Strategic Energy Technology Plan

Implementation Working Group on
Positive Energy Districts (PEDs)

Thematic Vision on Positive Energy Districts

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Executive Summary

The first 100+ PED initiator sites, recognised at the November 2025 SET Plan Conference, demonstrated that the approach works. The next step is to scale PED-enabling solutions to 1,000 districts with PED layers by 2040, and 100 Positive Energy Cities delivering multiple societal benefits — including operating as carbon sinks across the European continent — by 2050.

A Positive Energy District (PED) is the district-scale framework through which the European energy and climate transition meets the built environment and sustainable urban living. A PED is a layered system architecture integrating multiple interdependent dimensions: the building stock and urban infrastructure layer; the integrated local energy system as the operational layer; the digital, governance and stakeholder coordination layer; and the financial and investment layer enabling implementation and long-term operation. Within this architecture, municipalities, real estate actors, utilities, communities, financial institutions and other local stakeholders contribute through complementary roles distributed across local, regional, national and European governance levels.

The Vision is structured across four interrelated themes spanning 2030, 2040 and 2050:

(A) Anchoring PEDs in planning, governance and multilevel coordination frameworks.

(B) Scaling PED-enabling solutions and system demonstrators.

(C) Strengthening investment alignment, stakeholder mobilisation and cooperation between real estate actors, utilities and local ecosystems.

(D) Advancing resilient, integrated and decarbonised local energy systems.

By 2030, PEDs deliver on the Clean Industrial Deal, the Affordable Housing Plan, and the 55% 2030 climate target. PEDs are recognised in NECPs and national renovation strategies. Some of the existing PED initiator sites operate as a transformative system demonstrator portfolio, with at least one system demonstrator and accelerator per SET Plan country anchoring scaling within that country's framework and forming the foundation for its Implementation and Investment Commitment. PED-aligned business and investment foundations — tested business model archetypes, a third-party certification pathway, a de-risking instrument for structural investors — are operational at pilot scale. PEDs and PED-aligned districts account for around 10% of the energy used in urban areas across Europe.

By 2040, PED principles are mainstreamed in urban energy planning. PED-enabling solutions are scaled across at least 1,000 districts with PED layers, driven by coordinated governance and market mechanisms, with PEDs and PED-aligned districts meeting around 25% of local energy use. PED-aligned investment is integral to real estate portfolios and utility capital expenditure for standard PED components — PEDs are an ESG-benchmarked asset class and the transition from public R&I-led pilots to market-mainstreamed scaling is sustained by continued public roles in governance, regulation and local enablement.

By 2050, PEDs are an established urban energy architecture across SET Plan countries — having become the standard model of urban transformation — scaled across Europe and concentrated in at least 100 Positive Energy Cities (PECs), meeting around 50% of local energy use, alongside complementary approaches to the energy transition. PED finance is business-as-usual within standard real estate and utility capital expenditure. At least 100 European cities operate as Positive Energy Cities where the majority of citizens are served by PED or Energy Community frameworks — delivering multiple societal benefits, including operating as carbon sinks through diversified pathways suited to each region's geography, with deep energy demand reduction against 2020 levels and a net-positive energy balance contributed to the wider European system.

1. Introduction

1.1. PEDs as layered system architectures for local energy transition

The Implementation Working Group on Positive Energy Districts (IWG 3.2) was established by the SET Plan Steering Group to support the development, planning, deployment and replication of Positive Energy Districts across Europe. PEDs are layered system architectures operating at district scale, where the built environment, local energy systems, infrastructure, governance arrangements, stakeholder ecosystems and financing mechanisms interact within an integrated operational framework.

The district acts as an intermediate scale between buildings and the wider urban energy system — a scale at which energy generation, demand management, flexibility, infrastructure integration and governance coordination are organised in practice. PEDs combine multiple interconnected dimensions: deep retrofit and new construction; heating and cooling systems; distributed renewable generation; storage and grid integration; digital and data infrastructures; governance and regulatory arrangements; investment and financing structures; and stakeholder participation mechanisms. The district is also an effective scale at which to phase out fossil gas, coordinating the shift away from fossil fuels across connected buildings and networks.

Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources and promoted RES, and Directive (EU) 2024/1711 on active customers and the Citizens Energy Package have outlined two entities within the urban energy system—one physical and one legal—functional for implementing the energy transition toward a decarbonized, decentralized, and digitalized urban energy system, critical to achieving climate objectives.

Energy renewable communities (CERs) are the basic tool for the participation of citizens, local authorities, businesses, and third-sector entities in the energy transition.

An integrated sustainable urban transformation project requires coordination between multiple CERs and local configurations within the territory — a level of coordination that a PED can represent, uniting buildings, blocks of buildings and districts in a common project based on the green and digital transition promoted by the Green Deal.

Further considerations on the opportunity to guide the sustainable urban transition through territorial tools are born out by the implementation of the 2030 Agenda: the primary objective of European cities is, in fact, sustainable development, together with the implementation of the SDGs at the local level, specifically Goal 11.

The clean energy transition represents an enabling factor for the transformation of cities into sustainable cities. It is worth recalling that the Innovation Partnership Smart Cities and Communities focused on the energy domain and mobilized ICT technologies as a driver.

