would require centuries.'
>
> **2024 EPBD recast**

The neighbourhood/district approach is recognised in the 2024 EPBD recast as a cost-efficient way to scale up renovations while taking into account social and environmental aspects.

Within the oPEN Lab project, a positive energy neighbourhood (PEN) is an approach which aims to decarbonise a neighbourhood, while the Living Lab is a network of stakeholders which enables co-creation with the local community for testing of technological, process and social innovations in a real-life environment (see Figure 1). A PEN includes a cluster of buildings together with public space and shared services and facilities, and it includes specific technological and financial solutions, adapted to the local context. A PEN aims for energy-efficient and energy-flexible groups of connected buildings and urban areas which produce net zero greenhouse gas (GHG) emissions from energy use on an annual basis and actively manage an annual local or regional surplus production of renewable energy. The PEN project is enabled by a Living Lab which gathers groups of local stakeholders from the public, NGO and private sectors who will scale up PEN projects and other initiatives in the district/city. oPEN Lab Living Labs have a strong focus on engagement, consultation and co-creation processes, and trusting relations with local stakeholders and communities.

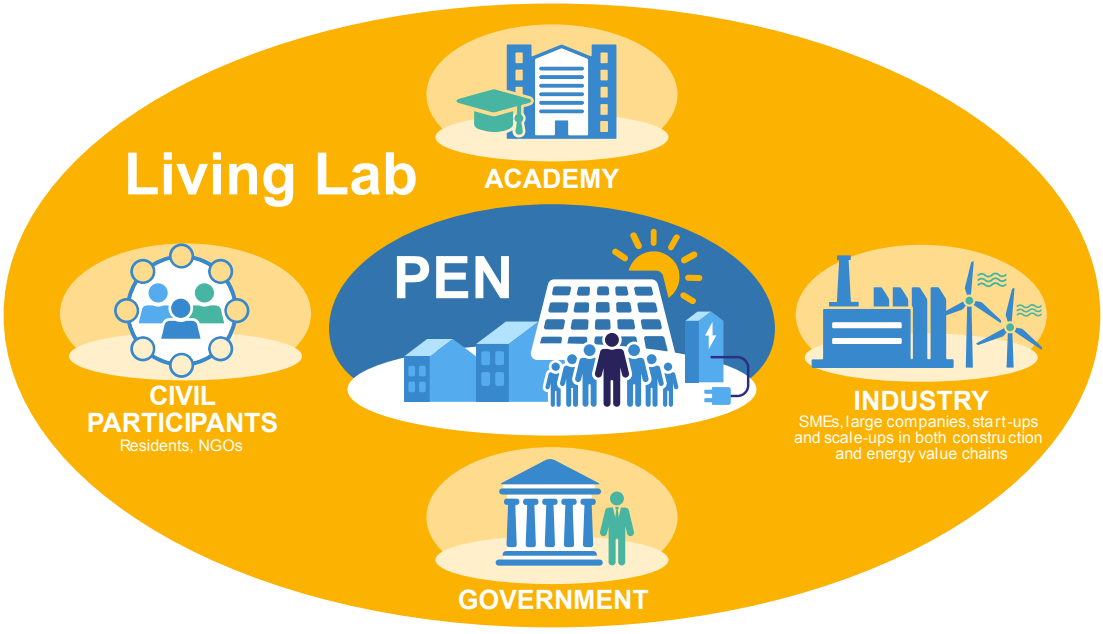

Figure 1 Conceptual difference between PEN and Living Lab

The 2024 EPBD recast for the first time considers the neighbourhood/district approach to renovations, shifting from an individual building approach to a building embedded in the urban infrastructure. Even though other directives and national, regional and local policies do not yet incorporate the neighbourhood approach, they relate to other relevant aspects for PENs, such as:

- Energy performance
- Collective production, sharing and selling of energy
- Demand-side flexibility
- Whole-life carbon and circularity

This analysis provides a base for tailored policy recommendations to facilitate PEN uptake in Spain, Flanders and Estonia. It is based on extensive desktop research, including the transposition of the 2018 Clean Energy Package in each pilot country, and a series of interviews and focus group sessions with key stakeholders of the three Living Labs, such as architects, developers, municipalities, energy agencies, and research institutions. The interviews helped to identify regulatory barriers and best practices for Livings Labs, and complemented the key national, regional and local policies relevant for PEN which were identified with the desktop research.

Experience from the Living Labs' local stakeholder ecosystems provides valuable feedback on the issues and best practices in transposing the EU Directives, ensuring a bidirectional exchange within different levels of local, regional and national governance.
Besides policy mapping, barriers and best practices were identified in the following areas:

- Financial barriers on how to ensure deep levels of renovation and engage vulnerable homeowners.
- Legal barriers regarding collective production of renewable energy linked with electricity market regulations, procurement processes and public tenders which do not encourage prefabrication or re-use of building elements, data privacy, etc.
- Lessons learnt from the Living Labs, adjusted and interpreted based on real-life conditions of current regulations.
- Possible solutions to identified policy gaps and barriers offered by best practices from other countries.

The goal of this Outline of the oPEN-Lab policy roadmap is to map the main policies and barriers for having a discussion with key stakeholders about working together to build the final policy roadmap. This first analysis will be used for stakeholder engagement sessions to co-create a non-technical solutions package with a view to overcoming PEN barriers. The goal of the final policy roadmap, due in 2026, is to embed the PEN approach into policies at all levels to work towards achieving local energy, environmental, housing and social goals.

