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

FLANDERS

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Abbreviations and acronyms

Acronym	Description
BAPV	Building applied photovoltaic
BIPV	Building integrated photovoltaic
CEC	Citizen energy community
CSC	Collective self-consumption
DSO	Distribution System Operator
CTE	Technical Building Code
EED	Energy Efficiency Directive
EMD	Electricity Market Design
EPBD	Energy Performance of Buildings Directive
EV	Electric vehicle
GHG	Greenhouse gases
MEPS	Minimum energy performance standards
NZEB	Nearly zero-energy building
OVAM	Public Waste Agency of Flanders
PEN	Positive energy neighbourhood
PV	Photovoltaic
REC	Renewable energy community
RED	Renewable Energy Directive
ZEB	Zero emission building

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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 and regional implementation of the EU policies which underpin the PEN approach to building renovations.

oPEN Lab draws from the experience of Genk oPEN Living Lab 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.

More concretely, in Flanders, while the PEN approach is not explicitly encouraged, local climate pacts and renovation incentives support elements of PENs, with pioneering efforts in minimum energy performance standards. However, challenges remain for energy sharing as collective self-consumption is limited to vertical apartment buildings and cannot easily applied to horizontally connected buildings. Furthermore, issues with energy storage and double taxation persist, impeding broader adoption.

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.

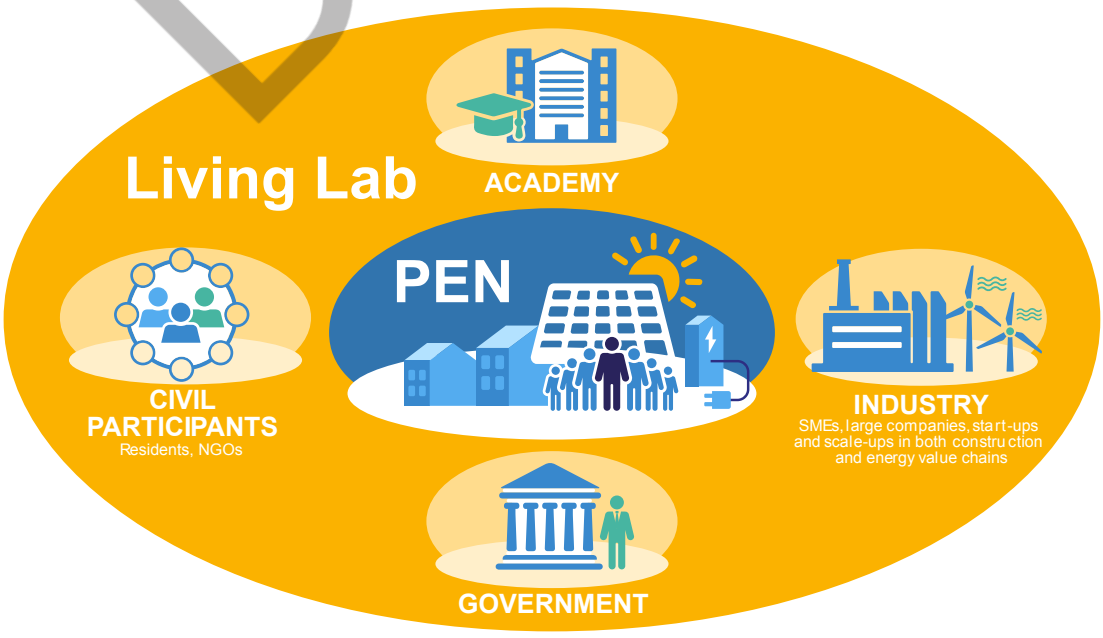

Figure 1 Conceptual difference between PEN and Living Lab

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 Genk (Flanders, Belgium) Living Lab

4.1 Introduction

The oPEN Living Lab Genk is located in the former coal mine region of Limburg, in Flanders, Belgium. Under the Belgian governance structure, the federal government oversees electricity transmission, large-scale generation and energy security, while the three regional governments (Flanders, Wallonia and Brussels Region), are in charge of areas such as renewable energy, energy efficiency, the regulation of retail energy markets, and housing. Thus, most PEN-related regulations – particularly those aimed at reducing GHG emissions in buildings, electrifying heating systems and giving buildings a more active role in the energy system – fall under a Flemish remit due to Flanders' regional authority in energy and climate matters. PENs are further driven by local governments, through local policies and action plans.

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The purpose of the following analysis is twofold:

1. Through policy mapping and analysis, the current readiness of Flanders' regulatory ecosystem for PENs is assessed. Based on extensive desktop research, the transposition of PEN-relevant EU directives in Flanders and other key policies relevant for PENs were scrutinised. This will provide a **first analysis of the key areas for 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 PENs:

- 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 sessions** with key stakeholders of the oPEN Living Lab Genk – such as research institutes, NGOs, and a social housing company – regulatory barriers were identified. **This provides a base for tailored policy recommendations to facilitate PEN uptake in Flanders going forward.**

To provide more information on the context in which the PEN scale-up is envisioned, the following section gives some background on the oPEN Living Lab Genk and the current state of Belgian, Flemish and Genk climate policy.