The definition of territorial coordination areas can serve as a local laboratory for building the energy transition and climate neutrality, as well as other European policies, the green and digital transition in general, and the achievement of other important primary objectives such as sustainability and citizens' quality of life.

These areas can serve as living labs for the transformation of cities into sustainable cities.

According to ENoLL, living labs are defined as "user-centered, open innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real-life communities and settings."

These innovative ecosystems enable the achievement, at the local level, of the objectives of participation, co-design, inclusion, and social equity that are the foundation of sustainable development.

At the territorial scale, PEDs are where the principles of the energy and climate transition are implemented in the built environment and across the dimensions of urban life.

The European Union has developed an integrated framework, represented by numerous European policies on climate, energy, and biodiversity, which enable cities to increase their sustainability.

In such contexts, integrated urban projects can be implemented that address multiple domains at the territorial level—energy, mobility, biodiversity, etc.—sustainable urban regeneration projects that enable cities to evolve towards sustainability in a gradual process of temporal and spatial steps.

This is how PEDs become one of the standard operating models for sustainable urban transformation, putting Europe on a path of sustainable and inclusive growth, supporting the Green Deal as the EU's strategy for implementing the United Nations 2030 Agenda and the Sustainable Development Goals.

This layered interpretation highlights the importance of multilevel governance and stakeholder mobilisation. Municipalities, regions, national authorities, utilities, real estate actors, financial institutions, industry, citizens and local communities all contribute through complementary roles distributed across governance levels. PED implementation depends on the combination of technological maturity, coordination capacity, regulatory alignment, investment readiness and long-term operational cooperation.

PEDs contribute to broader European objectives related to climate neutrality, resilience, competitiveness and energy security by functioning as integrated local energy systems capable of balancing supply and demand, integrating distributed resources and strengthening local flexibility under changing energy conditions, while delivering multiple societal benefits to citizens and communities.

1.2. The role of the IWG and the CIIP process

The IWG oversees the development of the Common Implementation and Investment Plan (CIIP), structured around three complementary components: this Thematic Vision, the Strategic Research and Innovation Agenda (SRIA), entrusted to the European Construction Technology Platform (ETIP ECTP), and the Implementation and Investment Commitments (IICs), expected in Q1 2027.

The IWG operates through collaboration among policy, industry, research and innovation stakeholders, including the real estate and construction sectors, energy and multi-utilities (covering water, waste, energy and thermal infrastructures, eventually mobility), energy service providers, and distribution system operators (DSOs), research organisations, European partnerships and city networks. PED implementation requires alignment across technology, governance, financing and operational dimensions.

1.3. From experimentation to coordinated implementation

The original 100-PED target, set in 2018 and reached and recognised at the November 2025 SET Plan Conference, demonstrated the relevance of PEDs as a framework for integrated clean energy transitions at the local level. The next phase moves from validating the PED concept to coordinated implementation and broad adoption. Thus, PEDs should no longer be considered as pilot projects or local experiments but should become the standard model of clean energy transitions in cities and urban areas in Europe.

Four questions the 2018 Implementation Plan did not fully answer shape the next cycle. First, how PEDs scale from pilot to mainstream. Second, how real estate and multi-utility capital is mobilised at scale. Third, how PED performance is measured, certified and integrated into sustainable and resilient urban energy planning with multiple societal benefits. Fourth, how system demonstrators are translated into scalable, investable and replicable implementation pathways — understood not as endpoints but as engines that generate replicable system configurations, business models and investment cases, and as starting points for implementation and investment pipelines. This Thematic Vision sets the direction; the SRIA carries the R&I priorities; the IICs carry the commitments.

In this Vision, system demonstrators are operational environments capable of generating transferable system configurations, governance approaches, business models and investment cases. They contribute directly to the implementation and investment pipelines that support wider deployment. The system demonstrator concept and its distinction from classical pilots is set out in Annex 1.

1.4. Key enabling conditions for scaling

Foundations and Policy drivers

This Vision builds on a decade of EU research and innovation on PEDs and a maturing standardisation effort.[1] PEDs operate within the EU's climate and energy policy frame — from the European Green Deal and Fit for 55 to the Renovation Wave, the 2040 climate target and the recast Energy Performance of Buildings Directive, which ends fossil-boiler subsidies from 2025. The EU Emissions Trading System, legally extended to buildings and road transport with ETS2 becoming fully operational in 2028, gives PED-relevant measures a binding price signal, while the Social Climate Fund supports vulnerable households and microenterprises through the transition. FP10 and a potential Competitiveness Fund are the funding horizon this Vision provides input to.[2]

Barriers and drivers

The first cluster concerns technological and system integration — components and system integration supporting PED functionality, alongside the creation of an industrial pipeline.

The second cluster is regulatory: load-shifting and cross-building energy trading; stakeholder coordination and knowledge gaps; grid connection constraints; financing alongside regulation.

The third cluster is financing and business models: lack of proven business models aligning real estate actors and multi-utilities around district-scale assets, absence of de-risked investment instruments for structural investors, limited standardisation and certification, and skills gaps in integrated district-scale design and operation. The framework for cooperation between real estate and multi-utilities is a key policy gap, with win-win arrangements across multiple actors as a precondition for active private-sector engagement.

