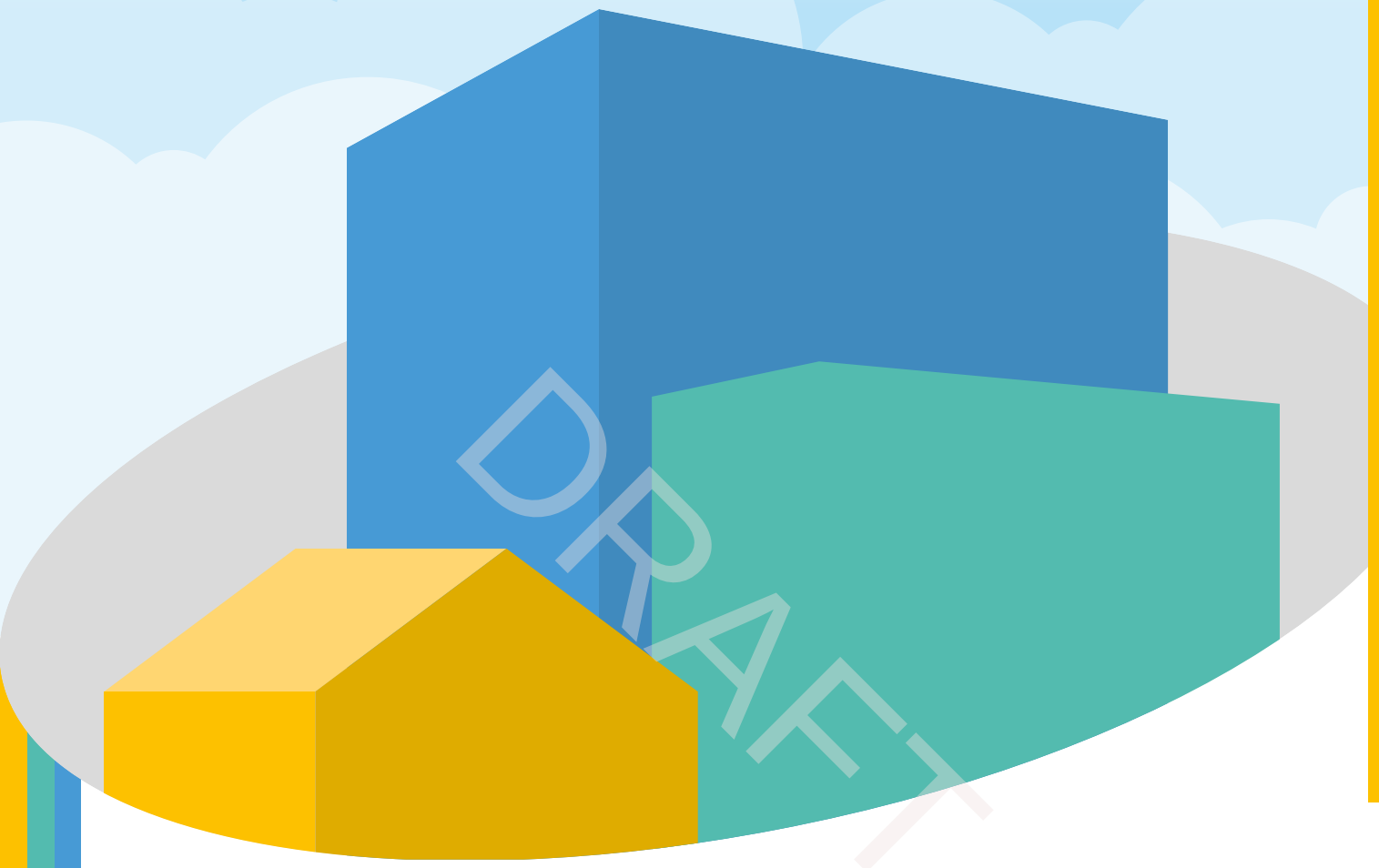
oPEN Lab
TARTU PAMPLONA GENK
LEADING THE TRANSITION TO POSITIVE ENERGY NEIGHBOURHOODS



ENABLING FINANCING FOR NEIGHBOURHOOD RENOVATIONS

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BPIE

Abbreviations and acronyms

Acronym	Description
CSC	Collective self-consumption
EPBD	Energy Performance of Buildings Directive
ESG	Environmental, social and governance
ETS	EU Emissions Trading System
GHG	Greenhouse gas
GDP	Gross domestic product
GP	General practitioner
PEN	Positive energy neighbourhood
REC	Renewable energy community
RED	Renewable Energy Directive
ROI	Return on investment
SMEs	Small and medium-sized enterprises
SPV	Special purpose vehicle

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Executive summary

Positive energy neighbourhoods (PENs) support the transition to a climate-neutral building stock while delivering a range of community and societal benefits, including enhanced comfort and public health, greater social inclusion, and improved climate resilience. PENs are holistic neighbourhood interventions that include deep renovation of buildings, infrastructure upgrades, and revitalising public space, greenery, water infrastructure and sustainable mobility.

PEN renovations are ambitious projects requiring the collaboration of a range of public and private stakeholders, such as the municipality, SMEs, homeowners associations, construction companies, service providers, social housing associations, NGOs, research partners and more. The neighbourhood approach can be a means to achieve climate, energy and social policy goals, such as decarbonisation of the building stock, deployment of renewables and electrification of heating, demand-side management and flexibility, circularity in the construction sector and energy poverty alleviation, among others. Compared to a single-building approach, PEN renovations can ensure ambition, scale and a holistic approach by finding place-based solutions best fitting the local socioeconomic context.

However, to achieve the more ambitious social, energy and environmental goals, PEN projects typically demand high upfront investments. The current economic environment, with rising renovation costs, inflation and high interest rates, poses significant challenges for PEN-focused renovations. Additionally, the overall increase in the cost of living has reduced many homeowners' capacity to fund extra renovation efforts.

