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LEADING THE TRANSITION TO POSITIVE ENERGY NEIGHBOURHOODS

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POSITIVE ENERGY NEIGHBOURHOODS DRIVERS OF TRANSFORMATIONAL CHANGE

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Executive summary

In light of EU climate goals and Russia's invasion of Ukraine, significant measures are needed to decarbonise the economy, reduce energy use and future-proof the building stock. With 75% of Europeans living in urban areas [1] and a rising focus on existing buildings to achieve full decarbonisation by 2050, there is significant opportunity and need to focus on innovative solutions in neighbourhoods and homes, beyond the individual building level. **Successful decarbonisation of the EU building stock calls for an integrated, participatory and neighbourhood-based approach** [2].

The concept of a positive energy neighbourhood (PEN) applies a community approach that can fully reap the benefits of energy efficiency, fuel switching, lifecycle thinking, and the implementation of renewable and low carbon technologies. A neighbourhood approach enables multiple synergies that can, in a more cost-effective way, help to decarbonise the building stock while incorporating the collective social potential of energy solutions. The aggregation of projects enables industrialised renovation processes, which can be achieved at a lower cost, in a shorter timeframe and at higher quality. Additionally, a neighbourhood approach can empower local communities to take an active role in their energy use, while accelerating the market uptake of novel technologies and business services at scale.

The following policy recommendations are provided and discussed to further facilitate and scale the implementation of positive energy neighbourhoods to achieve deeper energy gains and decarbonise the EU building stock:

- Endorse Member States to **identify appropriate neighbourhoods to implement integrated renovation programmes.**
- Establish a **harmonised definition of positive energy neighbourhoods (PENs)**, which should clarify the boundaries of the built environment, covering aspects related to use of renewables, energy communities, mobility, density and social cohesion.
- Reinforce existing policies with PEN solutions, including forthcoming national building renovation strategies.
- Overall, **redesign energy efficiency solutions as a dynamic concept.** Member States should conduct a national review of electricity market regulations.

Introduction

Russia's invasion of Ukraine has shaken the energy markets, driving oil and gas prices to extreme levels, and forcing many countries to reconsider their energy supply and security. Against the background of the recent release of the REPowerEU plan [3], the EU must accelerate radically the reduction of energy demand and roll-out of renewable energy. The current situation stresses (once more) that buildings are critical to reducing energy dependence and are an integral part of the EU's infrastructure, especially as an opportunity for reducing emissions. As buildings and cities can provide living and working spaces with lower energy consumption, they must be treated as a critical factor in Europe's strategic decisions on energy and security policy.

With 75% of Europeans living in urban areas [1] and a rising focus on existing buildings to achieve full decarbonisation by 2050, it is key to design and retrofit our cities and neighbourhoods to zero-emission standards, thus making them future-proof. Realising zero-emission buildings in existing urban environments will require more than standalone technological solutions on an individual building level, such as insulation materials and renewable energy installations. **Successful decarbonisation of the EU building stock calls for an integrated, participatory and neighbourhood-based approach [2].**

Ongoing EU policy initiatives (i.e., REPowerEU, NextGenerationEU, the EU Green Deal and the Renovation Wave) have so far failed to apply an integrated solution to the excessive use of fossil fuels, which is a problem beyond a single building or gas pipe. **By viewing buildings as standalone units, a huge opportunity is overlooked.**

The war has further spurred the EU to transform its energy sector from being a fossil-dependent system to renewable energy sources. Likewise, buildings are transitioning from being unresponsive and highly energy demanding to becoming active parts of the energy system, consuming, producing, storing and supplying energy in an orchestrated way. **A neighbourhood approach enables multiple synergies that can, in a more cost-effective way, help to decarbonise the building stock while incorporating the collective social potential of energy solutions.**

Figure 1 - Transition of Waterschei (Genk – BE) towards a Positive Energy Neighbourhood. EnergyVille and oPENLab.

Figure 2 - Avineon in the framework of the VLAIO project 'DITUR - Digital Twins for Upscaled Retrofits

Positive energy neighbourhoods can accelerate the spread of green buildings, go beyond nearly zero energy buildings or zero-emission building performance, and lead to higher lifecycle greenhouse gas emissions reductions. Overall, they are an integral approach to reach climate targets and reduce EU energy demand.