[1] Including Horizon 2020 and Horizon Europe, JPI Urban Europe, the DUT Partnership and PED Framework 3.0 (PED R&I Calls 2022–2025), the EERA Joint Programme on Smart Cities, IEA EBC Annex 83, the IEA Cities TCP and its proposed PED Task, Mission Innovation's Urban Transitions Mission, COST Actions, the PED Database, and the standardisation stack (IEC PED Technology Report, UNI CT 058, ISO, CEN).

[2] The wider policy frame also includes the EU Mission Climate-Neutral and Smart Cities, the Clean Industrial Deal (February 2025), the Affordable Housing Plan, the Net-Zero Industry Act, and the forthcoming European Innovation Act, European Research Area Act, Circular Economy Act and Clean Energy Investment Strategy adopted on 10 March 2026 (COM/2026/116).

The fourth cluster is resilience. Energy supply pressures — price volatility, security of supply, grid constraints and disruption risks — make district-scale integration increasingly valuable, as PEDs provide local balancing, flexibility and partial autonomy that help cities stay functional when external systems are under strain.

These dimensions are interconnected. Technology maturity alone does not deliver PED scaling. Coordinated progress in governance arrangements, financing structures, stakeholder mobilisation and implementation capacity is required.

2. Vision and Targets

2.1. Strategic orientation of the Vision

The Vision is developed with all nine SET Plan Guiding Principles in mind, recognising that PEDs contribute to the energy transition through an integrated and place-based approach. Two principles are foregrounded as joint lead: Security and Resilience and Competitiveness. PEDs deliver on resilience by integrating distributed resources, demand-side flexibility and partial autonomy at district scale; they deliver on competitiveness by mobilising European technology, business model innovation and demand-side measures, in line with the Competitiveness Compass, the Clean Industrial Deal and FP10 input. Circularity and Societal Needs sit alongside as complementary dimensions; Decarbonisation is the outcome the other principles serve. The remaining four are threaded through the horizon targets: Research and Innovation as the vehicle throughout, Technological Neutrality through the flexible-pathway design of the focus areas, Digitalisation and AI through district-scale optimisation and data infrastructure, and Skills through the workforce pipeline that retrofit at scale and integrated system operation both require.

Five strategic positions shape the horizon subsections that follow

First, positive energy is the primary framing, with cities operating as carbon sinks and delivering multiple societal benefits. Positive Energy Districts (PEDs) are the foundational model for both regenerating existing urban districts and developing new ones. As PEDs have spread across Europe, cities have adapted PED and Energy Community concepts into local policy to evolve into Positive Energy Cities (PECs). By 2050, the 100 Positive Energy Cities operate at this stage, with each Member State and region maturing the integrated decarbonisation pathways suited to its geography, infrastructure and policy preferences. Numerous carbon-removal strategies relating to the local energy system and built environment are being developed across the European continent — including, but not limited to, bioenergy with carbon capture and storage (BECCS), direct air carbon capture and storage (DACCS), biochar from agricultural residues and forestry, bio-based construction materials, carbonated concrete, enhanced rock weathering, and nature-based carbon sequestration. Clean transport electrification and circular, decarbonised waste-system and municipal solid waste transformation operate across all regions. The pathway portfolio is technology-neutral while the target remains constant.

Second, an integrated approach between retrofit and new construction is promoted, calibrated to the specific characteristics of the building stock and urban development trajectories of each context.

Third, affordability is approached as an evolving dimension of PED implementation: performance-led in the 2030 demonstrator cohort, affordability-integrated by 2040 as mainstreaming reduces costs.

Fourth, the transition from public R&I-led pilots to market-mainstreamed scaling is targeted by 2040, sustained by continued public roles in governance, regulation and local enablement, with the Net-Zero Industry Act and SET Plan cooperation acting as a potential operational bridge.

Fifth, scaling is a system challenge requiring coordinated approaches across policy, investment and implementation layers, where value is defined to include social, environmental and long-term system benefits beyond traditional financial metrics. PEDs strengthen Europe's contribution to global climate action by offering practical, system-level reference cases that inform international policy dialogue and bilateral exchange with regions facing comparable local energy pressures. PEDs function as active system nodes, capable of balancing supply and demand, integrating distributed resources and

supporting grid stability. Enhanced resilience at district level reduces system risk and strengthens the investment case for PED-aligned solutions.

Targets are organised around a four-theme matrix threaded through all three horizons, allowing each theme to be read either across time horizons or within a single horizon.

(A) Anchoring PEDs within planning, governance and multilevel coordination frameworks: from references in NECPs, Social Climate Plans, and regional and local planning frameworks including Mission Cities by 2030, to broader integration into planning practices by 2040, and standard approaches to planning and governance by 2050.

(B) Scaling PED-enabling solutions and system demonstrators: from 100+ PED initiator sites, with a subset developed into system demonstrators and accelerators (at least one per SET Plan country), meeting around 10% of local energy use, by 2030, scaling across 1,000 districts with PED layers and around 25% by 2040, to PEDs as an established local energy architecture and the standard model of urban transformation, meeting around 50% of local energy use, by 2050.