While PEN initiatives are more costly in the short term, they generate substantial long-term economic, social and environmental benefits. To make these projects more financially viable and scalable, there is a growing need to reduce reliance on public funding and actively leverage private finance, ensuring broader and more sustainable investment in the transition to climate-neutral neighbourhoods.

This paper taps into barriers and finance solutions that consider the wider co-benefits of PEN renovations. It explores how to deploy public funding most effectively to de-risk and unlock private investment, how to include vulnerable households in funding models, and how to leverage environmental, social and governance (ESG) finance. To illustrate this, we applied the MBx tool, a model that integrates social welfare, micro-economic and environmental aspects into cost-benefit analyses, to the Genk oPEN Living Lab. This initiative involves the deep renovation of social housing within a neighbourhood approach, and demonstrates how municipal and social housing association policy goals can be aligned with ESG financing strategies.

The insights presented in this paper are based on four roundtables conducted within the oPEN Lab project, aimed at breaking down silos between the construction sector, policymakers and the financial industry, who also represent the primary target audience. This paper is an invitation to collect further thoughts and engage key stakeholders. It will be followed by another publication on implementation plans for 12 sustainable investment programmes for PENs.

Key takeaways for leveraging private finance for PEN renovations:

- A neighbourhood-based approach that is responsive to the local context, such as a PEN project, is useful for scaling up deep renovation and benefits from synergies.
- ESG finance can be activated by aligning environmental and social policy objectives with capital mobilisation channels.
- Considering the environmental and social co-benefits, blended finance should be applied to support the renovation of public and private buildings, infrastructure upgrades and urban regeneration.
- Special purpose vehicles, whether integrated within renewable energy communities or operating independently, can help isolate risk and aggregate investment.
- Improved data collection at all stages of the PEN renovation process can also reduce investment risk.
- Vulnerable households must be included in PEN renovations by providing financing solutions that can cover up to 100% of investment costs, using a mix of grants, subsidies and public loan guarantees.
- Building knowledge and awareness is critical. This could include providing technical and financial advice targeting homeowners associations though one-stop shops, and organising knowledge exchange networks and study trips to renovated PENs.
- Identifying and quantifying social impacts through evidence-based research and tools such as MBx can support ESG compliance and reporting.

THE MULTIPLE BENEFITS OF POSITIVE ENERGY NEIGHBOURHOODS

The EU has set a vision for a decarbonised building stock by 2050, which requires scaling up the volume and ambition of energy renovations. An alternative to renovating individual buildings was acknowledged in EU policy for the first time in the 2024 Energy Performance of Buildings Directive (EPBD) recast, which introduced the concept of 'integrated district or neighbourhood approaches' for renovations. This goes beyond a mere clustering of buildings; the main advantage of a neighbourhood approach is finding place-based technical, economic and social solutions for renovations. Local-level constraints can be linked to building typology, heritage protection, socio-economic situation of the district, renewable energy production and storage potential, and grid capacity availability.

Renovations aiming for **positive energy neighbourhoods (PENs)** contribute to achieving a climate-neutral building stock, while offering **multiple benefits for the community and society**. These include improved comfort and public health, social inclusion, climate resilience and value retention. PENs provide a range of shared spaces, services and facilities, such as shared heat pumps, solar PV panels, heat and electric storage, electric vehicle charging stations, and more. 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, generating greater energy savings and economic benefits for homeowners. The complementary use patterns of residential and commercial/public buildings also optimise aggregated demand, while smart energy management can aggregate flexibility and maximise self-consumption. Besides shared investments in energy assets, neighbours can benefit from shared services, such as rental of electric vehicles and bicycles, and common spaces with greenery, water and biodiversity.

PENs go beyond simply combining individual positive energy buildings. **By integrating buildings and neighbourhood infrastructure, they create a dynamic interaction with energy, mobility and industry.** Tackling climate mitigation, adaptation and urban regeneration in a holistic project avoids lock-ins and optimises financial and human resources compared to repeated single interventions. This aligns seamlessly with the Renovation Wave's call for an integrated, participatory and neighbourhood-centred approach.

However, to achieve these more ambitious social, energy and environmental targets, PEN projects often require additional upfront investments compared to business-as-usual. Current economic dynamics, primarily high renovation costs, as well as inflation and high interest rates, risk jeopardising PEN ambitions. Added to this, increases in the overall cost of living have impacted homeowners' ability and willingness to finance additional renovation works.

Though more costly in the short term, PENs deliver multiple economic, social and environmental benefits long term. At a societal level, PENs contribute to lower greenhouse gas (GHG) emissions and improved air quality, leading to lower mortality and morbidity rates and lower expenditure on public health. Improved accessibility to public and cycling infrastructure contributes to physical and mental health, as well as inclusion and affordability. Optimised energy management and aggregated demand lower investment in grid upgrades.

At an individual level, improved indoor environmental quality yields health and productivity benefits for building occupants. For homeowners, deep renovation of properties increases their asset value, leads to lower vacancy rates and future-proofs them against changes in regulation.

Scaling up PEN renovations will require a substantial mobilisation of private finance. Neighbourhood approaches have a unique opportunity to integrate wider environmental, social and governance (ESG) objectives and align with the EU taxonomy for sustainable activities. To mainstream PENs and unlock their full potential, there is a pressing need for innovative financing solutions which acknowledge the multiple economic, social and environmental long-term benefits to building inhabitants, owners, communities and society as a whole.

CHALLENGES OF FINANCING NEIGHBOURHOOD RENOVATIONS

The Renovation Wave aims for a renovation of 35 million building units by 2030 in the EU.[1] According to the European Court of Auditors report, the EU committed to spending at least 30% of its 2021-2027 EU budget on climate action – about €87 billion per year. To reach 2030 climate targets, the budget estimated is around €1 trillion per year, meaning EU public funding makes up less than 10% of the total investment needed. The rest of the investment will need to come from national and private funds, so leveraging private finance is critical.