4.2 Background

The oPEN Living Lab Genk

The city of Genk has a population of around 66,000. The oPEN Living Lab Genk is located in a suburban neighbourhood called Waterschei, with semi-detached and terraced residential buildings. The oPEN Living Lab includes 27 dwellings in Nieuw Texas from the social housing company Wonen in Limburg (WiL) built in the 1990s in Waterschei. It also has eight privately owned dwellings in a neighbourhood originally built as Garden City in the 1920s, a home for mining families from the former coal mine of Waterschei. The collective renovation of the neighbourhood is part of the GEENkool ('no coal') plan, a roadmap towards climate neutrality in 2050 which is currently being worked on by the city of Genk.

oPEN Lab aims to transform these houses into energy-positive buildings through collective and individual innovative measures. For example, deep renovations are envisioned using prefabricated elements, in combination with heat pumps (either collective or individual) and various solar panel technologies. The area is designed to be a 'technological playground' where the various set-ups and combinations of different types of heat pumps, batteries, solar panels and ventilation systems can be tested and compared. In practice, these technologies are combined into energy boxes as plug-and-play solutions installed outside the semi-detached houses, serving several buildings at the same time. All the technologies are connected through a central data platform and a neighbourhood energy management system to steer demand-side flexibility. A bidirectional communication system is being implemented that allows the interaction of real-time data from individual building components with weather forecasts and dynamic tariffs (e.g. day-ahead prices). It automates demand-side flexibility smoothly and matches the cheapest times for energy consumption for individual buildings while still guaranteeing sufficient comfort. Different dwellings can have different schedules, accumulating to an optimal solution which spreads the energy load at district level. oPEN Living Lab Genk does not aim to change any active user behaviours.

Climate and environmental policy landscape

Before diving into PEN-specific policy and regulatory barriers and drivers, it is key to understand the Belgian climate and energy policy landscape. As per the last draft update of Belgium's National Energy and Climate Plan (NECP) from November 2023, the aim is for GHG emissions in Effort Sharing Regulation (ESR)[6] sectors to be reduced by 47% by 2030 compared to 2005 levels, and for renewables to provide 21.7% of the gross final energy consumption. The Commission has assessed that the NECP will only be able to reduce GHG emissions by 42.6%.[7]

The European Commission's country report for Belgium from 2023 stated that "Belgium faces significant challenges in moving to a green and climate-resilient economy", given its "strong reliance on imported fossil fuels" (p.5). Untapped potential to increase energy efficiency in buildings was particularly highlighted, with 80% of the building stock still not being energy efficient (Energy Performance Certificate (EPC) label C or lower).

[6] The EU target is a 40% reduction in GHG emissions by 2030. It refers to road transport, heating of buildings, agriculture, small industrial installations and waste management.

[7] https://commission.europa.eu/document/download/e0d758c6-a2e0-408f-9251-559801675f43_en?filename=SWD_Assessment_draft_updated_NECP_Belgium_2023_0.pdf

However, progress is being made: a change in the tax system was agreed in October 2023 to make investments in the efficient use of (renewable) energy tax-deductible. Furthermore, more than half of the EUR 5.9 billion in NRRP funding should go towards national climate and energy targets, with EUR 1.012 billion for building renovation.

According to the updated Flemish Energy and Climate Plan 2021-2030 (VEKP), Flanders aims to reduce its GHG emissions in the ESR sectors by 40% by 2030 compared to 2005.[8] The Flemish Climate Strategy 2050 from 2019 aims to reduce GHG emissions in the ESR sectors by 85% by 2050 compared to 2005, and reach a climate-neutral economy by 2050. In addition, the Flemish Region has set a goal to make all buildings and technical infrastructure carbon-neutral by 2045, and reduce their primary energy consumption by 35% by 2030 compared to 2005. There is an ambition to renovate all Flemish government buildings by 2030 to reduce their CO^2 emissions by 55%, and all buildings should be energy-efficient by 2040. To achieve these objectives, all governmental bodies must update the Long Term Renovation Strategy, which includes an energy masterplan.

The Long Term Renovation Strategy also set a target for an average EPC figure for residential buildings to be reduced by 75% to EPC label A by 2050 (p. 5). In 2023 only 6% of residential buildings in Flanders had an EPC A, and over 3% of dwellings will need to be renovated every year over the next 30 years (p.6). In 2022, Flanders implemented a revamped subsidy programme aimed at promoting renewable energy and enhancing energy efficiency. This initiative, backed by EUR 243 million from the Recovery and Resilience Facility, is expected to facilitate the energy-efficient renovation of nearly 200,000 homes by the middle of 2025.