(C) Strengthening investment alignment, stakeholder mobilisation and cooperation between real estate actors, utilities and local ecosystems: from pilot business models, emerging certification and ESG-benchmarking approaches and early de-risking mechanisms by 2030, through integration within real estate portfolios and utility capital expenditure supported by carbon pricing frameworks by 2040, to standard practice by 2050.

(D) Advancing resilient, flexible, integrated and decarbonised local energy systems: from the first regional integrations and partnerships, with around 10% of PED flexible load activated for grid balancing and system services, by 2030, through operational regional integrations across multiple SET Plan regions and around 25% by 2040, to 100 Positive Energy Cities operating as carbon sinks delivering multiple societal benefits across the European continent, with around 50% of PED flexible load activated for grid balancing, by 2050.

2.2. Short-term (2030)

By 2030, PEDs are no longer driven primarily by individual demonstration cases, but are increasingly embedded within local energy strategies and broader urban planning measures. With activities already underway since end-2025 and the CIIP finalised in Q1 2027, the window to 2030 is a scaling-readiness phase: some of the existing pioneering PED sites operate as system demonstrators that generate market-ready solutions — including tested business model and collaborative governance archetypes, reference methodologies, and replication-ready designs — enabling the 1,000-district trajectory at 2040.

Indicative direction across the four themes: planning and policy anchoring through NECP integration, national Climate Plans, regional and local energy plans, municipal Climate Action Plans, and Mission Cities labelling (A). Some of the 100 pioneering PED sites operating as system demonstrators contributing to market-ready solutions, with at least one system demonstrator and accelerator per SET Plan country anchoring scaling within that country's framework (B). Stakeholder mobilisation and cooperation for pilot-scale business model archetypes with real estate–utility alignment, alongside a third-party certification pathway and a de-risking instrument supporting alignment with mainstream investment (C). Regional integrations advancing across SET Plan regions, with each region pursuing the integrated decarbonisation pathways suited to its geography (D).

(A) Anchoring PEDs within planning, governance and multilevel coordination frameworks

PEDs are recognised across European, national and local planning and policy frameworks, including National Energy and Climate Plans, national building renovation strategies, national Social Climate Plans (under Regulation 2023/955), regional and local energy plans (including utility-led district plans), municipal climate action plans, and Sustainable Energy and Climate Action Plans (SECAPs) under the Covenant of Mayors across SET Plan countries. Member States are encouraged to reflect PEDs in the NECP cycle becoming operational from late 2027 onwards, with parallel anchoring in Social Climate Plans for the 2026–2032 implementation window where they are eligible structural measures. PEDs are integrated into the EU Mission Climate-Neutral and Smart Cities label and the Climate City Contracts of Mission 100 cities as one route to municipal anchoring, alongside city-led governance mechanisms in non-Mission cities.

(B) Scaling PED-enabling solutions and system demonstrators

At least one system demonstrator and accelerator per SET Plan country — a mature PED where the full value chain is proven and replicable. These demonstrators generate market-ready solutions — tested business model archetypes, reference methodologies, replication-ready technical and governance designs — that drive scaling from the initiator sites toward 1,000 districts adopting PED layers by 2040, and form the basis for aggregated portfolios and implementation and investment pipelines. The system demonstrator concept and its distinction from classical pilots is elaborated in Annex 1. Milestones: portfolio coordination established by 2027, supported by standardised reporting; reference methodology and KPI set published and adopted by 2029; market-ready solutions documented and made publicly available for replication by 2030, with uptake commitments from at least 100 real estate, multi-utility and municipal organisations across SET Plan countries connected to the system demonstrator PEDs. The system demonstrators provide a basis for international collaboration with regions facing comparable local energy pressures, including through the IEA CITIES TCP, Mission Innovation's Urban Transitions Mission Call Series, and similar initiatives beyond Europe.

(C) Strengthening investment alignment, stakeholder mobilisation and cooperation between real estate actors, utilities and local ecosystems

PED-aligned business and investment foundations are operational at pilot scale by 2030, including tested business model archetypes for real estate–utility alignment around district-scale assets (published for community use), a recognised third-party certification pathway, and a de-risking instrument for structural investors. The PED ESG assessment framework is operationalised, aligned with related bodies such as GRESB, ISO and CEN benchmarks. Each archetype is documented with its investment relevance, including impact on local and regional economies, environmental performance and long-term resilience. These elements move PEDs toward commercial viability beyond grants and subsidies, with operational models, ownership structures, and integration into local ecosystems creating the conditions for alignment with mainstream financing.

(D) Advancing resilient, integrated and decarbonised local energy systems

PEDs increasingly operate as flexible nodes in the local energy system, with around 10% of PED flexible load activated for grid balancing and system services. The first regional integrations across SET Plan regions advance through 2030 — with diversified carbon-removal and decarbonisation pathways at district level such as energy plants and waste-to-energy facilities, integration of bio-based construction materials, decarbonised municipal solid waste transformation, and clean transport

electrification at city scale. Pathways and partnerships are established, with each region pursuing the routes suited to its geography.