Public funding, while crucial, cannot unlock the full potential of PENs. A concerted effort is needed to attract private finance by developing tailored financial products and mechanisms that recognise the long-term value, but also the risks, of PENs.

Single-building renovations can struggle to access private finance because of fragmented ownership structures within apartment blocks, lack of scale, diverse building typologies and a lack of quality assurance. PEN projects have the advantage of aggregation, with an average investment cost of €10–70 million. However, PEN investments are perceived as more risky. They involve innovative aspects, even more complex ownership dynamics, and collaboration between private and public stakeholders with different bankability profiles. Other sources of uncertainty for PEN investments are decisions within homeowners associations, long permitting times for new grid connections and licensing of energy communities. Homeowners associations frequently lack professionalised management, access to technical advice or structured knowledge about funding programmes.[2]

PEN projects are innovative, not so much in their technical solutions as in their processes. These solutions may include energy efficiency upgrades, renewable energy and storage, infrastructure upgrades and urban regeneration, but rather than deploying them in isolation, PEN projects use an integrated and participatory approach to determine their optimal combination in a specific neighbourhood context. Some of these solutions provide revenue streams, while others offer avoided costs, often of public expenditure.With the multi-asset approach, there is a tendency for private investors to focus on more profitable aspects of PEN renovations, such as PV systems; however, substantial investments in building envelope and systems are necessary beforehand to lower energy demand. For more complex energy projects, such as district heating and cooling, public-private partnerships or special purpose vehicles (SPV) may need to be set up.

[1] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en
[2] https://www.bpie.eu/wp-content/uploads/2025/04/ComActivate_EU-and-National_Policy-analysis.pdf

Traditional private investors are typically attracted by short-term return on investment (ROI) and low-risk profiles. PEN projects, however, have the potential to attract investment from pension funds, impact and conventional finance, where ESG criteria are integral to decision-making. The main challenge lies in translating the project's technical aspects into clear, robust documentation that enables banks and other financial institutions to provide the necessary capital, a process that must be led by stakeholders with sufficient technical expertise.

INCORPORATING SOCIAL AND ENVIRONMENTAL BENEFITS INTO FINANCIAL SOLUTIONS

Genk oPEN Living Lab case study

The Genk oPEN Living Lab provides compelling results showing how financing solutions which consider social and environmental co-benefits can support PEN renovations. Part of the Horizon project oPEN Lab, the Nieuw-Texas neighbourhood is a demonstration site for a PEN approach to renovation of social housing. Located in Genk, a city of 60,000 people in Flanders, the Nieuw Texas neighbourhood includes 90 social housing tenants of 27 semi-detached dwellings. The dwellings belong to the social housing company Wonen in Limburg and were built in the 1990s. The collective renovation of the neighbourhood is part of the city's roadmap towards climate neutrality in 2050.

The Flemish Climate Strategy 2050 from 2019 aims to reduce GHG emissions in sectors covered by the EU Effort Sharing Regulation 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.[3]

Figure 1. Genk oPEN Living Lab.

[3] https://openlab-project.eu/toolbox/towards-a-regulatory-framework-for-positive-energy-neighbourhoods-outline-of-the-open-lab-policy-roadmap-flanders

Wonen in Limburg owns all social houses in the province and has an ambitious deep renovation strategy for 2030 and 2050. The oPEN Lab project is an opportunity for Wonen in Limburg to gain new insights into collective deep renovations. This is particularly relevant in the context of the REPowerEU Plan to phase out fossil fuel imports, and the new EU Emissions Trading System (ETS2), which addresses CO_2 emissions from fuel combustion in buildings and will incur additional costs for fossil fuel heating.

Genk oPEN Living Lab aims to transform the Nieuw Texas social housing neighbourhood into a PEN through a combination of innovative, scalable, and replicable solutions. By integrating advanced deep renovation techniques such as individual and collective heat pumps, solar panel systems, prefabricated components and ventilation, it offers a real-world demonstration of holistic and deep renovation. Central to the concept are modular, plug-and-play energy boxes, installed outside semi-detached homes. These serve single or multiple dwellings simultaneously, significantly reducing installation costs and maximising system efficiency.

This approach goes beyond an array of innovative technologies: it requires a whole new way of operation. All systems are linked via a centralised data platform (SmarThor) and a neighbourhood energy management system, enabling real-time, automated coordination of energy demand. Using a bidirectional communication infrastructure, the system responds dynamically to real-time data, weather forecasts and fluctuating energy tariffs (e.g., day-ahead prices). This ensures energy is consumed at the most cost-effective time while optimising grid stability, lowering costs, reducing GHG emissions and preserving occupant comfort. The energy management and optimisation is seamless for tenants and does not require active behavioural change – they only control temperature set points.

For investors, Genk oPEN Living Lab showcases a high-impact solution with strong scalability potential across urban and suburban markets, aligning with green finance criteria and ESG goals. For policymakers, it provides a concrete, data-driven example of how demand-side flexibility, decarbonised heat and decentralised energy systems can be integrated into residential areas without requiring changes in user behaviour, making it a powerful tool for meeting climate targets and supporting just energy transitions.

City model canvas

Deep renovation of neighbourhoods brings multiple environmental and social benefits for society, as well as the residents. The city model canvas[4] is a framework designed to capture these additional co-benefits and drive ambition by aligning goals, investment costs and potential revenue streams of the various stakeholders. Where the traditional business model canvas is designed to fit the needs of a private firm, the city model canvas is designed to align with the city's environmental and social policy goals. The canvas incorporates a mission statement, with which all layers of the business model canvas, such as key activities, resources and value proposition, are aligned (see Table 1).

[4] Krista Timeus, Jordi Vinaixa & Francesc Pardo-Bosch (2020) Creating business models for smart cities: a practical framework, Public Management Review, 22:5, 726-745, DOI: 10.1080/14719037.2020.1718187

Table 1. City model canvas for Niuew Texas PEN renovation.