What is a positive energy neighbourhood?

The terms positive energy neighbourhood and positive energy district are often used together or interchangeably. Positive energy districts (PEDs), according to JPI Urban Europe [4], are *"energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net-zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems while securing the energy supply and a good life for all in line with social, economic, and environmental sustainability."* The term "positive" here not only refers to the surplus production of green energy but has wider sustainability connotations, seeking societal goals within three dimensions: environmental, economic, and social.

A clear definition for positive energy neighbourhoods needs to define boundaries of what is included, not only geographically but also in terms of energy solutions, governance, and integration with other sectors. It is therefore essential to ensure that partial implementation is not being categorised as a truly energy-positive neighbourhood. The definition of positive-energy buildings and neighbourhoods is ongoing and will still need to be integrated into EU building policies.

Neighbourhood semantics: PED, PEN and SPEN

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.

According to Duany et al., districts are characterised by a single activity or function, while **the neighbourhood is limited to urban areas where human activities and functions are integrated; this mix of functionality leads to civic and community structures that contribute to social identity and cohesion [5].** For example, Amsterdam is divided into seven city districts, and those districts are divided into 26 "neighbourhoods with their own character" [6].

A neighbourhood approach is important for developing urban renovation projects for several reasons. First, the community identity enhances the efforts of these renovations towards a better urban environment that will improve the welfare of the inhabitants: positive energy neighbourhoods **aim for community wellbeing, supported by instruments for economic, social, and environmental development.** Likewise, PENs seek an integrated, participatory, neighbourhood-based approach tailored to local settings to improve outcome effectiveness, thereby maximising the benefits of innovative energy systems (such as novel solutions for heating and cooling, smart vehicle-to-grid (V2G) charging and neighbourhood storage). The term sustainable positive energy neighbourhood (SPEN) is also in use to further emphasise aspects beyond energy, covering for example indoor environmental quality, co-use and occupant satisfaction.

Neighbourhood approaches have the potential to lead to optimal solutions at the local level, combining energy efficiency, renewable energy production and flexibility with other benefits and ensuring the consistent sustainable development of cities and territories.

Comprehensive approaches aiming to upgrade not only single buildings but rather a whole neighbourhood at the same time are needed to **cost-effectively decarbonise the building stock and its energy systems**. Neighbourhood-level renovations also can lead to significant **cost savings through economies of scale, smart logistics and a faster renovation process**. This is also **more attractive to investors due to aggregation and distributed risk portfolios**. Moreover, this approach fosters synergies between technical and social transformations in the district, boosting innovative urban development and regeneration strategies.

Positive energy neighbourhoods to enable an integrated and aggregated approach

An integrated energy solution approach addresses both individual building measures and urban functionalities, creating substantial opportunities for the positioning of novel technologies and smart solutions. **Cluster deployment on neighbourhood scale enables optimal renovation and technology pathways towards decarbonisation.** An integrated approach happens on four levels:

1. Between a building and neighbourhood infrastructures (e.g., electric vehicle charging, district heating, common solar PV installation).

2. Within the same building: integration of technologies and techniques (e.g., active control and flexibility).

3. Between buildings (e.g., shared heat pumps).

4. Between the building sector and other sectors, mainly energy (e.g., demand flexibility), industry (e.g., use of excess industrial heat for district heating) and mobility (e.g., V2G).

The aggregation of renovation projects can lead to a reduction in overall costs and time overruns, as well as pooling of financing and facilitation services. Residents should be involved in the design and implementation of PEN plans early on to make sure user interfaces are easily accessible and smart appliances fit their needs, which is why thorough stakeholder engagement activities are part of most PEN projects.

PEN projects aim for **energy system integration by increasing connection between key stakeholders**, which usually includes building owners, tenants, financial institutions, public authorities, system operators, and the wider value chain of the energy and construction sectors.