Finally, Flanders has adopted a Local Energy and Climate Plan (LEKP), a pact for local energy and climate action signed by Flanders and the local governments. It encompasses around 300 municipalities and has four main pillars, one of which is collective renovation and renewables. More specifically, it sets the goal of there being one cooperative renewable energy project per 500 inhabitants and 50 collective housing renovations per 1,000 units by 2030. As a participating city, Genk is working on a climate strategy for 2030 to reduce CO^2 emissions by 40% compared to a 2011 reference level.

4.3 Analysis of the regulatory framework

Energy performance in buildings

Policy mapping and assessment

Reducing energy demand and increasing renewable energy production in buildings in a PEN are key to achieving a positive energy balance. The buildings of the oPEN Living Lab Genk will undertake deep renovations, with insulation of the envelopes and a mix of individual and collective heat pumps and storage systems.

Currently, Flemish policies set minimum requirements for energy performance for major renovations in accordance with the EPBD – and even provide a large number of incentives to go beyond it.

[8] Under the revision of the ETS directive, ETS2 will also include buildings long-term, however, in the VEKP Flanders still considers building emissions under ESR sectors.

The Flemish Energy and Climate Plan 2021-2030 (VEKP) recognises the need for renovation obligations as well as financial support, potentially linked to the final energy score of buildings. Trigger points for renovation such as transactions, new rentals or demolition were already defined in the Flemish Long Term Renovation Strategy. Flanders had already introduced the 'Energy Performance Regulations for New Construction and Renovation' (EPB) in 2006. This requires a minimum level of insulation, energy efficiency, ventilation, energy performance or share of renewables. It applies to new construction and extensive energy renovation. As seen in Table 2, nearly zero-emission building **(NZEB) levels have been updated for 2021** and are now set at a maximum of E30 for new construction or equivalent, which means 70% below the baseline primary energy demand of E100 and E60 for major renovations.[9] oPEN Living Lab Genk is aiming for deep renovations which reach an average E-level of -20 (EPC label A+).

Table 2 EPB requirements for residential buildings for 2023.

	E-level	S-level	Renewables
New construction	Max E30	Max S28	Minimum 25 kWh/m² per year (reduced to minimum 15 kWh/m² per year from 2025)
Major renovations	Max E60	N/A	Minimum 20 kWh/m² per year

While they are not yet mandatory, Flanders has been a frontrunner at setting MEPS; **renovations have been obligatory since January 2023** for new owners of residential real estate of EPC class E or F to a level of at least D within five years of the date of purchase. D is the first step, with further tightening of obligations in 2028, 2040 and 2045, as seen below in Table 3.

Table 3 Timeline of MEPS in Flanders.

	1/1/2023	1/1/2028	1/1/2035	1/1/2040	1/1/2045
EPC class to be achieved after renovation within five years	House: D Apartment: D	House: C Apartment: C	House: B Apartment: C	House: A Apartment: B	House: A Apartment: A

[9] https://www.vlaanderen.be/e-peil

The Flemish government via Fluvius[10] provides a number of incentives to encourage higher energy performance, which shows clear support for its renovation targets. The 'My Renovation Premium', co-financed via NextGeneration EU,[11] allows individuals and housing companies to get financial support for various interventions such as roof or floor insulation, heat pumps and replacement windows. For individuals the scheme is tied to income categories, and was extended to the end of 2024 for middle and low-income categories. Furthermore, there is a loan for renovation – 'My Renovation Loan' (up to EUR 60,000) – for those who buy real estate with labels A to D. There was also a reduced federal VAT rate of 6% in 2020 and 2021 for demolition and reconstruction (maximum area 200 m2). An EPC label premium (free EPC) in 2021 tied to the energy class achieved (at least C), financed via NGEU, was discontinued; however, the 'property tax reduction for energy efficient buildings' remains active. Its amount is tied to the E-level (recorded in the EPC) of the building, which will be calculated for new construction or after major energy renovations.

For social housing companies Flanders has various VKF subsidies (Vlaams Klimaatfonds Subsidies) which target energy renovations. Generally, renovations in social housing are financed via the government agency which provides loans, limited to EUR 4,000 per measure.

For social housing, renovations with prefabricated elements are particularly useful, as they allow tenants to stay on their premises, saving costs but also avoiding significant disruption in the lives of people who are already vulnerable. The oPEN Living Lab Genk plans to use prefabricated insulated elements that are attached to the existing façades. However, current financial incentives do not favour the use of prefabricated renovation. This is despite its benefits to the housing owners and the social housing companies, such as faster results, reduced waiting lists for social housing, and less waste onsite. The additional social value and cost savings for social housing companies from avoiding tenant movement is not currently factored into considerations for renovation loans.