2. The positive energy neighbourhood concept

2.1 Added value of neighbourhood approaches in building policies

PEN are at the pinnacle of the energy transition in urban environments. PENs can contribute to the decarbonisation of the building stock, while providing additional benefits for residents both at the building and neighbourhood level, enhancing wellbeing and social cohesion. Besides the deep renovation of individual buildings, PENs can encompass a range of shared spaces, services and facilities, such as shared heat pumps, photovoltaic panels, electric vehicles (EVs), EV charging stations, bicycles, and common spaces with greenery, water and biodiversity. Neighbourhood approaches provide additional benefits to demand-side flexibility compared to single apartments or buildings through the aggregation of energy assets and stacking of revenue streams – and thus generate greater energy savings and economic benefits for homeowners. **PENs go beyond the mere combination of individual positive energy buildings: they are the integration of buildings and neighbourhood infrastructure, creating a dynamic interaction with energy, mobility and industry.** This approach aligns seamlessly with the Renovation Wave's call for an integrated, participatory and neighbourhood-centred approach.

Renovations are a key requirement for the successful decarbonisation of the European building sector.[1] As recognised in the Renovation Wave,[2] deep renovations currently only occur in 0.2% of the building stock per year. The advantages of neighbourhood approaches to renovations as opposed to individual building approaches are acknowledged in the 2024 EPBD recast, and Member States are required to implement and report on the 'district and neighbourhood approaches' in their national building renovation plans.

> *(j) the promotion of district and neighbourhood approaches and integrated renovation programmes at the district level, which may address issues such as energy, mobility, green infrastructure, waste and water treatment and other aspects of urban planning and may take into account local and regional resources, circularity and sufficiency;*
>
> **2024 EPBD recast**

2.2 The positive energy neighbourhood concept in relation to policy

PEN as an enabler to achieve policy goals at local level

This section will detail the oPEN Lab concept and definition of PEN, in relation to decarbonisation policies for the building stock. PENs can contribute to achieving the following policy goals:

- Climate mitigation: reduce GHG emissions
- Climate adaptation
- Increase renovation rates
- Increase share of renewable energy

[1] https://www.european-calculator.eu/wp-content/uploads/2020/04/EUCalc_PB_no3_Buildings.pdf
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662

- Smart electricity grid, demand-side flexibility
- Reduce fuel poverty
- Sufficiency policies at city, neighbourhood and building scale
- Improve social cohesion and community engagement

The right scale to adapt to the local context

In summary, PENs are projects which implement renovations enabled by the Living Lab network of stakeholders to achieve social, climate and environmental policy goals, by adapting the array of available technical, process and financial solutions to the local context. The Dutch government has used a similar neighbourhood-level approach to implement the phase-out of fossil fuel heating systems in residential buildings (OECD, 2023). It used a multi-level approach for vertical and horizontal policy co-ordination:

- Plan a heat transition vision and implementation
- Lead natural gas-free pilot projects
- Engage a broad array of stakeholders, citizens and local businesses to take action

The neighbourhood is the right scale for public authorities to engage with local communities to collectively find technical solutions for renewable energy heating systems, depending on the renewable energy production and storage potential. For example, if there is a lake in the neighbourhood there is the potential for seasonal water heat storage. The neighbourhood is also the right scale to find solutions to overcome technical, social, regulatory and financial challenges. For example, a neighbourhood is likely to have similar heritage protection of buildings.

Integration with urban infrastructure

PENs consider the interaction of the building with the electrical and district heating and cooling grids. Smart systems, heat and electricity storage maximise self-consumption within PENs, allowing an excess of renewable energy which can be shared with the wider district or renewable energy community. The sharing of energy between a PEN and a renewable energy community can contribute to a sense of community, energy security and sufficiency, as well as empower citizens for active participation in the energy market and energy transition. This can contribute to getting citizens on board and leaving no one behind, and can contribute to the acceptance of climate policies.

Implementing sufficiency principles

Finally, PENs can contribute to the incorporation of the sufficiency principle in energy and environmental policies. Sufficiency is one of the key pillars in building policies to deliver decarbonisation while tackling inequalities in access to energy services (Figure 5). According to the 6th Assessment Report of Working Group III of the IPCC, ‘sufficiency policies are a set of policy measures and daily practices that avoid demand for energy, materials, land and water while delivering human well-being-for-all within planetary boundaries’ (Shukla et al., 2022). The main goal is to meet human needs and provide services required for human well-being (e.g. housing including thermal comfort, nutrition and mobility), which implies an economy that stays within planetary boundaries. The PEN approach can untap a series of sufficiency design strategies, with shared spaces, services, renewable energy systems and heating systems which can provide added community well-being while reducing material and land use. For example, this could be as simple as having one heat pump instead of individual heat pumps in each flat. Another example is having shared rental EVs or better access to public transport instead of personal cars, which would cut down on parking lots and pollution alike.

oPEN Lab PEN definition

Districts and neighbourhoods are frequently differentiated according to their scale and social connotations. The term ‘district’ is usually related to large-scale urban areas, while ‘neighbourhood’ typically refers to smaller interconnected urban zones. There are several reasons why a neighbourhood approach is important for developing urban renovation projects. First and foremost, a sense of community identity will enhance renovation efforts towards a better urban environment that will improve the welfare of the inhabitants: PENs aim for community well-being, supported by instruments for economic, social and environmental development.

oPEN Lab definition of PEN

According to the oPEN Lab project, a positive energy neighbourhood (PEN) is characterised by a group of buildings and public spaces with connected infrastructure, within a geographical area. A PEN aims for energy-efficient and energy-flexible groups of connected buildings and urban areas which produce net zero greenhouse gas emissions from energy use on an annual basis and actively manage an annual local or regional surplus production of renewable energy.

A PEN should focus on several key concepts:

- PENs seek an integrated, participatory, neighbourhood-based approach to maximise the benefits of innovative energy systems.
- The benefits of a PEN extend to providing affordable living, enhancing indoor environments, and promoting well-being among its residents.
- A PEN is linked to an urban energy system and it is driven by renewable energies, which provide optimised and flexible supply.
- Buildings within a PEN environment are energy efficient, and their reduced heat requirements allow for low-temperature and decarbonised heating systems like heat pumps and novel generation from district heating.
- A PEN facilitates increased utilisation of renewable energy within the local energy system by providing optimal flexibility and by managing consumption and storage capacities according to demand.
- A PEN features the sufficiency principle of energy, environmental and social strategies.
- A PEN supports the circular economy and residual value, by embracing lifecycle analysis of embodied energy and embodied carbon considerations.