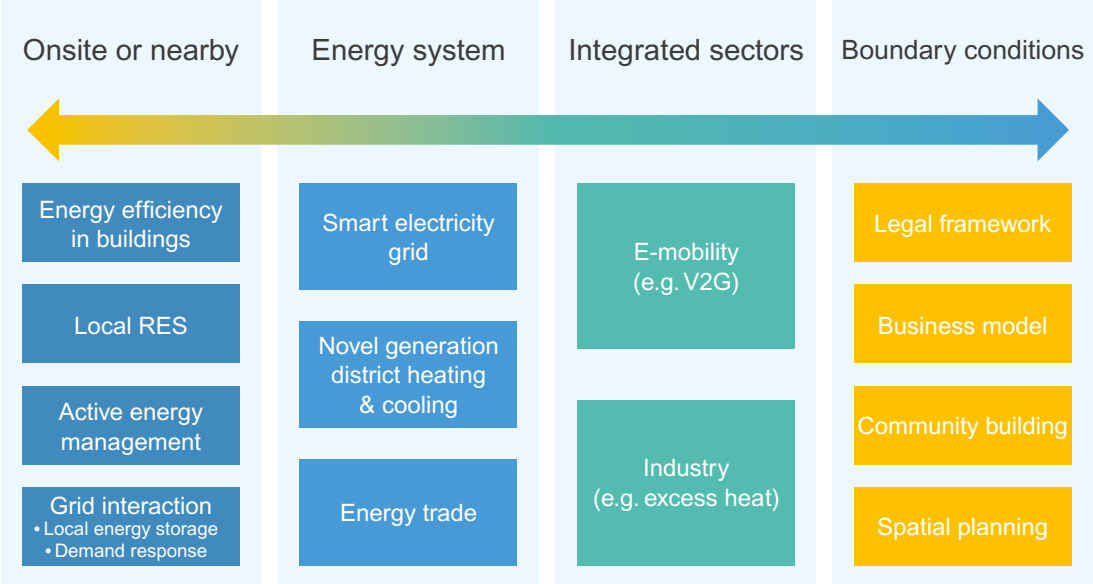

Figure 3 - An integrated approach towards positive energy neighbourhoods [7].

Integrated neighbourhood approaches point beyond energy communities[1] and collective energy actions by considering district-level heating and cooling, as well as energy savings, local mobility, and social infrastructures. Integrated planning can accelerate deep energy renovations at a larger scale and **contribute to greater public acceptance of renewable energy projects, helping attract private investment in the clean energy transition.**

[1] Energy communities are collective, citizen-led initiatives (but can take any form, including an association, cooperative, partnership, etc) working towards a clean energy transition, putting citizens at the core of decision making and action. Energy communities aim to re-structure energy systems via citizen participation.

Ongoing policy initiatives mark a rare opportunity to change course

The European Commission's Renovation Wave strategy highlights the importance of neighbourhood approaches, with a dedicated section on "placing an integrated, participatory and neighbourhood-based approach at the heart of the Renovation Wave" [2]. The strategy rightfully concludes that, "synergies for renovation become evident when scaled up to district and community approaches. Aggregating projects at this level may lead to zero-energy or even positive energy districts" [2]. However, when this was translated into concrete policy proposals, the neighbourhood approach was nowhere to be seen[2].

The European Commission published a proposal for revising the Energy Performance of Buildings Directive (EPBD) in December 2021 as being the key legislative tool to renovate and fully decarbonise the building stock [8]. This revision was launched as a response to the more ambitious vision and targets announced earlier in the Fit for 55 Package [9] and Renovation Wave and includes several new and strengthened provisions. In contrast to the Renovation Wave strategy, the legislative draft didn't include any concrete measure to foster neighbourhood approaches. The draft report submitted to the European Parliament's Committee on Industry, Research and Energy (ITRE) on the EPBD recast aims to amend this shortcoming of the Commission's proposal by pushing for integrated renovation programmes at district level. It is therefore important that Article 3a (Amendment 99) will survive political negotiations and will find its way into the final text of the law. Not including a specific provision on PENs would be a missed opportunity: without supportive policies, the transformation of existing neighbourhoods and the urban environment to become carbon neutral will remain sluggish.