Besides the building envelope, energy performance is also impacted by HVAC systems. In autumn 2022, the launch of EnergyVille's PATHS2050 — The Power of Perspective highlighted the pivotal role of heat pumps, alongside demand reduction, as a fundamental component for the decarbonisation of Belgium's building sector. The online platform offers key insights into achieving cost-effectiveness across various sectors, with scenarios consistently indicating the necessity of extensive heat pump deployment, supported by district heating regardless of the scenario considered. As regulated in the latest update of the 'Energy Decree of May 9, 2009' in 2021, all new buildings will have to be independent of fossil fuels from 2025. From 2023, new-build homes have been allowed to use hybrid heat pumps which can operate on gas and electricity. There are Premiums for a heat pump or heat pump boiler when conducting a renovation or repurposing. From 2026, natural gas connections will no longer be possible in new construction. In the 'Heat Plan 2025', the green heat, waste heat and heat networks calls were evaluated and merged into a single call without subcategories to rank all projects based on cost-efficiency and maximise the impact of the available budget. Support for low-temperature heat networks has been increased, and CO_2 calculations are aligned with the lifespan of the technology. The plan also discusses the importance of localised heating solutions and the role of municipalities in developing heat plans tailored to their specific spatial context.

[10] Fluvius is a the Flemish utility company, owned by 11 intercommunal organisations, owned by and operational in all 300 Flemish cities and municipalities throughout Flanders. It deals with the construction, maintenance and operation of essential utility networks in the Flanders region.
[11] NextGenerationEU is a temporary recovery instrument of EUR 800 billion to help repair the immediate economic and social damage brought about by the coronavirus pandemic and to build a post-COVID-19 Europe that is greener, more digital, and more resilient. https://next-generation-eu.europa.eu/index_en

Table 4 Overview of policies relevant for energy performance in buildings.

Policy	Level implementation	Key provisions	Relevance for PEN
Decree amending the Energy Decree of 8 May 2009 (18 March 2022)	Regional	Obligation to renovate extended to residential buildings (houses and apartments) from January 2023. New owners of a building with EPC label E and F have to renovate it within 5 years to at least level D (increasing ambition to A until 2045).	Renovating with a PEN approach can be an effective way to fulfil the obligation to carry out an energy renovation (MEPS).
Decree amending the Energy Decree of 8 May 2009 and the Flemish Housing Codex of 2021 (19 November 2021)	Regional	Registration tax reduced from 6% to 4%: natural persons who purchase a home as their sole residence from 1 January 2022 and who undertake to carry out major energy-related renovations or partial reconstruction benefit from an additional reduced tax rate and pay only 1% registration tax instead of 3%.	Financial incentives to renovate are crucial for PENs.
Energy Performance Regulations for New Construction and Renovation (EPB)	Regional	Sets minimum performance requirements for major renovations: beside overall energy performance of max E60, there are requirements for building elements and renewable energy: • Minimum roof insulation: if the minimum R-value of 0.75 m^2K/W for roof insulation is not achieved by the time of deed execution, then the roof must be insulated to a maximum U-value of 0.24W/m^2K. • Solar-control glass: glass must be replaced only by glazing with a maximum U-value of 1W/m^2K. • Central heating systems older than 15 years on the date of deed execution must be replaced by a new heat generator unless it can be demonstrated that the space heating system meets the minimum system requirements for renovation. • Mandatory share of renewables of 20 kWh/m^2per year.	Establishing high requirements for insulation, installation, ventilation and heating and renewable energy share means more actors are willing to innovate to achieve better performance towards a PEN.
Premium for solar panels on buildings	Regional	Subsidy for solar panels, will be phased out in 2024.	Solar panels are an integral part of PENs and subsidies for renewable energy are supportive of PEN business models.

Renovation credit with interest subsidy	Regional	Interest subsidy for those taking out a renovation loan to renovate within 5 years of purchase of a house labelled E or F. It is tied to the ambition of the renovation, meaning within 5 years a minimum EPC level from A to D is required depending on the loan amount (e.g. Level D for a EUR 20,000 loan with an interest subsidy of EUR 4,369, Level A for a EUR 60,000 loan with interest subsidy of EUR 22,781). By the government via banks until end 2024.	Encourages higher renovation ambitions, which can help to achieve positive energy balance at neighbourhood level and contributes to PEN business models.
Renovation loan (since 2022)	Regional	Loans up to EUR 60,000 are available for homeowners to improve energy performance or housing quality. The conditions differ, for example dependent on the income bracket. There is a discount on the statutory interest rate. Provided by the government via energy houses.	Renovations to achieve PEN level require high upfront costs, preferential interest rates and access to loans; also an important enabler for low-income homeowners to be able to join a PEN.
My Renovation Premium (updated in 2022)	Regional	Integrates renovation and energy premium from Wonen in Vlaanders and Fluvius for energy efficiency investment. Financial support for investments in energy efficiency (such as roof, wall and floor insulation, high-efficiency glazing, solar boiler, heat pump, heat pump boiler and gas condensing boiler) and investments in housing quality (electricity and plumbing, interior renovation, windows and doors). Government will extend the temporarily higher My Renovation Premium in the middle (35%) and lowest (50%) income categories for applications until the end of 2024, instead of for applications until the end of 2023. Initially, this higher premium would drop to 25% and 35% respectively.	Encourage deep renovations, regarding both energy performance and housing quality which serves the PEN approach. Targets middle income and vulnerable households, which otherwise would face difficulties being part of a PEN project due to high upfront costs.
Energy premiums for social housing actors (VKF subsidies)	Regional	With EUR 25 million of Recovery and Resilience Funds, more than 4,200 social housing units received an energy renovation in 2022.	The PEN approach can be an effective way to scale up renovation of social housing with high ambition levels.