3. Policy mapping framework

PENs represent a cross-sectoral approach to renovations, energy provision and urban planning whose value propositions rest on the synergies between these. As a result, PENs are impacted by various policy fields, and there is no dedicated policy initiative that regulates and supports them.

For the purpose of mapping PEN-relevant policy, the central sub-themes and PEN aspects are presented below. Each theme is listed and described in the following subsections. The results of the mapping of EU policy and the Fit for 55 package are presented in Section 4.

Energy performance of buildings

At the EU level, the previously implemented versions of the EPBD introduced minimum performance requirements for new constructions and major renovations. These also included minimum shares of renewable energy produced on-site. The minimum requirements for major renovations have been transposed into national building regulations with different levels of ambition, considering also climate differences.

For neighbourhoods to achieve a yearly net positive energy balance, policies need to encourage individual buildings or whole districts to go beyond minimum energy performance requirements and generate a surplus of renewable energy where possible. This needs to be coupled with the financial and non-financial incentives to do so, such as subsidies to renovate and facilitation services.

Collective production, sharing and selling of renewable energy

At EU level, REDII[3] and EMD[4] contain important provisions and definitions for a legal framework enabling the production, storage, sharing and selling of energy. REDIII, approved in November 2023, keeps the same definitions for collective self-consumption and renewable energy communities (Table 1).

Renewables self-consumers	**Article 21, REDII**	'A final customer […] who generates renewable electricity for its own consumption, and who may store or sell self-generated renewable electricity, provided that, for a non-household renewables self-consumer, those activities do not constitute its primary commercial or professional activity.'
Jointly acting renewables self-consumers (collective self-consumption)	**Article 21, REDII**	A group of at least two cooperating 'renewables self-consumers […] who are located in the same building or multi-apartment block' or, where permitted by a Member State, within other premises.
Renewable energy community	**Article 2 (16), REDII**	A **legal entity**, based on open and voluntary participation, autonomously controlled by shareholders or members in proximity to renewable energy projects, **consisting of natural persons, SMEs, or local authorities**, with the primary goal of delivering environmental, economic, or social community benefits rather than financial profits. They are limited to renewable energy systems (heat and electricity) and rooted in the local community.
Citizen energy community	**Article 2 (11), EMD**	A **legal entity**, also based on open and voluntary participation that is value-driven rather than by financial profits. **There is no geographical limitation and electricity only is being produced and shared.**

Table 1 Overview of different energy-sharing possibilities in EU directives.

[3] Directive (EU) 2018/2001
[4] Directive (EU) 2019/944

PENs rely on an enabling framework for sharing energy among individuals and groups – sharing and thus reaching a net balance is at the core of the PEN concept. Thus, for this section, the degree to which regulations encourage or inhibit energy production, sharing and trading and the functioning of renewable energy communities or collective self-consumption is explored.

Demand-side flexibility

With the electrification of heating and mobility, electricity will become the core of the energy system in the next few decades – and the IEA[5] emphasises the huge role that flexibility will play. The EPBD recast, REDIII and EED include important provisions to encourage energy storage, smart heating, integration with sustainable mobility, and energy management systems. Demand-side flexibility is a key service of PENs which aims to maximise self-consumption at neighbourhood level and provide flexibility services to the grid. To exploit this potential it is key that regulations promote demand-side flexibility and smart technologies.

Whole-life carbon and circularity

Previous EU legislation did not mandate Member States to implement regulations that promote the use of secondary construction materials, their circularity, or life-cycle assessment methodologies. Thus, for this section any relevant national policies that have emerged on the initiative of a Member State will be listed. Going forward, the Council Conclusions on the Circular Economy in the Construction Sector from 28 November 2019 urged the Commission to facilitate the circularity of construction products when revising the Construction Products Regulation (EU) No 305/2011. The Commission's proposal for the construction products regulation currently under revision includes clarity on reused pre-fabricated houses. Several provisions of the 2024 EPBD recast make the shift from operational GHG to embodied carbon, among them the introduction of global warming potential over a building's whole life cycle. However, at this stage, no minimum requirements regarding the whole life-cycle emissions are being introduced.

With the PEN approach, renovations are a key measure to improve energy performance and make the most of collective renewable energy assets. Ideally, sustainable material choices (e.g. also secondary construction materials) are facilitated by a coherent whole-life carbon perspective and methodology.

[5] https://www.iea.org/reports/net-zero-by-2050

4. Local, regional and national policies for Tartu (Estonia) Living Lab

4.1 Introduction

The city of Tartu is located in the southeast of Estonia. Within the oPEN Lab project, Tartu aims to demonstrate an innovative PEN model interconnecting refurbished public and high-storey apartment blocks with a local multi-vector energy system including large-scale storage. This will be the first of its kind in Estonia and the wider Baltic region.

PENs can make essential contributions to achieving not only emissions and renewable energy targets, but also renovation targets, creating more social cohesion in neighbourhoods and addressing the housing cost crisis by reducing long-term energy costs. **However, to make PENs a scalable concept in Estonia it is important to investigate any regulatory barriers that could hamper their uptake.**

The purpose of the following analysis is twofold:

1. Through **policy mapping and analysis**, the current readiness of the Estonian regulatory ecosystem for PEN is assessed. Based on extensive desktop research, the transposition of PEN-relevant EU directives in Estonia and other key policies were scrutinised. This will provide a first analysis of the key areas of policy recommendations to be further developed in subsequent stages of the project to identify non-technical 'solution packages'. Four aspects of policies were identified as relevant for PEN:

- Energy performance of buildings
- Collective production, sharing and selling of energy
- Demand-side flexibility and smartness
- Whole-life carbon and circularity

2. Based on a **series of interviews and focus group sessions** with key stakeholders of the Tartu oPEN Living Lab – such as the municipality, the energy agency, research institutions and the energy sector – regulatory barriers for Tartu oPEN Living Lab were identified. **This provides a base for tailored policy recommendations to facilitate PEN uptake in Estonia.**

The background section below provides key information about the Tartu oPEN Living Lab and the current state of Estonian and Tartu climate and energy policy.

