Towards equitable and resilient PEDs for everyone

PEDs have great potential to decrease energy poverty and enhance resilience, but it requires targeted policies to avoid widening inequalities.

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Summary

Energy poverty and energy resilience are two interconnected challenges shaping sustainable urban development. As cities transition toward cleaner energy, Positive Energy Districts (PEDs) offer a transformative opportunity to address both issues simultaneously, but only if designed with strong social safeguards. This policy brief, based on research in RESPED-project, outlines how PEDs can alleviate energy poverty while strengthening resilience, and sets out a policy pathway for inclusive implementation.

Millions of households across Europe still lack access to adequate heating, cooling, and electricity without sacrificing other essentials, and they do so in systems that are themselves increasingly fragile. Cold, inefficient homes drive respiratory, cardiovascular, and mental health problems, while energy systems face mounting stress from extreme weather phenomena, aging infrastructure, geopolitical shocks, and the demands of rapid decarbonisation. When disruptions occur, energy-poor households are hit first and hardest, with the least capacity to adapt, relocate, or invest in backup solutions. PEDs could help mitigate this situation by combining efficiency, local renewables, and energy flexibility at district scale, but without an equity lens they risk triggering rent increases, displacement, and selective access to benefits.

The core contribution of this work is to show how technical PED solutions and social policy must be designed together. This means prioritising investments in social housing and energy-poor districts, and making inclusion of low-income households a non-negotiable condition for public support and planning approval. It calls for public financing to be tied to strong social protections, so that e.g. improved buildings do not become unaffordable to their original residents. Municipalities and community organisations should be empowered to lead PED development in disadvantaged areas, backed by tailored financial instruments such as zero-interest or pay-as-you-save schemes that remove upfront cost barriers. Finally, PED roll-out must be coordinated with targeted energy subsidies and housing allowances, ensuring that district-scale efficiency gains translate into genuine reductions in energy poverty rather than new forms of exclusion.

Resilience gap

Energy systems face increasing stress from climate change impacts, extreme weather events, and geopolitical disruptions.

Status of energy poverty

Millions of households across Europe still lack access to adequate heating, cooling, and electricity without sacrificing other essentials.

Energy poverty and resilience gap

The problem of energy poverty and resilience gap lies in the way social vulnerability and stressed energy systems intersect, exposing households to both price shocks and physical disruptions. Energy-poor households tend to live in inefficient buildings, face high and volatile energy costs, and lack the buffers - financial, technical, and institutional, that make districts resilient to crises.

Energy poverty: health and social crisis

Energy poverty is more than a budget problem; it directly affects health and social inclusion. Households unable to maintain safe indoor temperatures during cold spells or heatwaves face heightened risks to respiratory and cardiovascular health, mental stress, and difficult tradeoffs between heating, food, and other essentials. Vulnerable groups such as elderly people, or low-income families in poorly insulated dwellings are disproportionately affected, particularly in regions where old buildings with weak envelopes shorten the time homes remain safe during outages.

Energy systems face growing stress

At the same time, the energy systems serving these households are increasingly stressed by climate extremes, aging infrastructure, market volatility, and geopolitical tensions. Heatwaves, cold surges, storms, cyberattacks, and fuel supply disruptions are no longer rare shocks but recurrent stressors that challenge grid stability and increase the likelihood of blackouts and sudden price spikes. When such disruptions occur, households already at the edge of affordability are least able to absorb higher costs or invest in backup options, so system stress translates quickly into social crisis.

The paradox of the green transition

The green transition promises cleaner and more efficient energy, but it can unintentionally deepen inequalities if not carefully governed. Electrification of heating, rapid renewable integration, and digitalized control systems can improve decarbonisation and technical resilience, yet they also make households more dependent on electricity systems that may fail under extreme conditions. New high efficiency districts and Positive Energy Districts can drastically lower energy use and bills inside their boundaries, but without strong inclusion and affordability safeguards, they risk becoming enclaves for higher income groups while energy poor households remain in older, leaky housing and face rising relative costs.

The core challenge

The core challenge is that energy resilience and energy poverty have often been treated as separate agendas: technical reliability on one side, social affordability on the other, despite being tightly intertwined in people's lived experience. When districts lack resilient infrastructure, efficient envelopes, and flexible energy mixes, the resulting outages and price volatility fall hardest on those who cannot relocate, retrofit,

or purchase alternatives, pushing them deeper into energy poverty during every crisis. Addressing the problem therefore requires integrated strategies that upgrade building stocks, diversify and harden local energy systems, and embed social equity into transition policies so that gains in resilience do not bypass, or even displace, the households most at risk.