1. Mission statement: *Create a positive energy neighbourhood in a social housing estate.*

6. Key partnerships

Operational

- Energy experts
- Architect and engineering firm
- Ecosystem of (local) companies: general contractors (building envelope renovation) and HVAC contractors (heat pump and ventilation)
- ESCO company (PV panels)

Strategic

- Wonen in Vlaanderen
- VEKA

7. Key activities (strategic)

- Co-creation sessions to define scope and goals for tenants
- Pre-renovation monitoring
- Design process
- Renovation execution
- Post-renovation monitoring
- Optimisation
- Setting up renewable energy community

8. Key infrastructure and resources

- Prefab renovations of building envelope to nearly zero-energy building (nZEB) standard
- Large-scale PV installation
- Individual and collective energy storage, both heat and electricity
- Neighbourhood infrastructure (including large-scale storage)
- Flexibility services
- Monitoring equipment
- EV charging stations

2. Value proposition

Social housing tenants

- Reduced energy costs
- Increased comfort (thermal, acoustic)

Social housing company

- Strategy for deep energy renovation while allowing permanence of residency during works
- Achieving goals of A-label buildings/ nZEB

Ecosystem of (local) companies

- Scaling up of industrialised renovation solutions

ESCO

- Expand offering to include all technical installations
- Expand plug-and-play concept

Distribution system operator and energy suppliers

- Flexibility services (including through energy storage)
- Grid balancing

4. Buy-in and support needed

- Neighbourhood engagement

5. Deployment

- Prefabricated building components
- Installing on-site
- Monitoring energy flows
- Optimising energy flows

3. Beneficiaries

- Tenants
- Social housing company
- Ecosystem of local companies
- ESCO
- Distribution system operator and energy supplier

9. Costs

Social housing company	Tenants	Technology provider (ESCO)	Municipality
• CAPEX studies and permits • CAPEX renovation • CAPEX installations	• OPEX energy costs	• CAPEX district infrastructure • CAPEX installations • OPEX: Maintenance HVAC • OPEX district infrastructure €49,000 per year	• CAPEX district infrastructure • OPEX district infrastructure

10. Revenue streams

Social housing company	Tenants	VITO/ EnergyVille	ESCO
• Increased rent for renovated homes	• Reduced energy costs • Health benefits	• Injection of surplus PV energy	• Selling produced heat/ electricity to tenants • Exporting surplus PV energy • Invoicing services

11. Environmental costs

- Embedded carbon of heat pumps
- Embedded carbon in added materials

12. Environmental benefits

- Direct GHG reduction
- Energy savings
- Heat recovery

13. Social risks

- Impact of renovations on liveability of homes

14. Social benefits

- Health benefits
- Neighbourhood cohesion
- Increased comfort levels
- Increased asset value
- Increase in disposable income due to reduced energy bills
- Reduced grid/global market dependency

Internalising co-benefits

Investors, asset managers and policymakers need evidence-based and commonly accepted methodologies to assess the sustainability of projects. Holistic, deep renovation of neighbourhoods brings social, economic, and environmental co-benefits including cost savings, social cohesion, health, inclusion, and improved public spaces. At a societal level, they contribute to lower GHG emissions and air pollution, leading to lower mortality and morbidity rates. For example, based on estimates of the potential for energy savings from building renovation, health benefits from improved indoor climate of renovations could amount to approximately €42-88 billion per year in Europe.[5]

The MBx tool[6] helps policymakers and investors identify sustainable investments and future-proof real estate by integrating ESG factors. It quantifies and monetises the social, economic and environmental benefits of building and neighbourhood renovations and new constructions.

Co-benefits are the many intended or unintended benefits of a policy or project that go beyond its primary objectives. In the context of energy efficiency and renewable energy investments, these include benefits for residents and society beyond energy-related benefits, such as savings in energy and decreased energy expenses. Non-energy related benefits of renovated homes and upgraded neighbourhoods include increased productivity, better health, improved educational outcomes, reduced need for new energy infrastructure, increased property values, employee satisfaction and retention, job creation and economic development.[7]

Physical impacts (e.g., life years saved, jobs created, GHG emission reductions) can be monetised using methods like avoided costs analysis. Using social cost–benefit analysis, the MBx tool compares the benefit–cost ratio and ROI of sustainable projects, such as PENs, against business-as-usual scenarios. This allows investors and developers to evaluate different ambition levels by comparing investment costs with long-term benefits and their monetary impacts. Below, the outputs of the social cost–benefit analysis for the GNICE neighbourhood in Salzburg are presented.

GNICE case study, Salzburg

GNICE in Salzburg is a large-scale PEN demonstration within the syn.ikia Horizon 2020 project, combining new construction of 250 social housing units and a kindergarten and renovation of the existing building stock in the same neighbourhood. The project, developed by Heimat Österreich in collaboration with the city of Salzburg, Caritas and other partners, integrates advanced technologies with strong social and environmental objectives.

GNICE positive energy neighboruhood, Salzburg

Passive design: optimised insulation, airtight envelope, daylight-optimised triple glazing, passive shading.

Hybrid construction: wood-based exterior walls on the east side, concrete exterior walls on the west side, solid floors with integrated underfloor heating.

[5] https://renovate-europe.eu/wp-content/uploads/2015/10/Multiple-benefits-of-EE-renovations-in-buildings-Full-report-and-appendix.pdf
[6] The MBx tool was developed by BPIE as part of the syn.ikia project (www.synikia.eu)
[7] A complete list of PEN co-benefits and their monetisation can be found in BPIE (2024) Multiple benefits of positive energy neighbourhoods and their potential impact on policy and investment decisions

Active energy systems:

- Heat pumps (ground-source and wastewater-based) for efficient heating and domestic hot water supply.
- Mechanical exhaust air ventilation systems to ensure high indoor air quality while maintaining low energy demand.