4.2 Background

Tartu Living Lab

The city of Tartu has a population of around 95,000. It is an EC Smart Cities and Communities Lighthouse City, and is the first Estonian pilot site for a PEN Living Lab. The Tartu municipality owns most of the land in and surrounding the oPEN Lab pilot area.

Estonia Tartu oPEN Living Lab has been particularly hit by high interest rates and higher renovation costs due to an increase in construction prices, which pose significant barriers to project finance. As a result, the project initially struggled to secure a pilot building. Estonia has a Best Practice Code for Inclusion which sets minimum principles for constructive engagement and consultations: this could be used as a code of conduct while planning PEN developments.

Climate and energy landscape

Before diving into PEN-specific policy and regulatory barriers and drivers, it is important to understand the Estonian climate and energy policy landscape. The National Energy and Climate Plan (REKK 2030) from 2019 set out various targets: for example, ambition has risen in the governance agreement for 2021-2023 which envisions climate neutrality by 2050. This goes beyond the 80% GHG emission reduction by 2050 which had been set out in the General principles of climate policy document from 2017 (KPP 2050).

In 2022, the Energy Sector Organisation Act was amended: by 2030, renewable energy must now account for at least 65% (~20.4 TWh) of national gross final energy consumption, with 100% renewable energy in the gross final consumption of electricity and at least 63% of renewables in the gross final consumption of heat (the latter figure is currently 51.64%). In the draft update of the NECP 2030 submitted to the Commission in August 2023, a goal is set to reduce primary energy use by 14% by 2030. An 80% reduction in GHG emissions compared to 1990 levels is envisioned for 2035.

The Energy Policy Development Plan (ENMAK) 2030 is another key document that lays out activities and goals for electricity and heat, housing and transport. For example, by 2030 80% of heat produced in Estonia must be from renewable energy sources, and the energy efficiency of buildings must increase to at least class C. The government is currently preparing the ENMAK 2035 to update these targets, in line with the 'Estonia 2035' general development strategy within the areas of energy security, energy transition, and increasing energy efficiency. It also builds on the '2021-2031-2040 Energy Roadmap' which was developed by stakeholders from the energy sector. **The roadmap anticipates a decrease in Estonia's overall energy consumption from 32,305 GWh in 2020 to 28,770 GWh in 2031, and further down to 24,335 GWh by 2040. This reduction aligns with the EU's energy efficiency goals, aiming for at least a 9% decrease in overall consumption compared to 2020 levels.** It emphasises enhancing energy efficiency in buildings, including residential, public and industrial buildings.

This involves renovating existing buildings and ensuring that all new buildings or properties are autonomous in their energy supply and do not rely on imported energy. The plan also calls for changes in everyday energy-related behaviours and consumption habits, such as adjusting indoor temperatures seasonally, promoting the use of public transportation and local goods, and adopting energy management practices.

The Estonian Long Term Renovation Strategy's main goal is to completely renovate the building stock to energy performance class C by 2050, so it is necessary to renovate 100,000 private houses, 14,000 apartment buildings and 27,000 non-residential buildings in the coming years.

Under EU requirements, Estonia must renovate 3% of the total floor area of public buildings annually, corresponding to about 24,000 m² per year. The government estimates the actual rate of renovation between 2021 and 2026 will be around 60% of the required volume. Estonia aims to renovate all buildings constructed before 2000 by 2050. This includes approximately 141,000 buildings, with targets to reduce building sector energy demand by 12% and total GHG emissions by 42% by 2035 versus 2019 levels, as set out in the Estonia 2035 strategy.

4.3 Analysis of the regulatory framework

Energy performance in buildings

Policy mapping

Reducing the energy demand and increasing the renewable energy production in buildings in a PEN are key to achieving a positive energy balance. In Estonia, buildings are responsible for around 53% of total energy consumption. To achieve energy targets, buildings will need to be renovated with a high level of ambition, and the heat system will need to be based on renewable energy. The ambition of the oPEN Lab project is to renovate one nine-storey and one five-storey apartment building to NZEB standards, and turn the block into a PEN by 2030. While Estonia has been piloting prefabricated five-storey apartment building renovation since 2021, this project aims to test its application to nine-storey buildings. Heat-recovering ventilation is installed using a demand-based ventilation system. The buildings themselves are connected to district heating, which currently operates on 85% renewable energy. District heating storage will be used to replace fossil fuel energy during peak hours. beyond the 80% GHG emission reduction by 2050 which had been set out in the General principles of climate policy document from 2017 (KPP 2050).

Currently, Estonia has a law in place that sets minimum energy performance requirements and also defines ZEB.[6] The law was last updated in 2019, and regulates existing and major renovations. Requirements are set for the whole building, but locally installed renewable energy production systems serving the building are included in the calculation of energy efficiency.

[6] The translation used later in the Long Term Renovation Strategy is nearly zero energy buildings.

From 2020, Energy Performance Certificate (EPC) class A has been a minimum requirement for new buildings, while refurbished buildings needs to reach class C (126-150 kWh/m^2 per year) –which, compared to the rest of the EU, is not very ambitious. Estonia's Long Term Renovation Strategy sets no requirements for local renewable energy production. However, local experts estimate that existing targets will be sufficient to reach a positive energy balance at building level, as envisioned by oPEN Lab.