2.3. Medium-term (2040)

The 2040 horizon is the keystone of the Vision. It outlines four interrelated directions aligned to the four-theme matrix: a broader mainstreaming of planning approaches (A); the scaling of PED-enabling solutions to 1,000 districts with PED layers, meeting around 25% of local energy use (B); increased integration within real estate and utility strategies, with a transition from public R&I-led pilots towards market-oriented scaling (C); and the operationalisation of regional integrations across SET Plan regions, with flexibility deepening to around 25% of PED flexible load activated for grid balancing (D). Mainstreaming depends on mechanisms that support coordination across portfolios, the aggregation of projects and the alignment of capital at scale.

(A) Anchoring PEDs within planning, governance and multilevel coordination frameworks

PED principles are integrated into local energy planning practices across SET Plan countries by 2040. The reference methodology and KPI set are adopted by 2035 and reflected, where appropriate, in municipal building codes, national renovation programmes, and city-level governance instruments including Climate City Contracts. Planning mainstreaming is supported by structured local coordination — bringing together municipalities, energy companies, real estate actors and finance partners through shared local energy planning frameworks aligning data, investment and decision-making. The trajectory of the EU Mission Climate-Neutral and Smart Cities cohort through the 2030s — from the original Mission 100 to a broader cohort of climate action cities by 2040 — is one route through which planning mainstreaming becomes operational at city scale.

(B) Scaling PED-enabling solutions and system demonstrators

PED-enabling solutions — the integrated district energy configurations, business model archetypes, certification pathways and governance arrangements developed and tested through the 2030 system demonstrators — are scaled across at least 1,000 districts with PED layers by 2040 within SET Plan countries, driven by coordinated governance and market mechanisms, with PEDs and PED-aligned districts accounting for around 25% of the energy used in urban areas. Scaling is measured against the reference methodology and KPI set adopted under Target 2040-A, ensuring comparability rather than definitional drift. The 1,000-district trajectory supports the 2050 horizon of PEDs as an established local energy architecture and the standard model of urban transformation, scaled across Europe and concentrated in Positive Energy Cities.

(C) Strengthening investment alignment, stakeholder mobilisation and cooperation between real estate actors, utilities and local ecosystems

PED-aligned investment is integrated into real estate portfolios and utility capital expenditure planning for standard PED components by 2040, with reduced reliance on dedicated public subsidy. This is supported by a combination of mechanisms operating together: the recognition of PEDs as an ESG-relevant investment asset class with risk-adjusted return profiles; the broader uptake of business model archetypes piloted in the 2030s — joint real estate–utility asset vehicles, integrated energy service contracts, district-scale operation models; the alignment of real estate and utility investment commitments with the SET Plan CIIP process; and the articulation of leverage ratios between public PED R&I funding and committed private investment. The transition from public R&I-led pilots to

market-mainstreamed scaling takes shape, supported by continued public roles in governance, regulation and local enablement, with the Net-Zero Industry Act and SET Plan cooperation providing an operational bridge. From the late 2020s, the extension of EU carbon pricing to buildings and road transport reinforces this shift, strengthening the PED business case. An aligned value proposition emerges, supporting cost-of-capital reduction for real estate actors and greater capex deployment certainty for utilities.

(D) Advancing resilient, integrated and decarbonised local energy systems

Flexibility deepens as a continuous goal, with around 25% of PED flexible load activated for grid balancing and system services. Regional integrations are operational across multiple SET Plan regions by 2040 — including diversified carbon-removal pathways at district energy plants where local conditions support, alongside clean transport electrification and circular, decarbonised waste-system and municipal solid waste transformation at city scale. Comparable forms of integration emerge across SET Plan regions, with each Member State and region pursuing the routes suited to its geography, infrastructure and policy preferences. This horizon develops the technical, governance and financing architecture that supports the 2050 ambition.

2.4. Long-term (2050)

By 2050, PEDs are an established local energy architecture across SET Plan countries — having become the standard model of urban transformation — scaled across Europe and concentrated in at least 100 Positive Energy Cities, alongside complementary approaches to the energy transition. The four-theme trajectory is realised: planning and governance operate as a default (A), deployment extends across the building stock (B), real estate and utility planning treats PED-aligned investment as business-as-usual (C), and 100 Positive Energy Cities deliver multiple societal benefits — including operating as carbon sinks across the European continent — through diversified pathways suited to each region's geography (D).

(A) Anchoring PEDs within planning, governance and multilevel coordination frameworks

PED principles are embedded in municipal building codes, utility regulatory frameworks, and standard real estate development practice across SET Plan countries by 2050. Local energy planning structures piloted in the 2030s and developed through the 2040 reference methodology evolved into a common coordination mode for local energy decisions. PEDs move from a distinct category to a standard component of local energy systems.

(B) Scaling PED-enabling solutions and system demonstrators

PED and PED-equivalent district configurations play a central role in new development and retrofit programmes by 2050, according to each country's specific circumstances. Building on the trajectory from 100+ PED initiator sites in 2025 and the scaling to 1,000 districts with PED layers by 2040, deployment extends across a broad share of the building stock in urban areas, with PEDs and PED-aligned districts accounting for around 50% of the energy used in urban areas and functioning as flexible nodes within a net-zero European energy system. Because the large majority of the 2050 European building stock already exists today, the deep retrofit of existing buildings is the principal driver of this trajectory: retrofit and energy efficiency are scaled as an active lever from 2030 and accelerate through 2040, rather than being treated as a 2050 endpoint, in coordination with IWG5 on Energy Efficiency in Buildings and anchored to the EPBD trajectory for 2030 and 2035. Heritage

districts draw on adapted approaches that preserve cultural values. The target connects to the EPBD recast, national building renovation strategies, and the skills and supply-chain build-up that the 2030 and 2040 horizons initiate.