Flexibility and energy communities:

- Shared heating system: renewable systems designed to gradually replace existing oil boilers in nearby buildings.
- Shared electricity: large photovoltaic power plant integrated across the neighbourhood for renewable electricity generation.
- Energy community model: residents collaborate to create a renewable energy community, enabled by recent regulatory changes.

Shared mobility: neighbourhood mobility hub integrating electric and flexible transport options.

Environmental ambition: klimaaktiv (sustainable buildings and neighbourhoods) and Greenpass (high-quality green spaces) certifications. Neighbourhood upgrading by improving the surrounding building stock and public spaces.

Together, these technologies form an interconnected energy system that demonstrates how neighbourhoods can become net producers of clean energy, while also creating co-benefits such as improved comfort, reduced greenhouse gas emissions, and lower long-term energy costs.

Given the social housing context, the MBx analysis mainly focused on health co-benefits, such as GP visit costs or the occurrence of respiratory diseases (Table 2). The health benefits result from living in healthy buildings and making use of sustainable mobility, such as cycling. For private homeowners, other co-benefits could be included, such as asset value increase or vacancy cost reduction.

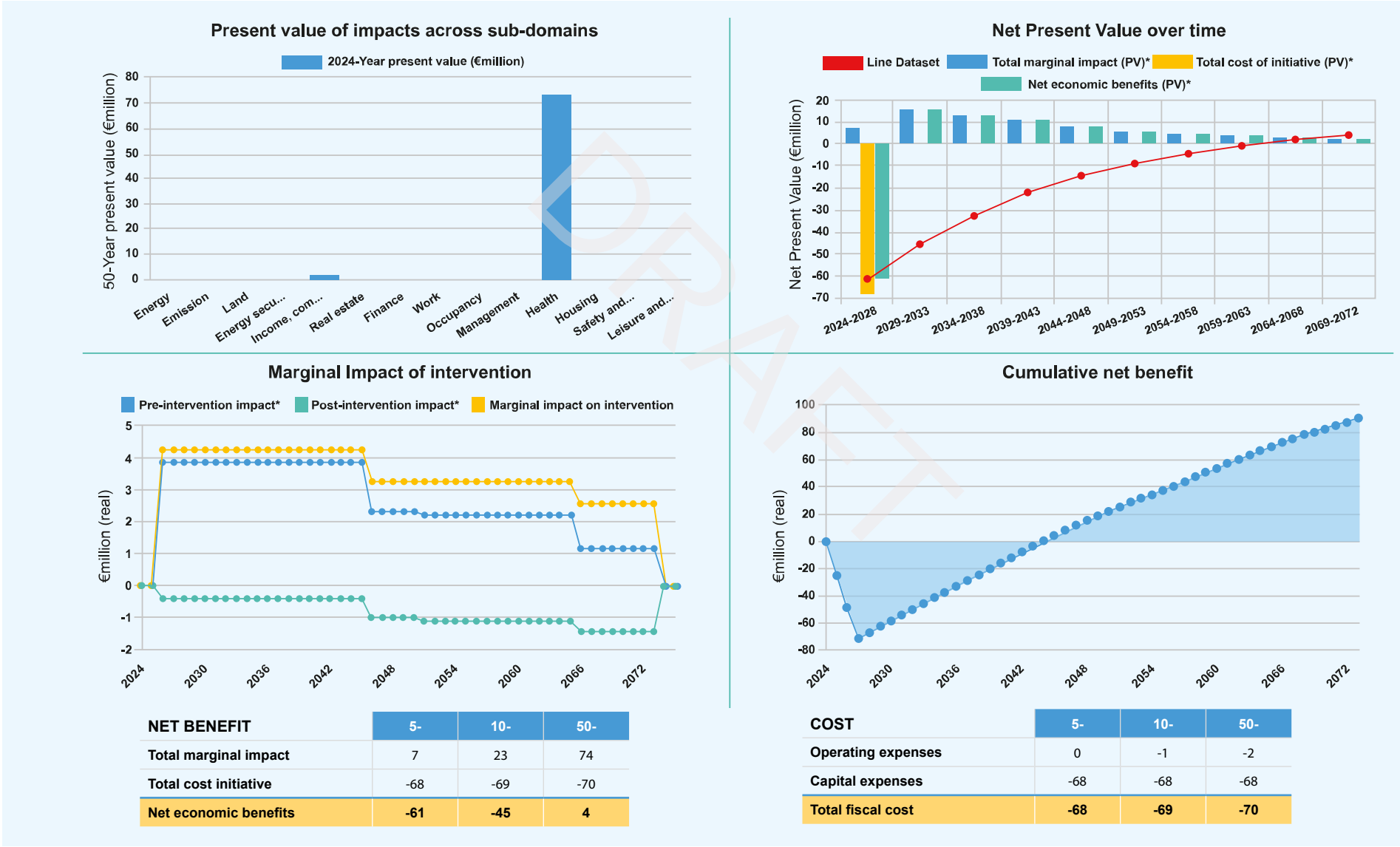
Table 2. Overview of the co-benefits of GNICE PEN.