The connection between energy poverty and energy resilience

Energy resilience and energy poverty are intertwined aspects of districts and energy systems that must be understood as mutually reinforcing concepts rather than separate topics. Energy resilience directly shapes the vulnerability of households to energy poverty. When districts lack resilience (through aging infrastructure, inadequate thermal efficiency, or limited energy flexibility), the burden falls disproportionately on vulnerable households who cannot afford backup systems, emergency heating alternatives, or the consequences of prolonged disruptions. During energy supply disruptions, whether acute shocks such as extreme weather events or chronic stressors like price volatility, energy-poor households experience compounded hardship because they typically reside in poorly insulated dwellings with minimal passive survivability, forcing them into difficult choices between thermal comfort, health, and financial stability.

Addressing both energy poverty and resilience together brings the greatest overall benefits, across environmental, social, and economic domains. When these areas are tackled in an integrated way, investments in resilient infrastructure can also help reduce poverty, improve health, boost labour productivity, and strengthen community ties. In contrast, treating them as separate issues often leads to missed opportunities and unintended consequences. Such fragmented approaches can worsen inequalities, create poorly adjusted outcomes, and weaken progress toward long-term sustainability.

Low resilience increases vulnerability to energy poverty; PEDs can mitigate both if designed inclusively.

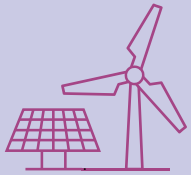
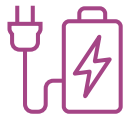
Concepts

PED:
"energy-efficient and energy-flexible urban areas with net-zero energy import and greenhouse gas emissions and interact with the urban and regional energy grid"

Energy poverty:
"a situation in which households are unable to access essential energy services that underpin a decent standard of living and health, such as adequate warmth through heating, cooling, lighting, and energy to power appliances"

Energy resilience:
"a range of preparation, absorption, recovery, and adaptation measures that ensure availability, accessibility, affordability, and acceptability of energy supply, transmission and distribution over time"

PEDs, energy poverty, and energy resilience

	Solutions in PEDs	Implications for energy poverty	Implications for resilience
Energy efficiency 	Envelope improvements Smart controls	+ Reduces households energy consumption and cost - High investment costs can increase rents and exclude disadvantaged groups - Risk of gentrification and exclusion	+ Reduces overall energy demand + Lowers operational costs and encourages energy-saving behavior + Improves insulation and envelopes, enhancing survivability during disruptions
Renewable energy production 	Photovoltaic Heatpump (geothermal, airsource)	+ Can lower household energy bills if benefits are shared equitably - Cost for investment and maintenance could increase recurrent cost	+ Increases energy autonomy for households + Reduces reliance on central grids + Shields communities from market price fluctuations
Energy flexilbility 	Demand-side management Energy storage Local energy sharing	+ Potential to reduce bills if flexibility is accessible to all - Digital skills/devices required may further marginalize	+ Enables households to shift energy use to cheaper periods + Optimizes energy loads, improving system adaptability + Community energy sharing can enhance collective resilience