(C) Strengthening investment alignment, stakeholder mobilisation and cooperation between real estate actors, utilities and local ecosystems

PED-aligned investment is integrated within standard real estate portfolios and utility capital expenditure by 2050, with limited need for dedicated public subsidy for standard components. PED investment becomes a new normal investment category for real estate and utility actors, treated as part of routine practice — the cumulative effect of the foundations established by 2030 and the scaling realised by 2040. The role of the SET Plan in shaping PED finance is fulfilled.

(D) Advancing resilient, integrated and decarbonised local energy systems

At least 100 European cities operate as Positive Energy Cities by 2050 — cities whose majority of citizens are served by PED or Energy Community frameworks, supported by enabling local policies (the draft definition of the Positive Energy City is set out in Annex 2). Each Positive Energy City achieves deep energy demand reduction against 2020 levels, acts as a carbon sink, and contributes a net-positive energy balance to the wider European system, while delivering multiple societal benefits including just transition, wellbeing and resilience.

The 100 Positive Energy Cities deliver substantial carbon-removal capacity to the European climate balance by 2050, anchored to the EU Industrial Carbon Management Strategy and the Carbon Removal Certification Framework. The pathways are diversified across regions and integrated through district energy infrastructure. Numerous carbon-removal strategies relating to the local energy system and built environment are being developed across the European continent and are integrated through PED architectures — pathways of decarbonising or creating carbon sinks in the energy system and built environment — alongside a circular, decarbonised waste-system and municipal solid waste transformation. Each Member State and region selects the routes appropriate to its geography, infrastructure and policy preferences. Together, the PEC network functions as continental climate infrastructure, with PEDs as the integrating frame within which these pathways combine, and around 50% of PED flexible load activated for grid balancing and system services.

2.5. R&I priorities for MFF 2028–2034

Two aggregated governance and technological areas require particular attention in the next multiannual financial framework (2028–2034) — the principal innovation gaps the next funding cycle must close. First, integrated and flexible district energy systems, deep-retrofit strategies, circular materials, and decarbonised municipal solid waste and resource flows at district scale require further demonstration and validation under real-world conditions. Priority areas include heating and cooling, decentralised flexibility, energy storage, grid integration, vehicle-to-grid solutions, and retrofit-led building transformation. Given that approximately 88% of the European building stock expected in 2050 already exists today, accelerating the decarbonisation and upgrading of existing buildings is the most significant scaling lever. Second, energy-positive and carbon-negative technology pathways require continued demonstration and system-scale validation, including a technology-neutral portfolio of carbon-removal and decarbonisation solutions.

Across both areas, governance and regulation are essential cross-cutting dimensions. Future R&I investments should therefore not only advance technological innovation but also develop and test viable business models, risk-sharing mechanisms, ownership and operational models, and market

designs capable of delivering multiple societal benefits. Technology maturity is not the binding constraint on PED scaling — real estate–utility alignment, de-risking, and the governance conditions enabling them are.

3. Conclusions and Next Steps

SRIA entrustment

The IWG entrusts the SRIA to ETIP ECTP, developed in partnership with the Driving Urban Transitions Partnership (and its successor) — which has led PED development to date — together with the EERA Joint Programme on Smart Cities, the IEA TCP Cities and the CETPartnership, for submission by 15 October 2026. ECTP, with the DUT Partnership in a leading coordination role, will consult Eurocities, ICLEI, Energy Cities, Mission Cities, ERRIN, and the real estate and utility associations named in this Vision. The SRIA translates R&I priorities into specific activities, KPIs and funding levels, addressing the role of real estate owners, developers and utilities in the PED value chain. Local energy platform models, city-level coordination structures, and procurement pathways for commercial viability beyond grants are elaborated in detail in the SRIA.

Cross-IWG synergies

PEDs are inherently cross-cutting. The most important synergies are with IWG4 Energy Systems — integration of buildings and energy systems at district scale, bridging technological innovation and urban implementation, systemic integration and cross-sector cooperation — and IWG 5 on Energy Efficiency in Buildings — PEDs are the district-scale unit within which the building-by-building work of IWG 5 integrates — and with the IWGs on energy grids, storage, flexibility, heating and cooling, and digitalisation. The Conclusions of the integrated CIIP will reflect these connections; the SRIA elaborates them.

International coordination

International coordination is sustained through the IEA CITIES TCP — including the proposed PED Task — the IEA EBC TCPs, and Mission Innovation's Urban Transitions Mission Call Series (delivered through the DUT Partnership), NetZero Industries Mission, Green Powered Future Mission, Carbon Dioxide Removal Mission and Clean Hydrogen Mission, with system demonstrators providing reference cases for global cooperation. The Vision supports multilevel implementation approaches aligned with emerging international urban climate governance frameworks.