EU concept	Evidence Quality	5 years	10 years	50 years
Inpatient hospital visit reduce	**HIGH**	1.3	4.2	9
Inpatient hospital visit reduce (2)	**HIGH**	0.9	2.8	9.3
Inpatient hospital visit reduce (3)	**HIGH**	0.7	2.1	7.6
GP visits - Publicly funded (institution contribution) reduce	**MEDIUM**	0	0.1	0.1
GP visits - Privately funded (patient co-payment) reduce	**MEDIUM**	0	0	0.1
Health and Quality life gains (Quality-adjusted life year (QALY) gained)	**MEDIUM**	0.3	1	2.2
Increase in disposable income due to energy efficiency (reduction in energy poverty)	**MEDIUM**	0.1	0.3	1.1
Physical health gain from walking	**HIGH**	2.8	8.8	31.7
Physical health gain from cycling	**HIGH**	0.4	1.2	4.1
Health and Quality life gains (Quality-adjusted life year (QALY) gained) (2)	**MEDIUM**	0.3	0.9	2.9
Health and Quality life gains (Quality-adjusted life year (QALY) gained) (3)	**MEDIUM**	0.5	1.6	5.8

Unit: € million

The social cost–benefit analysis covers a 50-year period and applies a 4% discount rate. The net present values of costs and benefits are adjusted according to Austria's consumer price index and GDP values, based on Eurostat data, and are expressed in millions of euros. **Including health benefits results in a benefit–cost ratio of 1.06. The ROI is 5.7%, indicating that, when co-benefits are incorporated, ambitious PEN renovations become a financially viable investment.**

Figure 2. Outputs of the MBx tool for GNICE PEN.



NET BENEFIT	5-	10-	50-
Total marginal impact	7	23	74
Total cost initiative	-68	-69	-70
Net economic benefits	**-61**	**-45**	**4**

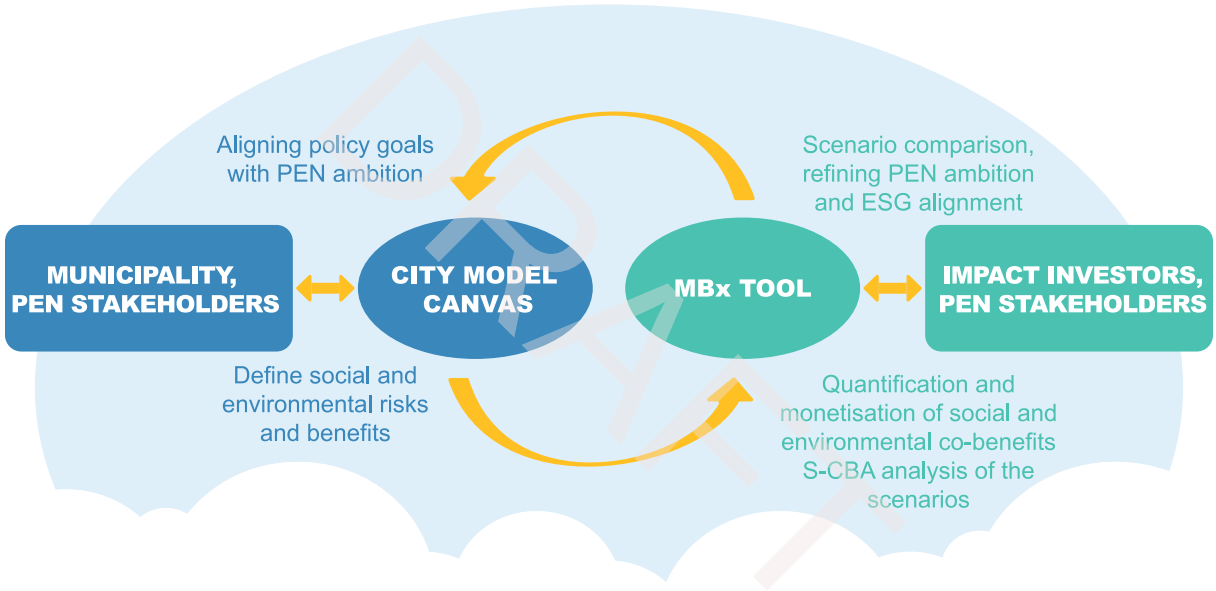
COST	5-	10-	50-
Operating expenses	0	-1	-2
Capital expenses	-68	-68	-68
Total fiscal cost	**-68**	**-69**	**-70**

ENABLING FINANCING FOR POSITIVE ENERGY NEIGHBOURHOODS

ESG finance

Community renovation projects such as PENs, with ambitious GHG emission reductions, positive energy balance and community building, are aligned with principles of sustainable finance, which accounts for ESG aspects when making investment decisions. Environmental considerations might include climate change mitigation and adaptation measures for infrastructure and public spaces. Social considerations could refer to involving vulnerable households or reducing energy poverty. Governance refers to the participation of both public and private stakeholders and the decision-making processes involved in planning and implementing the project.

Figure 3. Aligning policy goals with PEN ambition and ESG finance.



From a broader, long-term perspective within the framework of decarbonising the building stock, ESG finance plays an important role in aligning private capital with climate, energy and social policy objectives, while also supporting economic growth. Traditional investments often face the challenge of balancing profitability with sustainability, as markets tend to favour short-term returns over long-term resilience and societal impact.[8] ESG in real estate has to balance additional risks, but in return offers the potential to future-proof investments, avoid exposure to stranded assets and enhance reputational value.

There is a growing recognition that the 'S' in ESG frameworks is underdeveloped, lacking robust methods to quantify and valorise its benefits.[9] As a result, ESG frameworks used by investors and governments are heavily weighted toward environmental performance, while social value, particularly in real estate, remains marginalised. Even where KPIs exist, they often appear uniform but are not interoperable due to differing definitions and methodologies; **there is a lack of standardisation, consistency and granularity**. The city model canvas and the MBx tool presented in the previous sections are useful evidence-based methods for advancing and harmonising reporting on social co-benefits.

[8] www.cisl.cam.ac.uk/news/blog/esg-dead-long-live-esg
[9] www.ihrb.org/resources/toolkit-making-the-case-for-green-and-affordable-housing-investment-in-europe

To shift away from extractive, short-term investment logic toward stable, long-term and inclusive returns, ESG frameworks must evolve. Improving ESG reporting, particularly for the social component, requires clear guidelines, the adoption of best practices and the development of metrics that support better decision-making. This includes better data infrastructure (e.g., digital building logbooks), credible social metrics, and consistent compliance procedures for green and social loans. Prioritising projects that embed these approaches could enhance the social and environmental performance of real estate and investment portfolios without sacrificing profitability.