Policy recommendations

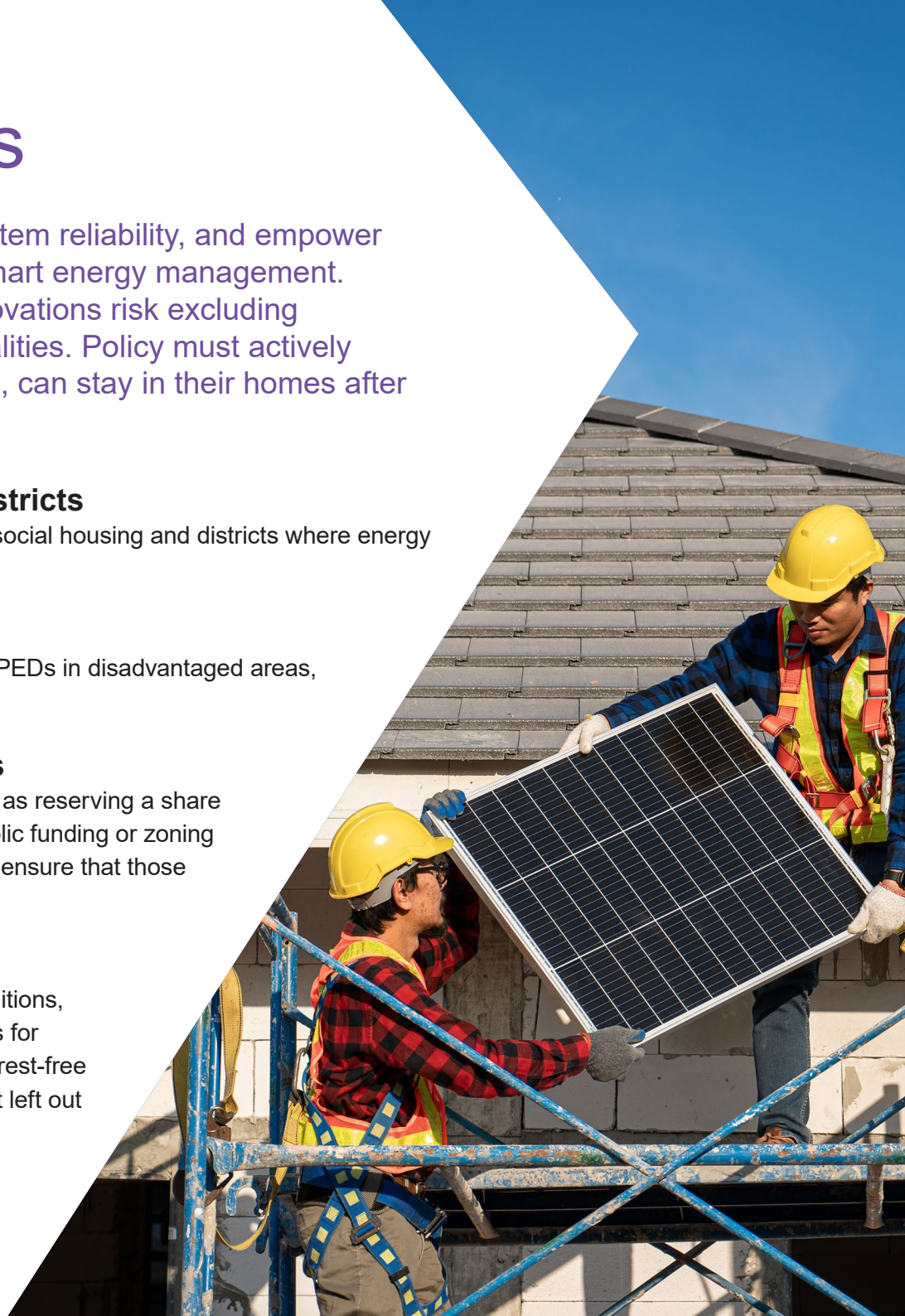
PEDs can reduce household energy costs, enhance system reliability, and empower communities through local renewable generation and smart energy management. However, without deliberate policy measures, these innovations risk excluding vulnerable populations and exacerbating existing inequalities. Policy must actively ensure that energy-poor households access renewables, can stay in their homes after efficiency upgrades, and participate in decision making.

1. **Prioritise social housing and energy poor districts**
   Renovation programs and PED investments should focus on social housing and districts where energy poverty is most severe.

2. **Empower municipalities as PED developers**
   Municipalities should be encouraged to act as champions for PEDs in disadvantaged areas, ensuring that local needs and affordability remain central.

3. **Inclusion of low-income households in PEDs**
   PED projects must include clear social inclusion criteria, such as reserving a share of homes for low-income or energy-poor households, and public funding or zoning approvals should be linked to measurable equity outcomes to ensure that those most in need receive the benefits.

4. **Public financing for social housing**
   Public funding for PEDs should come with binding social conditions, including rent caps, anti-eviction clauses, and dedicated funds for upgrading older social housing, while targeted grants and interest-free loans should be used to ensure that vulnerable groups are not left out of the energy transition.



5 Protect housing affordability after renovation

Policymakers must protect affordability after renovations by guaranteeing tenants the right to return at affordable rents, using rent controls and legal safeguards to prevent displacement and ensure that improved homes remain accessible to low-income residents.

6 Develop financing tools for low-income households

Tailored financing tools, such as zero-interest loans, pay-as-you-save schemes, or public guarantees, should be provided to help low-income households afford energy upgrades, with flexible terms for renters and protection from upfront costs.

7 Balance upscaling of PEDs with social policy

The expansion of PEDs should be balanced with social policy, combining efficiency measures with targeted subsidies and housing allowances, so that the benefits of PEDs are maximized without slowing down renovation momentum or relying solely on private investment.

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www.resped-project.eu

RESPED project develops new energy flexible and affordable PED concepts to improve energy resilience and mitigate energy poverty in cities. The project aims to support cities in their transition towards a more sustainable, resilient and affordable economy and infrastructure by studying how PEDs can drive this development. There was no clear definition for energy resilient districts, so that was developed in RESPED project through literature reviews and expert discussions. The working definition for energy resilient districts developed for the use of the project is the following:

"An energy resilient district is a geographically defined and interconnected cluster of buildings, energy infrastructure, and local resources that can anticipate, withstand, adapt to, and recover from energy-related stressors and disruptions, whether physical, operational, or economic, while ensuring continuity of critical services, particularly thermal and electrical supply, and supporting the health and well-being of end users and communities."