The path to Implementation and Investment Commitments

The IWG launches the IIC process in parallel with SRIA finalisation, with national consultation in November–December 2026 and private-sector outreach to real estate and utility actors through ECTP, the DUT Partnership (which runs to the end of 2033 and can carry implementation beyond the 2030 horizon), Eurocities and Energy Cities. The IICs collect national commitments and EU-level partnership commitments structured around the four-theme matrix, with monitoring indicators developed in line with Commission guidance. The complete CIIP is finalised in Q1/Q2 2027 for endorsement by the SET Plan Steering Group.

Closing

The first 100+ PED initiator sites demonstrated that the approach works. The next cycle is about scaling PED-enabling solutions to 1,000 districts with PED layers by 2040, and 100 Positive Energy Cities delivering multiple societal benefits — including operating as carbon sinks across the European continent — by 2050, making PEDs an established local energy architecture and the standard model of urban transformation across SET Plan countries.

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Annexes

Annex 1. The Concept of System Demonstrators

System demonstrators in the PED context are integrated, real-world configurations of buildings, energy systems, governance arrangements and financing structures, designed to address district-scale challenges and serve as an interactive learning portfolio for the PED community in operational settings. They differ in three important respects from classical pilots and proof-of-concepts.

Scope. Where classical pilots typically focus on validating a single technology or solution, system demonstrators integrate multiple technologies, actors and governance layers — the district is the unit of demonstration, not a single component within it. The integration itself is a central object of demonstration.

Purpose. Classical pilots focus primarily on technical validation and produce learnings that may not transfer beyond the R&I context. System demonstrators are designed to generate replicable evidence — informing policy, business models, regulatory adjustment, certification pathways, and aggregated implementation. They contribute to the early stages of the implementation and investment pipeline rather than marking the conclusion of a research phase.

Role. System demonstrators maintain a research and learning function throughout deployment and operation. As operational systems they continue to generate evidence, support the refinement of business models, and inform the evolution of standards as they scale. The research dimension extends beyond initial implementation and remains embedded in operation.

Within the SET Plan IWG 3.2 Vision, system demonstrators are the mechanism through which the 100+ PED initiator sites identified in 2025 and the new emerging ones contribute to the development of market-ready solutions for the 2040 scaling trajectory. The system demonstrator and accelerator subset — at least one system demonstrator per SET Plan country, as outlined in Target 2030-B — comprises the mature PEDs where the full value chain is proven and replicable within the broader 100-PED portfolio, anchoring scaling within each country's regulatory and policy framework.

Annex 2. Working definition: Positive Energy City

A Positive Energy City (PEC) is a city whose majority of citizens are served by Positive Energy District (PED) or Energy Community, supported by enabling local policies, integrated urban energy planning and coordinated infrastructure investment.

The PEC concept does not redefine PEDs at city scale. PEDs remain district-scale units with defined spatial boundaries and verifiable energy balance. The PEC describes a city-level state of PED and Energy Community saturation that emerges from sustained mainstreaming.

The PEC complements the EU Mission Cities cohort (focused on climate neutrality) by adding a specific architectural dimension: how the city's residential and commercial energy footprint is met through district-scale integrated systems and citizen-led energy organisations.

A mature PEC functions as continental climate infrastructure by 2050, contributing carbon-removal capacity to the European climate balance through diversified pathways suited to its regional geography, infrastructure and policy preferences. The PEC concept is offered here as a working definition for community discussion within the IWG and the wider SET Plan community.

Annex 3. PED System Architecture Layers

The defining technological characteristic of a Positive Energy District is not the presence of specific individual technologies, but rather the existence of a layered and vertically integrated system architecture capable of enabling coordinated, optimized, and flexible operation at district scale. In this perspective, a PED should not be understood as a simple aggregation of efficient buildings and renewable energy systems, but as an integrated urban energy ecosystem in which multiple technological, digital, and operational layers interact continuously.

At the foundation of this architecture lies the Physical Asset Layer, which includes all the tangible components enabling energy production, consumption, storage, and exchange within the district. This encompasses high-performance buildings and envelopes, HVAC systems and heat pumps, photovoltaic and solar thermal installations, electrical and thermal storage systems, EV charging infrastructure, district heating and cooling networks, as well as substations, inverters, and other grid-related components. Together, these assets provide the material infrastructure upon which the PED operates.

Above this foundational layer operates the Energy Flow Layer, which describes the dynamic interactions between electricity, heat, cooling, and mobility systems. Within a PED, energy flows are inherently multi-vector and interconnected: locally generated electricity can supply buildings, charge batteries, feed heat pumps, or support electric mobility, while thermal networks and storage systems contribute to balancing demand and enhancing overall system efficiency. Sector coupling mechanisms — including power-to-heat solutions, vehicle-to-grid and vehicle-to-building interactions, and integrated storage strategies — allow the district to function as a coordinated multi-energy system rather than as a set of isolated infrastructures.

The functioning of such a complex system requires continuous real-time observability, ensured through the Sensing and Data Acquisition Layer. Smart meters, environmental sensors, IoT devices, occupancy monitoring systems, local weather data, and edge gateways transform the district into a data-rich environment capable of continuously monitoring generation profiles, energy demand, storage conditions, and system performance. This pervasive sensing capability is essential for enabling adaptive and responsive operation.