An assessment report by the IEA from 2023 found that less than 10% of the buildings in Estonia have a valid EPC, since these are optional and are not considered necessary by apartment owners. Lack of data regarding the building stock is a barrier for mapping the worst-performing buildings which have to be renovated first (Article 9, EPBD recast). At the same time, Estonia is currently developing a method to calculate dynamic EPCs based on actual metered energy demand, leveraging the high penetration of smart meters and digitalisation, including an e-construction platform with digital twins of the building stock.

The Estonian Business and Innovation Agency (KredEx) is running renovation programmes with a combined budget of EUR 366 million, funded by EU Structural Funds and the EU Recovery and Resilience Facility. These programmes aim to support the renovation of apartment buildings and single-family homes. KredEx offers state-backed guarantees (for example for housing associations) and provides grants for buying housing or improving its energy efficiency. Apartment building renovation grants supporting full renovations ran from 2015 to 2023; a new round will be available in 2024. There is no requirement to use prefabricated elements under the programme, but they are subsidised under a complementary innovation grant.

Besides renovation, energy performance takes into account the efficiency of heating, ventilation and air conditioning systems. Heat energy used in buildings was directly responsible for 6.5% of total GHG emissions in 2021.[7] This was largely due to individual gas and oil boilers, even though heating in Estonia is commonly supplied via district heating, as is the case in the Tartu oPEN Living Lab. District heating is regulated by the District Heating Act of 2003, which allows local governments to grant district heating companies a monopoly status. As this provides no incentive for district heating companies to upgrade to more efficient and renewable heating options, the Estonian government is incentivising local heating solutions that use biomass to increase the share of renewable energy used by district heating systems.[8]

[7] https://www.iea.org/reports/estonia-2023
[8] https://energiatalgud.ee/sites/default/files/2022-12/D7%20%282%29.pdf

Table 2 Overview of policies relevant for energy performance in buildings in Estonia.

Policy	Level implementation	Key provisions	Relevance for PEN
Minimum energy efficiency requirements	National	This regulation establishes minimum requirements for the energy performance of buildings, including low energy buildings and nearly zero-energy buildings (equivalent to NZEBs). This scope of this regulation extends to new buildings with indoor climate control and to major renovations. New constructions require class A, while major renovations require class C.	The ambition level for major renovations – class C – is very low: other Member States require up to or slightly below NZEB level. A deep renovation level is needed by PENs, and class C may not be enough to achieve a positive energy balance.
Energy Sector Organisation Act	National	This act codifies the measures for achieving the national energy efficiency target and establishes the requirements for improving energy efficiency. It designates the obligated parties in both the public and private sectors. This includes energy distributors, retail energy undertakings, and energy service providers.	Regulation promoting energy efficiency is an important part in the PEN jigsaw.
Loan guarantee for apartment associations	National Foundation KredEx	A loan guarantee is available for associations of apartment owners who want to take a bank loan to finance work to raise the quality of life of their residents but whose risk is deemed by banks to be higher than normal (e.g. a high share of people are in debt, the apartment is located in an area with low property values or in a monofunctional settlement, or the investment per square metre is significantly higher than normal).	With this loan guarantee it is possible to renovate buildings outside of county centres and in areas with low property values; it thus increases the potential areas for PENs, while involving vulnerable households.
Apartment building renovation loan	National Foundation KredEx	This loan is intended for apartment associations that have received a negative response to their renovation loan application from a bank, or an offer with unreasonable terms (e.g. very short term, or an interest rate that is significantly higher than usual). With the help of the loan it is possible to finance renovation works, and the loan can be combined with reconstruction support offered by KredEx.	With this loan it is possible to overcome financing barriers.

Regulatory barriers

The majority of the Estonian building stock has a low energy performance, with a rating of class D or lower, according to a 2022 analysis by the governmental-managed platform Energitalgud.[9] **While Estonia has transposed the 2018 EPBD and put in place minimum energy performance requirements, the absence of a long-term and adequate vision for decarbonising heating and cooling is a key policy barrier.**

[9] https://energiatalgud.ee/sites/default/files/2022-12/D7%20%282%29.pdf

There is a lack of sustainability criteria for most biomass. In addition, the silo approach towards decarbonising heating and cooling systems in buildings is frequently criticised.

Even under current energy prices the financial savings from energy efficiency renovations are only marginal for electricity, given that heat is not electrified. The district heating makes it unnecessary to electrify heat, as is being done in other oPEN Lab pilot projects. Furthermore, PEN technologies such as photovoltaic (PV) and storage are only used for purposes other than heating, such as appliances, lighting and communal services. High renovation prices and high loan interest rates clearly disincentivise investments in energy efficiency and renewable energy. A key benefit of the PEN in Tartu is the improvement in the indoor air quality and comfort; other benefits include an increase in real estate value. However, these aspects are more difficult to quantify and communicate to residents.

The subsidies for renovations from EU funds were allocated on a first come, first served basis, with no guarantee that a loan would be received. The funds were depleted quickly, and no preference was given to energy-poor or vulnerable households. Recently, the regional subsidies were reformed to include an income-based requirement.

Barriers	Policy recommendations	Stakeholder
Minimum requirements for major renovations are for class C, which is not an ambitious level and does not guarantee decarbonisation of the building stock.	In the implementation of the 2024 EPBD recast, more ambitious minimum requirements for major renovations should be adopted, which would enable a positive energy balance at PEN level.	National government
There are no public incentives for going beyond minimum energy performance requirements in renovations.	Set up public incentives in line with the 2024 EPBD recast, with a special focus on vulnerable households and deep renovations.	National and regional government
The multiple benefits of renovations (e.g. improved indoor air quality, increased real estate value) are difficult to communicate to residents.	Municipalities need to set up one-stop-shops in accordance with guidelines provided in the EPBD recast (Article 18) (in areas where Member States aim to implement integrated district renovation) and use innovative tools and calculation methods which take into account multiple benefits.	Local government
Less than 10% of the buildings in Estonia have an EPC, making it difficult to plan and implement policies targeting the worst-performing buildings.	Implement EPBD provisions to roll out EPCs and digital building logbooks. Provide public incentives for free renovation advice (EPCs and renovation passports) to lower-income households.	National and local government
Building renovations are difficult to finance, especially for vulnerable households.	Introduce and implement incentives and financing schemes targeting vulnerable households, in line with the 2024 EPBD recast.	National and local government
Uncertainty of available funds and finance.	For PEN developments, public-private partnerships and public guarantees may be suitable approaches.	National government