Regulatory barrier analysis

Flanders has transposed the 2018 EPBD effectively, and has put in place minimum energy performance requirements and financial incentives for renovations. An obligation to renovate was introduced early. Nevertheless, renovation rates remain too low, and using the PEN approach to renovate clusters of the worst-performing buildings may be an effective way to increase them. Social housing could also contribute, and some public funds have been made available; however, enabling private finance is crucial.

For the PEN approach, serial prefabricated renovations can help to efficiently achieve renovation targets for simply designed dwellings. They are specifically of interest to social housing companies which can avoid moving their tenants during the renovation phase. However, current policies do not mention the use of renovations with prefabricated elements, and any benefits from their use are unrecognised. Using prefabricated elements is as yet very expensive, since the large-scale industrial production required is not anchored to a steady demand. Furthermore, the space required for the innovative use and combination of technologies at a local level to harvest the benefits of the PEN approach is not yet taken into account in local urban planning.

Barriers	Policy recommendations	Stakeholder
Current regulations and incentives **do not** acknowledge the benefits of prefabricated renovation or offer incentives to promote it.	Subsidies and public funding should support the widespread use of prefabricated renovation, for example via public procurement.	Regional government
The financial threshold per renovation measure set for different technologies for social housing companies taking up loans is very low. **This does not allow social housing companies to go beyond minimum requirements.**	Financial products should be made available for very ambitious renovation projects such as PENs, which acknowledge the multiple benefits of deep renovations both for tenants and for society.	Financial institutions
The placement of 'energy boxes' outside the house can interfere with urban planning regulations and requires flexibility from local governments.	Facilitate exceptions and regulatory sandboxes, especially for innovative projects such as PENs. Incorporate changes to urban planning based on the results of pilot projects such as oPEN Lab.	Local governments

Collective energy production and sharing

Policy mapping

A precondition for PENs to unfold their potential is a regulatory framework that enables collective production and storage of energy. For the oPEN Living Lab Genk, the ambition is to set up a renewable energy community (REC) in which excess renewable electricity can be shared either with neighbourhood infrastructure or the neighbours themselves. The social housing company WiL would like to offer this excess of electricity to other tenants living in the neighbourhood who are not part of the Living Lab.

In the Flemish transposition of the REDII and 2019 EMD, citizens and energy communities were given a more prominent role in the energy market from 2022. The Flemish regulator (VREG) imposed a trajectory on energy sharing for 2022-2023.[12] Energy sharing was originally implemented through collective self-consumption (CSC) at building level, where each apartment had its own supplier and where energy sharing was only possible between citizens with the same supplier. This was changed gradually, giving time to the distribution system operator Fluvius to deal with the technical complexity involved.[13]

[12] https://www.vreg.be/sites/default/files/document/rapp-2022-23.pdf
[13] https://uploads.strikinglycdn.com/files/d0f7e7f1-5434-4f17-ab7a-68f6da40884f/First policy and market recommendations (1).pdf

Table 5 Transposition of EU directives on energy sharing in Flanders.

EU concept	Law FL	Key provisions	Relevance for PEN
CSC (REDII)	Energy Decree	4.4.2 The right to become an active consumer is already defined in the 2009 version, as well as the right to self-consumption. 7.2.1 (energy sharing) Energy sharing without cost: between two properties of the same owner or within an apartment building. In an apartment, dwellers can invest together in renewable energy in the building, but grid tariffs apply when it is shared between inhabitants. 7.2.2, §2 (peer-to-peer trading) 7.2.3 (Sales in apartment buildings and multi-purpose buildings) Protocol Energy selling: peer-to-peer trading between two dwellers or many-to-one, or the (communal or private) owner of an apartment building can sell electricity to the inhabitants. Grid tariffs and administration costs for the energy company apply.	Facilitates energy sharing. Extends the scope of how energy can be shared and sold. Removes grid tariffs for CSC within an apartment building and beyond, as long as it remains within the low-voltage grid.
REC (REDII)	Energy Decree	4.8.2., Definition of a REC and its rights. 4.8.4. Definition of REC activities.	Geographical boundary not defined. Financial incentives such as grid tariff exemption could be set for energy sharing within low and medium-voltage grids because this avoids investments in grid upgrades. Currently, most energy cooperatives are set within 30 km of their installation.
CEC (EMD 4)	Energy Decree	4.8.1. Definition of a citizen energy community (CEC) and its rights. 4.8.4. Definition of CEC activities.	A CEC is limited to electricity, while for a PEN a mix of technologies including heat production and storage may be necessary.