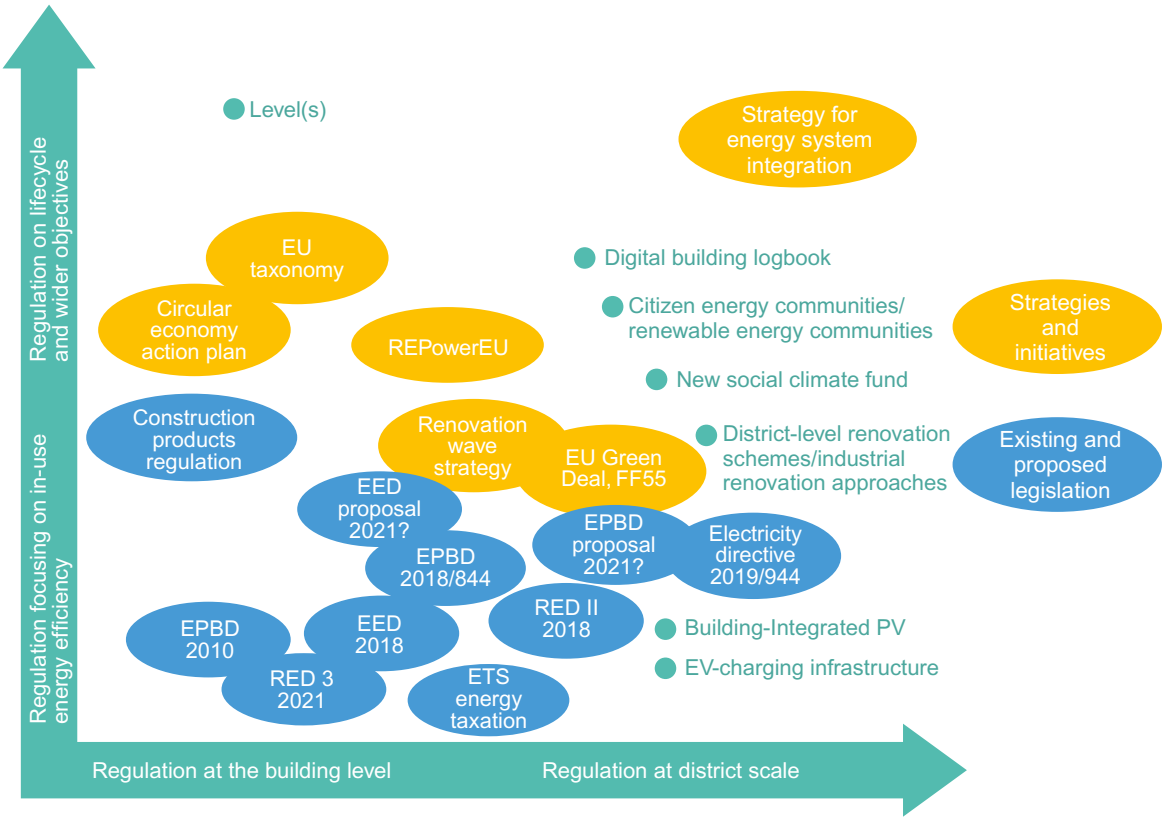

Figure 4 - PENs in the wider policy context.

[2] https://www.europarl.europa.eu/doceo/document/ITRE-PR-732742_EN.pdf

Why should we endorse the key pillars of PENs?

Positive energy neighbourhoods should be a guiding star for EU policies and initiatives aiming to decarbonise buildings and the energy system. Due to their ability to reach deeper energy savings and greater emissions reductions, PENs should be viewed as the next level for energy communities, going beyond individual net-zero buildings. There are social, economic, and technical reasons to do so. Four main arguments are highlighted below.

Argument #1

Positive energy is easier to achieve at the neighbourhood level than on an individual building level

A neighbourhood approach can foster synergies between energy efficiency and energy generation in the district, including the development of local renewable energy sources and urban development strategies. By utilising the savings potential, self-consumption and flexibility of multiple sites, neighbourhood approaches optimise systems and synergies.

A neighbourhood approach can optimise solutions at the macro level, identifying the equilibrium between investments in energy demand reductions (e.g., upgrading the efficiency of buildings and industry) and supply-side upgrades (e.g., novel generation district heating system or smart grid system), as well as investments in smart and flexible technologies.

Argument #2

Aggregation of projects enables industrialised renovation processes at lower costs and higher quality

Renovations at the district and neighbourhood level can lead to significant potential cost savings through economies of scale and smart logistics. They can also be more attractive to investors thanks to project aggregation and distributed risk portfolios. Aggregating the demand for renovation from several individual building owners in a neighbourhood can increase market prospects for those involved in selling or supplying new products and services.