Blended financing solutions

PEN renovation projects require investments in private, commercial and public building energy renovations, neighbourhood renewable energy and flexibility assets, and sustainable mobility, as well as infrastructure upgrades, greenery, accessibility of public spaces and urban regeneration. The configuration of the solutions and the ambition level of the project is place-based and must answer policy objectives such as local heating and cooling plans, renewable acceleration areas, decarbonisation of the building stock and tackling energy poverty, as well as more specific needs of the community reflected in the city model canvas described above in Table 1.

Given the multiple co-benefits PEN projects generate, both to residents and society, **blended finance solutions** can make best use of both private and public investments. Public investments should go beyond providing grants and subsidies, by merging public and private investments in infrastructure and urban regeneration. This contributes to de-risking the overall project by matching different forms of finance with the most appropriate form of innovation or activity, brought together within a single investment fund or portfolio.

Legal frameworks

By creating **special purpose vehicles (SPVs)**, municipalities or private companies can isolate the risk of a PEN project and provide public guarantees to unlock the additional private funding required. An SPV is a legal entity created for a specific purpose or project, which manages its own assets and liabilities, raises capital and manages debt. SPVs could be the right legal framework for municipalities or private stakeholders, such as developers, to aggregate investments and assets into PEN projects. For example, the municipality of Copenhagen used an SPV legal framework for an ambitious project to reduce the GHG emissions of the district heating system with solutions such as geothermal energy and heat recovery to lower the reliance on biomass. The municipality of Dijon aggregated multiple smaller projects, such as public investments in PV systems in parking lots, under an SPV umbrella. The municipality of Aarhus set up an SPV to unlock a €13M private bank loan to roll out a municipal PV scheme across 70,000 m^2 of rooftops.

An SPV, as a legal entity, can enable aggregating private and public investments into a PEN renovation for a specific project. An SPV has various advantages, such as centralised procurement managed by the public sector. The **renewable energy community (REC)** legal framework, as set out in the Renewable Energy Directive (RED), can be useful for enabling various SPVs for PENs, individual renovations, investments in renewables or flexibility assets (see box).

(16) 'renewable energy community' means a legal entity:

(a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity;

(b) the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities;

(c) the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits;

Article 2 Definitions Directive (EU) 2018/2001

Smaller PEN projects which do not require a legal entity like an SPV or REC, can be enabled through **collective self-consumption (CSC)** or 'jointly acting renewables self-consumers'.

(15) 'jointly acting renewables self-consumers' means a group of at least two jointly acting renewables self-consumers (…) who are located in the same building or multi-apartment block;

Article 2 Definitions Directive (EU) 2018/2001

Even though the RED stipulates that CSC only applies to consumers within the same building, some Member States, such as Spain, have extended it to those within a 2 km range. **Investing collectively in renewable energy, storage and flexibility assets by a cluster of nearby buildings without the need to set up a legal entity can enable more citizen-led PEN renovation initiatives.** Other advantages of CSC schemes are the ability to share locally produced renewable energy, allowing homeowners to benefit from a share assigned directly on the bills, instead of selling at very low prices to the grid due to peak solar production hours, as well as being exempted from grid tariffs. SPV and REC initiatives, since they require a legal entity and governance rules, are usually driven by the municipalities, which handle the bureaucratic burden. They are suitable for more ambitious PEN projects, or even a series of PEN renovations over a longer period.

Good practice example – Pamplona Renewable Energy Community network

The municipality of Pamplona set up an REC in each district of the city. Within this legal framework, the municipality invests in renewable energy or enables PEN renovation projects as a collaboration between private and public stakeholders with smaller CSC schemes. Special attention is given to energy-poor residents, for whom 10% of the renewable energy generated within the REC is reserved.

De-risking private investments

To enable private financing of PEN projects, public funds should be mainly used to de-risk the investment or to invest in infrastructure upgrades and interventions in the public space.

Another way to de-risk investments in ambitious PEN projects is through improved use of data across all phases of the renovation process, from design to execution to post-renovation performance. In the Genk oPEN Living Lab, for example, a digital twin approach is used before renovation to model and simulate the expected energy performance of the buildings. This helps to assess the impact of different renovation strategies in advance and provides a basis for informed decision-making. After the renovation, real-time energy monitoring and indoor climate sensors are deployed in the homes to track actual energy use and comfort levels, allowing comparison between predicted and realised performance and enabling fine-tuning where needed. Additionally, the project integrates building information modelling and prefabricated renovation elements, which contribute to a more efficient and predictable renovation process by reducing on-site risks, minimising construction time and improving quality control. This combination of digital design tools, monitoring and industrialised renovation techniques is a key strategy to reduce financial, technical and social risks in large-scale district renovations like Genk oPEN Living Lab. One potential drawback is the administrative burden associated with monitoring, data collection and processing to ensure compliance, for example, in the case of green loans.

As previously outlined, PEN projects are often perceived as risky by investors and homeowners because they are perceived as innovative. However, the innovation lies mostly in the processes, including social innovation and decision-making, and less in the technologies deployed in isolation. Genk oPEN Living Lab and other publicly co-financed demonstration projects contribute to proving the concept with data and building confidence among investors. PEN pilots collect important KPI data on the actual energy performance, such as demand reduction, self-consumption share and peak shaving, as well as economic and social KPIs. It is important for the public sector to lead by example, which is why many PEN pilot projects are social housing renovations.