From June 2022, the possibility of peer-to-peer trading was added. Now energy sharing within a single building with the same energy supplier is possible, as well as selling or donating a surplus of self-produced energy peer-to-peer (an amount of EUR/kWh per transaction is possible, unlike with energy sharing, which must be at no cost for the energy component). Since July 2022, it has also been possible to share energy with individuals with other assets (holiday house, rental house etc.) in Flanders) or with a municipality with publicly owned buildings (City hall, swimming pool, library etc.). As a result, at the end of 2022, Fluvius had 600 customers engaging in energy sharing.

Furthermore, since 2023, energy sharing within an REC or CEC has been permitted, and the limit on only sharing energy among entities with the same energy supplier has been lifted. Individual self-consumption at household level is promoted, since the consumption of electricity during renewable energy production is fully exempted from fees and taxes. Yet active customers are not permitted to sell or donate electricity to multiple active customers. Only natural persons or legal entities – e.g. a community – are permitted to share. Other conditions also need to be met, such as having an individual connection to the grid and a digital meter with quarter-hour values. These changes address a number of barriers to energy sharing which were outlined in an assessment by REScoop from 2023. The capacity limit of 40 kVA for CSC was lifted, and photovoltaic (PV) was no longer treated as the only production technology.

Table 6 Overview of energy sharing policies in Flanders.

Policy	Implementation level	Key provisions	Relevance for PEN
Decree of 17 December 2021 amending Energy Decree 08 May 2009	Regional	Includes the concept of **energy communities and CSC**, and several changes of the operation of the distribution grid, including closed electricity distribution networks that only supply/transmit to limited production locations, as opposed to private networks. It also has a clearer definition for different energy sharing concepts, as outlined above.	The update has lifted a key barrier for PENs, as energy sharing as active consumers is now possible even with different energy suppliers. Active consumers sharing energy do not need to be in the same building provided they are organised as a legal entity (e.g. REC).
Decree 25 November 2022 amending Energy Decree of 8 May 2009	Regional	Legal basis to require natural or legal persons to install a certain number of PV panels. Applying to building owners with annual gross electricity consumption of more than 1 GWh (and also government buildings with a consumption above 250 MWh, or 100 MWh from 2026).	Relevant for PENs with large non-residential stakeholders.

Regulatory barriers analysis

The concept of the citizen energy cooperative has a history in Flanders. While the Flemish policy landscape has been gradually evolving more in favour of collective energy models, **there is still no clear vision about the purpose of energy communities**. The transposition of EU directives does not always align with the original vision of cooperatives or the regional regulatory setup in Flanders. While there is recognition of their opportunities – such as social aspects and inclusion, cooperation and trust on a local level, solving local congestion, integrating flexibility, maximising decentralised renewable production, Demand Side Flexibility – the concept itself is not really understood, and the target group remains unclear. This has led to work-arounds which avoid aspects of the legislation, and hasty implementation without

Results from Flux 50, the energy learning network, confirm that starting up an energy community is still perceived to be too complex for an average citizen. Communities, apartment owners and city districts as well as SMEs have expressed an interest in being part of an energy community in Flanders. However, in 2023 only a very few fully functional ones have actually been implemented. Experiences have shown that the different types of energy communities and modes of energy sharing (CSC, RECs, CEC etc.) create confusion. Setting up a new entity or association is too complex or too labour-intensive for many citizens and companies – although a recent initiative to help with this, a 'Technical Assistant Hub' (TA Hub),[14] was launched in December 2023.

The incentives for energy sharing and setting up renewable energy communities are low. This is because distribution grid tariffs must be paid, and energy companies charge high costs for administration to both producer and consumer of the shared energy. Thus, it is very **difficult to ensure a positive business case in the long term**. Even though making a profit should not necessarily be the main goal of an energy community, investments will not be made if the business case turns out negative or too risky. Revenues can come only from sharing energy and selling excess to the grid, and thus are small due to low volumes and fluctuating energy prices, while grid costs, taxes and levies must be paid. These cannot be balanced because of high participation/administration costs for the energy suppliers. Only when large volumes can be shared between large companies with a high overlap between supply and demand have they been profitable so far.

The energy sharing system is currently targeted at apartment blocks with electricity consumption for shared spaces that have a separate connection to the electricity grid. For PENs, energy infrastructure connected to the grid (i.e. the energy box in oPEN Living Lab Genk) might be shared horizontally among connected buildings with a collective meter and no clarity on payment shares. While in a social housing context the housing company handles the bills and recoups costs through rents (separate meters), in private housing the existing lack of bill separation poses a significant barrier to PENs. This also means that energy cannot easily be shared among neighbours, but needs to be sold at a low price to the grid. When shared for free, the transportation and distribution fees are paid twice, once for injection and the second time for consumption, which is another important barrier to CSC.