Argument #3

Neighbourhood approaches can empower local communities and address social aspects such as comfort, wellbeing, and social integration

The transition to energy-positive buildings and neighbourhoods will not be driven by energy savings alone but rather by emotionally charged benefits like indoor environmental quality, safety, health, and quality of life. Measures simultaneously addressing energy performance and a healthy indoor environment are thus key to increase demand for PENs.These benefits do not stop with residents but can be felt in the surrounding neighbourhood. Examples include growth of local businesses and local job creation as a result of urban regeneration and improvement of community facilities, accessibility, safety and public spaces. Synergies with the social agenda become evident when scaled up to neighbourhood and community approaches. PEN initiatives underscore the importance of co-design, social support and community engagement to achieve maximum impact and ensure a socially inclusive transformation.

Argument #4

Positive energy neighbourhoods accelerate the market uptake of combined novel technologies and business services

A PEN environment facilitates the implementation of combinations of different close to market-ready technologies and services. Examples of PEN solutions include shared heating and cooling systems and services that can be combined as a prefabricated unit, installed per dwelling or as part of a district heating system. Additionally, there is potential for the use of innovative heat pump systems and combining existing systems with storage solutions to feed into the collective system.

A neighbourhood approach allows the use of microgrids to maximise the use of locally produced renewable energy across several buildings, in combination with the energy efficiency measures and flexible solutions implemented. Smart home systems include smart metering, home temperature and ventilation control, energy consumption visualisation and feedback.

Combining flexibility services with PV production and storage will allow the grid operator to optimise the neighbourhood energy consumption according to grid demand and supply, reducing greenhouse gas emissions.The heating network will provide heat storage for peak loads and grid demand-based block consumption management to maximise the energy efficiency in the buildings.

Facilitating the scale up of PEN – moving from pilots to the mainstream

To facilitate the scale up of PEN solutions, **appropriate funding, markets and business models are essential to sustain PEN projects, while integrating the entire construction and energy value chains.** The creation of incentives could help to apply solutions at the neighbourhood level that would otherwise not be feasible from an economic perspective. Local governments can create incentives to support and enable clean energy deployment, such as offering refunds on purchasing equipment, tax incentives and accelerated permits, among others [5].

Integration of renewable and flexible energy technologies, along with appropriate management services and policies, is needed to deploy PENs across Europe. Guidelines are necessary for the further operation of PENs across different levels, from EU to national and regional levels. Although many laws are shaped to some degree by the EU, **local level decision- and policymaking is critical for the effective rollout of PENs, especially if addressing social and technical challenges in coordination with robust joint stakeholder engagement.** Support is needed for cities, and EU and national policies can increase their efforts towards accelerated sustainable urban renovation while becoming leaders in the field of the energy transition.

Policy recommendations

Even though comprehensive renovation strategies and neighbourhood approaches are being positively referenced in the Renovation Wave strategy, the concept of neighbourhoods as micro-energy hubs is still largely overlooked by policymakers. No long-term regulatory targets or requirements exist at the EU or national level for positive energy neighbourhoods [10].

The ongoing recast of the EPBD offers the opportunity to bring clarity to the debate and introduce clear definitions and provisions on neighbourhood approaches. The following recommendations outline key policy intervention points to bring PEN solutions to scale as a tool to meet EU energy goals.

Recommendation #1

Establish a harmonised definition of positive energy neighbourhoods

- Establish a framework definition of PEN that clarifies the boundaries of the built environment, covering aspects related to use of renewables, energy communities, mobility, density, and social cohesion. The definition should be developed throughout a study mandated by the EPBD recast proposal.[3]
- Strengthen definitions to support the ambitious energy performance level required by positive energy buildings and neighbourhoods. Achieving PENs also has implications for individual buildings, so the recast EPBD should define the "positive energy building". Positive energy buildings should meet all the following conditions:
    - High efficiency standards with energy needs for heating, cooling, ventilation, and hot water equal to or below 15 kWh/m^2/year.
    - The production of more kWh of renewable energy on-site than necessary for any residual energy needs over the timespan of one year, including high self-consumption and high energy flexibility.
    - High-quality indoor environment that guarantees the comfort and well-being of the building occupants.
    - Optimised for reduced lifecycle global warming potential including building materials and renewables during manufacturing, installation, use, maintenance, and demolition.
- Add an A+ label to energy performance certificates corresponding to positive energy buildings (with the A label corresponding to zero emission buildings).