Collective production, sharing and selling of energy

Policy mapping

A precondition for PENs to unfold their potential is a regulatory framework that enables collective energy production and storage. Given the density of the apartments (nine storeys), rooftop PV will not be enough to achieve PEN levels, therefore vertical PV on the prefabricated elements is used as well. Additional roof space on public buildings in the area and electricity storage will also play a big role. The oPEN Living Lab Tartu aims to renovate two high-rise apartment buildings, demonstrating solutions for mechanical ventilation, and piloting the use of prefabricated elements (currently prefab-renovations in Estonia are mostly done for maximal 5-storey buildings). Heat is provided via district heating in most parts of Estonia; in Tartu, around 85% of the district heating comes from renewable energy sources, and the aim is to increase this to 100% for the Tartu Living Lab. Energy sharing models in existing apartment blocks are less common in the Estonian policy landscape.

In the Energy Market Act and recent changes to the Energy Sector Organisation Act, REDII was transposed, increasingly introducing concepts for collective energy production and sharing. RECs are defined in the Energy Market Act, but CECs from EMD were not transposed in Estonia. The concept of energy associations was introduced into law in 2013. In an amendment from February 2023, an income tax exemption for small green producers was approved. Other incentives are provided by KredEx, such as a grant for solar panels.

Table 3 Transposition of EU directives on energy sharing in Estonia

EU concept	Transposition into Estonian law	Key provisions	Relevance for PEN
CSC (REDII)	Energy Market Act	P 32(6) Apartment associations are permitted to divide and sell electricity to apartments for the purpose of supplying electricity. In 2013, the concept of energy associations was introduced into law. Energy can be sold to people in one building without a licence.	This arrangement requires a single contract and electrical connection with the DSO, and the use of sub-meters for internal electricity division. This can pose a major barrier because it means each apartment owner needs to be convinced to give up their private energy contract.
REC (REDII)	Energy Market Act (2021 amendment)	RECs may act as limited liability companies as well as public limited companies. The only restriction is that an REC cannot be a general partnership or a limited partnership within the meaning of the Commercial Code, since the members of these two legal entities cannot be local governments (NECP Estonia, 2019).	The definition has been introduced in regulation, but it is not yet widely used.
CEC (EMD)	Not transposed	N/A	N/A

Decisions on energy sharing need to be made collectively by members of apartment associations. Apartment owners in Estonia are organised in apartment associations, as was established in the Apartment Ownership and Apartment Association Act. For refurbishment work, more than 50% of apartment owners in each building need to agree on the scope and budget.[10] This has recently been changed – previously, a larger share of owners had to agree.

Estonia is a frontrunner on digitalisation, including in the energy sector. The development of dynamic energy consumption EPCs and digital twins have started, with the first version expected by 2025. A working group led by the Tartu Regional Energy Agency (TREA) – closely involving the Ministry of Economic Affairs and Markets, RAM and all market players interested in the sector – is helping to kick-start energy communities. A handbook for renewable energy communities was finalised in 2020 by TREA.[11]

Table 4 Overview of energy sharing policies in Estonia.

Policy	Level implementation	Key provisions	Relevance for PEN
Electricity Market Act (ELTS)	National	RECs are regulated with this act.	The act regulates what an energy community is, but it does not lift barriers around virtual energy sharing.
Energy Sector Organisation Act (2023 amendment)	National	This promotes the creation of RECs. These communities are important for energy sharing as they can engage in generation, distribution, supply, consumption, aggregation, energy storage, energy efficiency services, or EV charging.	Promotion of collective production.
Grant for solar panels of an apartment building	National Foundation KredEx	Apartment owners will be supported to invest in activities that promote energy efficiency in buildings and the introduction of local renewable energy.	With this grant it is possible to get renovated building to a positive energy level.

[10] https://www.housing2030.org/project/supported-self-management-estonian-cooperative-apartment-associations/
[11] TREA is the Estonian energy agency.

Regulatory barriers

Currently, energy sharing within condominiums is regulatorily challenging, due to tariff and contracting structures. Energy from a roof PV, storage or similar can only be shared for common areas (e.g. hallways). Under current regulations, using the energy privately would require just one energy contract for all tenants. Having a smart meter for the whole building and contract is legally possible; however, it would require internal self-organisation to install individual smart meters per apartment unit to allocate cost-sharing internally. It would also require every apartment owner to cancel their individual contract with their energy provider. This has been a main barrier to easy energy sharing in Tartu. In other countries like Spain, the issue was solved through an enabling system according to which shares of PV consumption are allocated to each tenant, and lifting legal issues to allow individual billing which reflects varying self-consumption.

Furthermore, apartment associations are run by volunteers and are a bottleneck for the realisation of collective energy production projects. They can sell energy to the grid as they are a legal entity.

Barriers	Policy recommendations	Stakeholder
Tariff structures do not currently allow CSC outside of common spaces in apartment buildings. Tariff structures do not currently allow virtual energy sharing.	Draft clearer regulations on CSC to facilitate individual billing for collectively produced energy.	National government
Decision-making for energy sharing relies on the capacity of apartment associations and their voluntary leaders to access information on financing and energy regulation.	Increase information on the benefits of collective energy production.	Local government

Demand-side flexibility

Policy mapping

PENs can play a key role in the transformation of the energy system, as they can provide flexibility services to the distribution grid. Smart technologies and automation are a pivotal part of enabling this flexibility of consumption. In Tartu, the plan is for energy efficiency in apartment buildings to be enhanced with a ventilation system that responds to CO_2 levels to regulate fresh air supply. This system will be integrated with smart home technologies, allowing residents to manage their apartment's temperature and ventilation within energy-efficient limits. Additionally, smart metering will aid housing associations in management and billing, while also providing residents with data on their energy usage to encourage energy-saving behaviours. PV will be combined with storage to allow for flexibility services and optimise neighbourhood consumption.