There is no price for shared electricity, while an injection price is paid to the prosumer if they decide not to share. This disincentivises sharing and makes individuals more likely to sell to the network, even if the moments when there is a surplus of energy to sell to the grid coincide with the lowest prices. Furthermore, **members of the energy community who inject energy are still not allowed to sell energy to the other members – unless they apply for a supplier licence, which entails additional responsibilities.** Thus, even if economically it is more convenient to collectively self-consume renewable energy rather than sell to the grid, how to implement this is not well explained and is too complex for most people, as well as for administrative staff in cities and municipalities. Neither does the lack of a business case encourage market actors to develop dedicated products and services.

Finally, there is weak enforcement on the conditions of an REC. As the registration process is currently automated, there are no checks in place to make sure that only natural persons, SMEs and municipalities are part of them, as required by RED.

[14] Technische Assistentiehub Energiegemeenschappen (energiehuislimburg.be)

Barriers	Policy recommendations	Stakeholder
Lack of coherent and shared vision of CSC/REC/CEC concepts among stakeholders.	Clearly transpose different concepts of energy sharing into the Flemish Energy Decree.	Regional government
CSC is currently only possible in apartment buildings and houses, not horizontally between housing units.	Extent CSC to horizontally connected buildings and a wider range than apartment blocks.	Regional government
Double grid tariffs for sharing energy with CSC or in an REC do not contribute to a business case and encourage selling to the grid at a low price. They are discriminatory compared to single family prosumers.	Remove grid tariffs for CSC within one property and beyond, within low and medium voltage grids.	Regional government
Poor control over registered RECs.	Establish a supervising agency to approve RECs and reinforce the requirement of limiting membership to persons, SMEs and municipalities only.	Regional government

Demand-side flexibility

Policy mapping and assessment

PENs can play a key role in the transformation of the energy system as they can provide flexibility services to the distribution grid. Energy storage and building automation and control systems (BACS) are a pivotal part of energy management and optimisation at building and neighbourhood scale for providing demand-side flexibility services.

The region of Flanders has no specific policy encouraging demand-side flexibility. However, efforts were undertaken to roll out **smart meters** in Flemish households. Since 2019, Flanders has rolled out digital energy meters in an effort to switch to smart meter systems, targeting uptake of 80% by 2024 and 100% by 2029 for clients of Fluvius (which encompasses 11 Flemish intermunicipal utility companies).[15] As of 2021, smart meters can be acquired free of charge and installed by Fluvius: from 2025, no installation will be refused. Incentives for having a home battery were increased from 1 April 2021. This is vital, as selling flexibility only becomes economically feasible once a storage element is added to the system. Overall, there is increased interest in demand-side management on a TSO level, with more limited interest from Distribution System Operators (DSOs), since they are key stakeholders in a strategy to prioritise demand-side flexibility over grid upgrades.

The Flemish electricity and gas regulator (VREG) has been recognising the importance of flexibility for the energy system, although it is still early days.[16] In January 2023, VREG introduced a new methodology for calculating household electricity bills for small customers, switching to a 'capacity tariff' system. Previously, **energy bills** consisted of three parts: the energy cost, the network tariff, and levies (e.g. VAT).

[15] https://www.biseps.eu/wp-content/uploads/2018/09/Digital_metering_tariffing_Flanders.pdf
[16] https://www.vreg.be/nl/flexibiliteit

Now, the network tariffs are calculated in a different way, not based on total consumption (kWh) but on the capacity of the distribution network used (kW). An average peak is measured on a quarterly basis. For those who do not yet have a smart meter, a fixed fee must be paid assuming a monthly peak of 2.5 kW; a simulator by VREG can be used to determine grid costs. The highest quarterly peak on a monthly basis triggers a capacity tariff. For consumers this means that drawing high peaks is more expensive. The minimum baseload per customer is 2.5 kW and leads to the minimal tariff. If a household lands beyond 2.5 kW it will be charged accordingly. In most cases, avoiding a high-capacity tariff is achievable, provided one is prepared to adapt one's habits (fast-charging an EV, simultaneously switching on an oven, electrical heater, flat iron, tumble dryer etc). In Genk oPEN Living Lab demand-side flexibility is not achieved by making residents change their habits, but rather by seamlessly automating the energy optimisation process.

Table 7 Overview of demand-side flexibility policies in Flanders.

Policy	Implementation level	Key provisions	Relevance for PEN
17 May 2019 – Decision of the Flemish government to amend the Energy Decree of 19 November 2010	Regional	Fluvius replaces the traditional gas and electricity meter with a digital meter **in all Flemish dwellings**. Replacing the meters is done **free of charge. By 2024, 80%** of households will have a digital meter, **and by July 2029** the goal is **100%.**	Digital meters are a first step towards more control over energy consumption and thus enabling demand-side flexibility, one of the key services a PEN can provide to the grid.
Tariff methodology 2021-2024 VREG	Regional	Change of capacity tariff calculation, starting in January 2023, including peak consumption in the balance.	With the electricity price more tied to real consumption and peak hour consumption being more expensive, people are encouraged to reduce their energy consumption, which is done in an automated, seamless way within a PEN.