[3] There is a lot of existing expertise and ongoing initiatives in this field like COST Action PED [11] and IEA Annex 83.

Recommendation #2

Endorse the identification of the most appropriate neighbourhoods for aggregated renovations

- Member States should encourage and support regional and local authorities to identify neighbourhoods to implement integrated renovation programmes. Programmes should include:
    - Urban planning, green spaces, green infrastructure, overcoming the heat island effect.
    - Waste and water treatment management.
    - Comprehensive heating and cooling assessments and plans.
    - Integration with sustainable urban mobility plans, encompassing public transport, sharing mobility and charging.
    - Exploration of energy system integration potential of the neighbourhood.
    - Prioritisation of local and regional resources.
    - Focus on circularity and sufficiency.
- Member States should set up district and regional level one-stop-shops to inform on the design and implementation of aggregated renovation programmes.
- Recommendations in the EU-wide renovation passport scheme should include neighbourhood-level connectivity and wider network benefits/ potential.
- Clarify how the Commission intends to map the potential of integrated district or neighbourhood approaches when reviewing the EPBD by the end of 2027.[4] The EU Commission should develop benchmarks to support the assessment of national policies and measures put in place to support district and neighbourhood approaches and reported by Member States within the framework of national building renovation plans (mentioned as reporting indicator in Annex 2 of the EPBD proposal).

[4] Article 25 of the recast proposal states that the Commission will review the EPBD by the end of 2027 and in that framework examine in what manner Member States could apply integrated district or neighbourhood approaches in Union building and energy efficiency policy.

Recommendation #3

Policy integration – Reinforce existing policies with PEN solutions, including forthcoming national building renovations strategies

- Introduce long-term strategies and targets for the roll out of PENs in the **forthcoming national building renovation strategies** and action plans.
    - Strategies should include requirements to screen, in collaboration with cities and regions, the national building stock to identify neighbourhoods suitable for PEN implementation, as well as reporting on its progress.
    - The long-term strategies and targets for the roll out of PENs should look at the **synergies and potential of district and community approaches**, including how these could bring about healthier, greener, and more affordable buildings.
    - **Solar rooftop provisions in the EPBD** (through REPowerEU) are potentially relevant measures to promote connection and procurement of flexible distributed energy generation, as well as the appropriate governance structures that offer a level playing field and fair remuneration for active customers and energy communities. These provisions should, however, go further and couple energy communities with energy efficiency measures and renewables-based district heating and cooling infrastructure to initiate integrated, whole-neighbourhood approaches.
    - Member States should provide support to neighbourhood initiatives, such as citizen-led renovation programmes and programmes for renewable heating and cooling, by establishing technical assistance facilities, including through one-stop-shops. These should target all actors involved in building renovations, including homeowners and administrative, financial and economic actors, including small and medium-sized enterprises, energy communities, citizen-led initiatives, local authorities and energy agencies.

Recommendation #4

Flexibility and demand response – overall, redesign energy efficiency solutions as a dynamic concept

- To enable better accounting of the potential of demand response and flexibility, conduct a Member State-level review of electricity market regulations, which in several regions prevent PEN from exporting energy to the external electricity grid and district heating network [10]. Identify unique market barriers and where regulation needs to be amended to enable wider participation in the market.

While still in the development phase, both in terms of a concept and in practice, positive energy neighbourhoods are the next step for energy communities, with the potential to strengthen current EU climate policy and initiatives. Through further development of a clear definition, the identification of potential neighbourhoods suitable for PEN, and integration with existing and upcoming policy, there is real potential for positive energy neighbourhoods to significantly contribute to EU decarbonisation efforts.

The EU's Strategic Energy Technology Plan (SET-Plan) has set out a vision to create 100 positive energy districts in Europe by 2025. For further information on positive energy neighbourhoods, see the Horizon 2020 funded projects ***oPENLab*** and ***Syn.ikia***, and the research initiatives COST Action PED-EUNET [11] and IEA EBC - Annex 83 on PEDs [12].

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