The Estonian grid is currently desynchronised[12] with the Russian grid, and plans were made in 2023 to connect to the Continental Europe Network grid (CEN) by early 2025. The transmission system operator (TSO) is dividing the balancing market into three segments going forward. Currently, one market is available, the 'manual Frequency Restoration Reserve' (mFRR),[13] and two more will be introduced (aFRR and FCR).[14] This division could be a strategy to manage different aspects of grid balancing, such as short-term, real-time and reserve services, more effectively. Currently, the mFFR is a part of the balancing market, but with the opening of new markets there will be a need for additional regulation for the TSO. The Living Lab is planning to offer flexibility services with the battery, integrated into a virtual power plant, to the TSO.

According to Estonian legislation, 100% coverage of smart electricity meters should have been reached in 2017, ahead of the EU goal of 2020. This was implemented through the Elektrilevi[15] Smart Metering programme which started in 2013. For offices and households the goal was already achieved in 2016,[16] yet work remains to be done toward the smart management of the energy sector. Since 2017, Estfeed has been operating as a data exchange platform. The Estfeed content management system gives third parties access to users' information while citizens remain the owner of their data. The front office of this system is the e-Elering portal, where customers can check and compare and grant access to personal energy metering data. Furthermore, the NetFix tool was created by the distribution system operator (DSO) to prevent power outages by monitoring the power grid via smart meter data and detecting defects and their root causes.

Estonia is the first country in the word to have a 3D digital twin of its building stock. The digital twin makes it possible to walk through neighbourhoods, and visualises data from the building register from planned, erected, existing and demolished buildings.[17] These data are matched with building information models, and areas related to heritage protection or environment and technical zones can also be displayed. It is used as a tool for decision-making, and in the long term it will also support the development of PENs.

Table 5 Overview of demand-side flexibility policies in Estonia.

Policy	Level implementation	Key provisions	Impact for PENs
Digital construction communication	National	Transition to digital construction to enhance efficiency, the use of business information model modelling, and the development of a digital 3D twin of Estonia's built environment. This approach aims to improve sector management, foster new business models, and increase construction productivity.	These digital advancements enable more efficient planning, construction, and maintenance of energy-efficient buildings, facilitating the integration of renewable energy sources and smart energy management systems, and contribute to PEN objectives.

[12] This refers to a state when two or more power grids are not operating at the same frequency. For Estonia, being desynchronised from the Russian grid means that its electricity system is not physically or electrically connected to the Russian system anymore, preventing any direct power exchang.
[13] mFRR is a process for restoring the frequency and power balance in a power grid.
[14] https://elering.ee/en/baltic-marke
[15] Estonian DSO
[16] https://www.elektrilevi.ee/uudised/avaleht/-/newsv2/2016/11/08/elektrilevi-vahetab-kauglugemisele-uleminekuks-viimaseid-arvesteid
[17] https://mkm.ee/uudised/uuendatud-eesti-3d-kaksikus-naeb-naabruskonda-kerkivaid-hooneid

Regulatory barriers

In some countries, transfer fees from batteries for small consumers (like residential households) have been removed; however, they have not in Estonia. Transfer fees are the costs associated with moving electricity from one place to another, and are often included in energy bills. For households these fees can be significant, sometimes around EUR 118/MWh,[18] which can discourage energy sharing. There is a need to avoiding double taxation. When purchasing energy from the grid for storing purposes the buyer has to pay all grid fees, then if they sell it to the grid and someone else purchases that energy, they pay all the fees again for the same electricity. While this makes sense for the energy transfer fee (as the user still uses the grid), it does not make sense for the excise or renewable energy fee. This makes energy sharing and storing – and thus flexibility – less financially viable for small consumers. Some countries such as Austria and Spain have introduced exemptions to grid tariffs if the energy is being used within a low or medium-voltage grid.

Banks still seem to be hesitating to give out loans for PENs and flexibility-relevant energy storage systems. This is because their business case hasn't yet been proved.

The DSO is a key actor in PENs, as it has power over the renewable energy source capacity that can be assigned. The DSO in Tartu currently has no incentive to provide the infrastructure and licences for more decentralised, small-scale PV systems in urban areas, which is a requirement to maximise local self-consumption. It is currently easier to achieve decarbonisation targets by increasing grid capacity to bring in renewables from offshore plants; however, this approach requires additional public investments in grid upgrades.

Barriers	Policy recommendations	Stakeholder
Lack of awareness of the multiple benefits of smartness, such as energy security and reduced investments in grid upgrades.	Communicate multiple benefits to residents, developers and potential investors.	Local and national government
High transfer fees.	Set incentives for cheaper transfer fees for charging batteries from the grid when demand is low (off-peak hours) to balance the grid.	National government
Double taxation inhibiting the viability of energy storage.	Adapt the Electricity Market Act to reduce renewable energy charges.	National government

Whole-life carbon and circularity

Policy mapping

PENs may contain buildings of varying types and uses and a combination of technological systems, allowing for some flexibility for materials and technology choices in renovation processes. Under the recast EPBD the calculation of embodied emissions will be obligatory (EPBD recast, Annex III). Current regulations in Estonia such as the Building Code and Product Conformity Act mandate what kind of materials can be used in construction. The Building Code focuses on increasing the use of renewable energy source in the building sector.