PEN projects bring together a range of private and public stakeholders who have different risk and financial profiles, and each can access loans with varying conditions. Vulnerable households might risk being excluded from PEN renovations if they cannot access ordinary renovation loans. Homeowners associations in Estonia are able to take a loan on behalf of their members via the national KredEx, which offers a mix of grants, loans and public guarantees. A loan guarantee is offered to associations whose loan risk is deemed by banks to be higher than normal because of a high share of people in debt, if the building is located in an area with low property values or in case the investment per square metre is significantly higher than normal. Joint loans to homeowners associations are also more attractive products for traditional banks because of the aggregating effects. **Scaling investments differs from aggregation because scaling also requires a standardisation of loans.**

Some features of PENs, such as renewable energy, can be perceived as more attractive investments than others, such as building envelope upgrades or flexibility assets. However, demand reduction and maximising self-consumption are essential for renewable energy deployment to avoid costly investments in grid upgrades. It is important to prevent cherry-picking and ensure that the full package of interventions is financed and implemented. With this in mind, PEN projects are particularly suited to institutional investors who prioritise long-term, lower but stable returns and social impact in the community, such as pension or impact investment funds.

Leaving no one behind

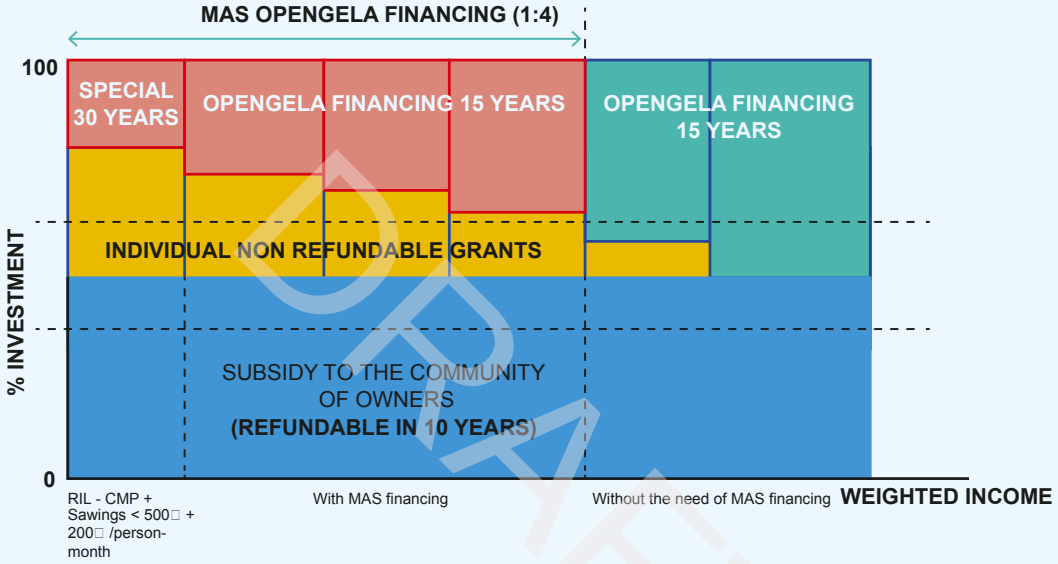
The upfront costs associated with deep renovation and the integration of innovative energy solutions, as in PENs, are often beyond the reach of the most vulnerable households and SMEs. It is important to ensure that vulnerable households or those affected by energy poverty take part in PEN renovations and the financial burden doesn't fall disproportionately on those least able to afford it. By supporting reduced energy consumption through deep renovation, PENs can lead to a reduction in subsidies for fossil fuel heating and solve energy poverty in a systemic way. Public funding, while crucial, is insufficient to meet the scale of investment required, and a diverse mix of blended financing sources, instruments and mechanisms is needed.

The EPBD encourages Member States to prioritise vulnerable households and use revenue-based parameters when providing financial support (e.g. grants). Several renovation grants or subsidy schemes target lower-income groups. However, these income groups benefit to a lesser extent from public subsidies because they often lack savings or cannot access conventional renovation loans. **To engage all types of stakeholders in PEN renovation projects, tailored financing solutions for different income groups should be developed within one-stop shops.** Without offering guarantees to cover the rest of the investment needed, grants will not reach the target groups. Prefinancing of grants is another important aspect, and should be prioritised over other subsidies such as tax rebates.

One-stop shops can make the renovation journey simpler and easier to navigate, offering bureaucratic support besides information and financing solutions. One-stop shops are also important because they can help standardise projects and financial solutions and have a large-scale approach. This can facilitate the financing process with the banks. However, the administrative costs for banks to offer tailored financial products, such as those targeting lower-income groups, must be addressed in collaboration within a public scheme. Lastly, **one-stop shops can shift the renovation process from individual buildings and individual responsibility to community approaches by offering PEN renovation and energy community advice.**

OPENGELA financing solution

The Basque Country has set up a network of one-stop shops, OPENGELA. The financing solution was developed by GNE Finance in collaboration with the Basque government and local banks in the context of the BIRTUOSS Life project. For the lower-income group, a mix of grants and subsidies covers up to 80% of the renovation cost, the rest being a loan with special conditions offered for 30 years with public guarantees. For middle- and higher-income groups, the grant proportion is lower, and they can access conventional renovation loans.



CONCLUSIONS

To achieve a climate-neutral building stock by 2050, there is the need to scale up deep renovations that adopt a neighbourhood-level approach tailored to local contexts. The case study of GNICE PEN demonstrates a return on investment of 5.7% indicating strong potential for financing when co-benefits are accounted for through a social cost–benefit analysis. To align environmental and social policy objectives with capital mobilisation, the city model canvas could be a useful approach. Considering the environmental and social co-benefits, blended finance can support renovations of both public and private buildings, infrastructure upgrades, and broader urban regeneration efforts.

To facilitate investment, risks should be isolated and aggregation mechanisms enabled through SPVs, either within RECs or independently. Risk can be further reduced by ensuring reliable data collection throughout all stages of the PEN renovation process.

It is also crucial to include vulnerable households in PEN renovation initiatives by securing financing solutions that can cover up to 100% of investment costs, combining grants, subsidies, and public guarantees for loans. Finally, to ensure compliance with the social dimension of ESG reporting, it is necessary to identify and quantify impacts using evidence-based methodologies and tools such as the MBx.

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