Regulatory barrier analysis

A key barrier for PENs in Flanders seems to have been the lack of incentives. However, high electricity prices and the new calculation method introduced by VREG which includes peak consumption may make investments in storage and BACS more profitable.

For the moment, the grid in Flanders is not relying on demand-side flexibility from PENs, which limits their business case. The capacity of the grid is not under pressure, as the DSO is investing constantly in grid upgrades to make it futureproof (EV and heat pump-ready). Flexibility is only expected from large-scale installations with that specific goal. The possibility of purchasing flexibility services from large numbers of small co-operating assets is not considered by the DSO or Transmission System Operator (TSO), and thus is not taken into account. Flexibility can make grid capacity investments less necessary and reduce the need for material. This makes it potentially profitable for the DSO to do more to incentivise flexibility services, thereby also making PENs more profitable.

VITO is working on a digital twin for Flanders which can be used to model demand and supply data, with the long-term goal being to automate energy trading and to sell flexibility as a service. It will allow the creation of informed models of how to transform a neighbourhood into a PEN. It will be a district renovation tool to 'PENify' neighbourhoods, with solution packages with more precise and valuable predictions. However, there is not currently an enabling policy framework to support this.

Barriers	Policy recommendations	Stakeholder
There is a clear lack of guidance and regulation on monetising flexibility as a service.	There is a need for time-dependent prices and day-ahead information to better adjust when appliances, charging stations etc. use energy	Regional government
Lack of public support and incentives to invest in storage and BACS.	Enable small-scale capacities to sell flexibility services and provide public incentives.	Regional government
Batteries, a pre-requirement for demand-side flexibility, shared at a neighbourhood level are currently connected to the grid directly. However, current regulation is such that there is a need to pay for when it is charged as well as when it is discharged.	Change of tariff structure to remove double taxation.	Regional government
Currently there is no district-level data providing insight into whether a transformer can handle an energy load.	Ensure sound implementation of data sharing and information provision requirements for DSOs under the new Energy Market Design directive.	National government

Whole-life carbon and circularity

Policy mapping and assessment

A PEN might hold buildings of varying types and use a large variety and combination of technological systems, allowing for some flexibility with the materials used in renovation processes or technology choices. Under the Flanders Material Programme initiated in 2011 by the Flanders Public Waste Agency (OVAM), the region defines a long-term vision for a circular economy. OVAM has been developing a methodology for using a whole-life carbon perspective in buildings called TOTEM: it is an online tool for architects that calculates the environmental footprint of buildings. According to a study by VITO from 2020, the methodology can complement the current EPB to determine the energy performance of buildings, also considering combinations of materials used and technical installations from the whole-life-cycle perspective.

The Flemish government will make an EUR 8 million investment in ConstrucThor at the Thor site with EnergyVille, aiming to help the sites in Genk to develop and test sustainable and circular technologies.This will be implemented alongside OPEN Living Lab Genk.

ConstrucThor aims to test new technologies for climate-neutral construction, including modular designs and digital solutions for building interaction. oPEN Living Lab Genk set the goal of carrying out embedded life-cycle assessments for the renovation and energy production processes. When developing high-level renovation approaches at district level, life-cycle assessments should be taken into account.

Regulatory barrier analysis

Barriers	Policy recommendations	Stakeholder
Currently, there are no obligations or public incentives to consider embodied emissions in renovations.	Implement the calculation of global warming potential from the 2024 EPBD recast and the display of the indicator in the EPC. Promote the use of the TOTEM regional methodology with information and incentives.	Regional government
The recyclability and revenue from selling building materials again at a later point is not calculated in the financial structure of housing companies. The future revenue can thus not be taken into account in the business model.	Design public incentive programmes that consider the long-term value of building materials and circular approaches.	Regional government

5. Conclusion

The current Flemish policy landscape does not explicitly encourage the PEN approach. However, there are various policies, incentives and initiatives in place which encourage important elements of PENs. For example, the local climate and energy pact encompassing almost 300 municipalities aims for collective renovations and cooperative or participatory renewable energy projects. Various incentive programmes for renovation and renewable energy installation support the implementation of PENs. Flanders has also been an EU pioneer in setting MEPS.

The transposition of EU law has been particularly difficult for energy sharing. While key changes were made in the past two years to better facilitate CSC, peer-to-peer trading and energy communities, significant barriers remain. CSC is still limited to apartment buildings, shared energy is not renumerated while injecting in the grid is, energy storage and CSC is double-charged. Changes to electricity tariff structures to disincentivise peak consumption may contribute to storage and demand-side flexibility; however, they may currently also disincentivise the electrification of heat. Neither on an EU level or in Flanders are there clear requirements or incentives to incorporate a whole-life carbon perspective into renovations.

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 2024 EPBD recast 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 national building renovation plans.

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