[18] This includes transfer fee, renewable energy fee, excise, VAT: https://www.elektrilevi.ee/-/doc/8644141/kliendile/Elektrilevi_hinnakiri_vorguteenuse_hinnad_alates_01.01.2024.pdf

As of 2022, Estonia did not have a **circular economy policy**; however, it is part of the 'Estonia 2035' strategy. The country committed to develop a circular economy white paper (Ringmajanduse valge raamat) in 2022, although the white paper does not specify any targets except for identified actions. Even though there has been a waste strategy for 2022-2028, construction waste has not been considered as a topic.

The Green Public Procurement policy (GPP) has mentioned circularity since 2022; however, only for copy and graphic paper, cleaning products and services, office information technology (IT) equipment, and furniture. GPP is mentioned in the Estonia circular economy white paper as an area of action.

Table 6 Policies for embodied emissions and circularity in Estonia.

Policy	Level implementation	Key provisions	Impact for PENs
Building Code – Riigi Teataja	National	The Code establishes the basis and procedures for design work and building work, and the use and registration of construction works. It imposes an obligation to observe good construction practices in design and construction.	Could include stricter requirements to promote sustainable materials.
Product Conformity Act	National	The law limits what kind of materials can be used for construction.	Can support sustainable material use in construction.

Regulatory barriers

The Tartu oPEN Living Lab is working with nine-storey buildings, which are excluded from existing fire protection regulation (which covers buildings of up to 8 storeys). This makes it difficult to use certain materials such as wood for renovations. Woodhouse Estonia, an association for wood manufacturers, is already working to remove this regulatory barrier.

Barriers	Policy recommendations	Stakeholder
GPP includes circularity only for certain items, currently excluding the building sector.	Include circularity requirements for buildings in the GPP regulation.	National government

5. Conclusion

Estonia's policy landscape, while not directly encouraging PENs, supports significant aspects of them. Notably, Estonia leads in digital advancements with its digital twin technology, which supports energy sharing and technology integration. However, Estonia also faces hurdles, such as a lack of incentives to exceed minimum renovation requirements and challenges in decision-making processes within housing associations. These have recently been addressed to some extent by legislative changes.

Various barriers remain. Even though NZEB levels were set for new constructions, the minimum requirement for major renovations is label C, which does not encourage ambitious renovations. Furthermore, there are no incentives to go beyond minimum requirements. Estonia is seen as a leader on prefabrication; however, this is entirely based on voluntary initiatives. Housing associations are a bottleneck for PENs in Estonia, due to cumbersome decision-making processes (and a dependence on the time and interest of voluntary leaders); however, recent changes in the Non-Profit Legal Entities Act make it easier to make collective decisions for PEN-relevant interventions.

CSC has been transposed from REDII, but it is limited within a building and, due to metering barriers, virtual energy sharing in practice is impossible. CEC has not been transposed from EMD. Double taxation of energy means energy storage and sharing are not yet profitable. This means it is not yet widely supported by banks, and there are no financial incentives for storage. While the TSO and DSO agree that storage is essential for the grid, they have no active incentives to promote their acceptance in the market. Estonia is developing advanced handling of data with its digital twin. The country is paving the way towards allowing a digital system that could not only support PENs – demand-side flexibility, energy sharing and combination of technologies – but could also help identify where PENs could be implemented.

PEN is a promising approach for achieving EU energy objectives, but its success depends on national governments including it in their own policies and programmes. The explicit mention of neighbourhood and district approaches for renovations and the requirement to report on progress within national building renovation plans in the new EPBD is an important milestone for the PEN approach. To further foster the uptake of PENs there is a need for a common definition and framework. The definition must leave enough flexibility to enable local adjustments, depending on limitations such as heritage regulations, renewable energy potential, and electricity grid capacity. However, the concept, approach and calculation method should be harmonised to allow for comparison between projects. In addition, such a definition is critical to enable meaningful follow-up on the policy goals related to the progress of district and neighbourhood approaches in the national building renovation plans.

6. References

Blumberga, A., Vanaga, R., Freimanis, R., Blumberga, D., Antuzs, J., Krastinš, A., Jankovskis, I., Bondars, E., & Treija, S. (2020). Transition from traditional historic urban block to positive energy block. Energy, 202, 117485. https://doi.org/10.1016/J.ENERGY.2020.117485

Brozovsky, J., Gustavsen, A., & Gaitani, N. (2021). Zero emission neighbourhoods and positive energy districts – A state-of-the-art review. Sustainable Cities and Society, 72(May), 103013. https://doi.org/10.1016/j.scs.2021.103013

Hedman, Å., Rehman, H. U., Gabaldón, A., Bisello, A., Albert-Seifried, V., Zhang, X., Guarino, F., Grynning, S., Eicker, U., Neumann, H. M., Tuominen, P., & Reda, F. (2021). IEA EBC Annex83 positive energy districts. Buildings, 11(3). https://doi.org/10.3390/buildings11030130

Malik, J., Hong, T., Wei, M., & Rotmann, S. (2023). Prioritize energy sufficiency to decarbonize our buildings. Nature Human Behaviour, 8(3), 406–410. https://doi.org/10.1038/s41562-023-01752-0

OECD. (2023). Decarbonising Homes in Cities in the Netherlands: A Neighbourhood Approach. www.oecd.org.

Saheb, Y., Shnapp, S., & Paci, D. (2019). From nearly-zero energy buildings to net-zero energy districts. https://doi.org/10.2760/693662

Shukla, P. R., Skea, J., Reisinger, A., Slade, R., Fradera, R., Pathak, M., Al, A., Malek, K., Renée Van Diemen, B., Hasija, A., Lisboa, G., Luz, S., Malley, J., Mccollum, D., & Some, S. (2022). Climate Change 2022 Mitigation of Climate Change Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. www.ipcc.ch

Vandevyvere, H., Ahlers, D., & Wyckmans, A. (2022). The Sense and Non-Sense of PEDs—Feeding Back Practical Experiences of Positive Energy District Demonstrators into the European PED Framework Definition Development Process. Energies, 15(12). https://doi.org/10.3390/en15124491

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