Equally important is the Communication and Interoperability Layer, which allows heterogeneous technologies and platforms to communicate coherently. PEDs typically integrate systems originating from different vendors and sectors — including Building Management Systems, Energy Management Systems, EV infrastructures, sensors, and distributed energy resources — making interoperability a critical enabling condition. Communication protocols, middleware platforms, data standardization frameworks, and secure digital networks ensure that data can circulate effectively across the entire district ecosystem.

Building on this digital backbone, the Monitoring and Control Layer translates data into operational actions. Through local controllers, automation systems, microgrid management platforms, and real-time dispatch strategies, the PED can dynamically regulate HVAC systems, storage units, EV charging processes, and distributed generation assets. In this sense, the district operates as an adaptive cyber-physical system capable of continuously responding to changing environmental conditions, user behavior, and energy system requirements.

At a higher level, the Optimization and Intelligence Layer provides predictive and strategic system management capabilities. District-level Energy Management Systems integrate forecasting tools, model predictive control, artificial intelligence algorithms, machine learning techniques, and, increasingly, digital twins of the district energy system. These tools enable the PED to optimize its operation according to multiple objectives, including maximizing self-consumption, reducing peak

loads, minimizing emissions and operational costs, improving flexibility, and enhancing the overall positive energy balance of the district. Intelligence therefore becomes not an additional feature, but a core operational dimension of PED functionality.

Finally, the Grid and Market Interaction Layer defines the PED's relationship with the broader energy system. Rather than behaving as passive consumers, PEDs increasingly operate as active and flexible nodes capable of interacting dynamically with external grids and energy markets. Through demand response mechanisms, flexibility services, aggregation of distributed energy resources, and price-responsive strategies, PEDs can contribute to grid stability, renewable integration, and system-wide decarbonization processes. This interaction reinforces the role of PEDs not merely as local energy solutions, but as scalable components of a broader urban and regional energy transition.

Taken together, these interconnected layers illustrate how PEDs embody a systemic and integrated approach to urban energy transformation. Their technological identity does not reside in any single component, but in the capacity to orchestrate physical infrastructures, energy flows, digital systems, and operational intelligence into a coherent district-scale framework capable of supporting climate neutrality, flexibility, resilience, and urban sustainability objectives.

Annex 4. Acronyms and Abbreviations

This appendix lists the acronyms and abbreviations used in this Vision.

AI — Artificial Intelligence

BECCS — Bioenergy with Carbon Capture and Storage

CEN — European Committee for Standardisation

CETPartnership — Clean Energy Transition Partnership

CHP — Combined Heat and Power

CIIP — Common Implementation and Investment Plan

COM — European Commission Communication

COST — European Cooperation in Science and Technology

CRCF — Carbon Removal Certification Framework

DACCS — Direct Air Carbon Capture and Storage

DSO — Distribution System Operator

DUT — Driving Urban Transitions Partnership

EERA — European Energy Research Alliance

EPBD — Energy Performance of Buildings Directive

ERRIN — European Regions Research and Innovation Network

ESG — Environmental, Social and Governance

ETIP ECTP — European Technology and Innovation Platform — European Construction Technology Platform

ETS — Emissions Trading System (EU ETS, with ETS2 covering buildings and road transport)

EU — European Union

FP10 — Framework Programme 10 (the next EU R&I Framework Programme post-Horizon Europe)

GRESB — Global Real Estate Sustainability Benchmark

ICMS — Industrial Carbon Management Strategy

IEA — International Energy Agency

IEA EBC — IEA Energy in Buildings and Communities Programme

IEC — International Electrotechnical Commission

IIC — Implementation and Investment Commitment

ISO — International Organization for Standardization

IWG — Implementation Working Group

JPI — Joint Programming Initiative

KPI — Key Performance Indicator

MFF — Multiannual Financial Framework

MRV — Monitoring, Reporting and Verification

NECP — National Energy and Climate Plan

NZIA — Net-Zero Industry Act

PEC — Positive Energy City

PED — Positive Energy District

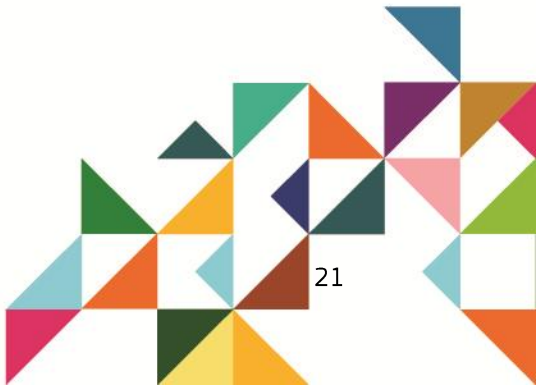
R&I — Research and Innovation

SET Plan — Strategic Energy Technology Plan

SETIS — SET Plan Information System

SRIA — Strategic Research and Innovation Agenda

TCP — Technology Collaboration Programme (under the IEA)

UNI — Ente Italiano di Normazione (Italian National Standards Body)

UNI CT 058 — UNI Technical Committee 058 — Italian standardisation activities on Positive Energy