energies

Editorial

Harmonizing Urban Innovation: Exploring the Nexus between Smart Cities and Positive Energy Districts

Paola Clerici Maestosi

ENEA—Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Department Energy Technologies and Renewables TERIN-ICER Tools and Services for Critical Infrastructures and Renewable Energy Communities, 40129 Bologna, Italy; paola.clerici@enea.it

1. Introduction

The emergence of the Smart City concept in Europe in the early 2010s emphasized the enhancement of livability and sustainability in urban environments through the integrated use of data and sensors as tools for designing comprehensive governance scenarios [1]. Data integration aimed not only to address urgent urban issues but also to integrate existing services or offer new ones to citizens within a human-centered paradigm. Rather than tackling challenges such as waste management, mobility, climate adaptation, and energy independently, there was a growing belief in the potential for significant economic and environmental benefits through a more integrated approach. The focus was on developing solutions capable of simultaneously addressing multiple challenges across different domains such as electricity, health, and security.

At the core of Smart City development was the establishment of common technical foundations and open standards aimed at promoting interoperability and portability across different systems [2]. Therefore, Smart Cities can be described as complex urban systems integrating various services and functions, a sort of system of systems, capable of providing access to services, applications, platforms, and infrastructures. Through leveraging digital solutions based on these principles, cities aimed to increase citizen engagement and promote innovative ecosystems, ultimately improving livability, sustainability, and lifestyles. Indeed, rather than exclusively addressing challenges such as sustainable waste management, mobility, water, buildings, heating, cooling, and energy systems separately, the Smart City concept emphasized the benefits derived from adopting a more integrated approach.

The term "smart" served as an umbrella term for innovative technologies that inherently incorporated a minimum level of artificial intelligence [3,4]. Key features of smart technologies included the ability to acquire information from the surrounding environment and respond accordingly. With the recent rapid evolution that artificial intelligence has undergone, the concept of the Smart City will find renewed vigor, especially in the context of defining scenarios, particularly in energy-related aspects.

The long-term goal of smart technology is to improve people's well-being, and one of the main innovations introduced by the Smart City in everyday living is the "smart home" [5–8], a specific solution aimed at improving livability, especially in terms of energy consumption. While smart home concepts assist end-users in understanding their energy consumption, Positive Energy Buildings (ZEBs), derived from Nearly Zero Energy Buildings (nZEBs), aim to reduce energy consumption through innovative building envelope solutions supported by smart sensors and also through contributing to energy production, to the extent of having a local energy production greater than the energy consumed by the building itself [9,10]. From this concept to the idea of expanding energy production and exchange between buildings, the concept of Positive Energy Districts (PEDs) emerged [11].

Therefore, Positive Energy Districts (PEDs) arise from the vision of the Smart City that promoted the integrated use of data, sensors, and systems, which now aim to improve citizens' livability through innovative services and shape those systems and infrastructures

Citation: Clerici Maestosi, P. Harmonizing Urban Innovation: Exploring the Nexus between Smart Cities and Positive Energy Districts. *Energies* **2024**, *17*, 3422. https://doi.org/10.3390/en17143422

Received: 12 April 2024
Accepted: 11 June 2024
Published: 11 July 2024

through which services are delivered due to artificial intelligence. Thus, Positive Energy Districts (PEDs) represent the visionary legacy of the Smart City. This high and futuristic ambition represents the natural evolution of the Smart City, whose legacy has been adopted and structured within the EU's SET Plan [12]. Positive Energy Districts are defined as districts with the goal of achieving net zero energy import and annual CO_2 emissions while aiming for a local surplus production of renewable energy, thus reshaping energy infrastructures and modulating flexibility. Therefore, PEDs expand the vision of the Smart City as an integration of systems by aiming to reach climate neutrality in urban areas while continuing to promote integration among buildings, users, and systems proposed by the Smart City; this is all while moving from the local level to regional and national scenarios where energy infrastructure systems, mobility, and ICT infrastructures collaborate. Energy systems within PEDs must refer to broader regional and national energy contexts to avoid limiting integration, expansion, and replication opportunities. The PED's approach requires the development of bidirectional energy networks capable of accommodating energy exchange with renewable energy sources, addressing issues of flexibility and grid stability.

As the EU commits to ambitious climate targets by 2030, attention on Positive Energy Buildings (PEBs) and Positive Energy Districts (PEDs) intensifies. While many building regulations are already in place, the emergence of PEDs poses new regulatory, organizational, and certification challenges. However, initiatives such as those of the Clean Energy Package together with the Energy Communities concept can contribute to the diffusion of the PED concept and its realization. Some cities participating in the Mission 100 Climate Neutral Cities are considering including PEDs in their City Climate Contracts, not only as active components of the energy system [13], but also as a broad objective capable of aggregating multilevel governance towards a common goal.

2. Exploring the Nexus between Smart Cities and Positive Energy Districts

Since Positive Energy Districts (PEDs) are considered to be the visionary legacy of the Smart City, what is the nexus between the two? And what are the discernible dimensions that characterize them?

The papers collected in this Special Issue each highlight a specific dimension. Before delving into the analysis of the papers, the discernible dimensions that highlight the connection between the two concepts are proposed below: framework conditions (I), prefiguration (II), emerging impacts (III), integration between technical and non-technical capabilities (IV), and key structural aspects (V).

Framework conditions (I) encompass a set of fundamental principles essential for the effective execution of both Smart Cities and Positive Energy Districts (PEDs). From a technical standpoint, the energy infrastructure underlying PEDs is characterized by a wide range of renewable energy sources, high energy efficiency, and a flexibility of the energy system. The balance to be found for the development of PEDs is more complex than that of Smart Cities because it extends beyond the local level to the regional level and, in the case of central government energy strategies, to the national level. Thus, it moves from the intrinsic capacity of local governance to delineate the development of a Smart City to the multilevel governance necessary for the development of PEDs.

Prefiguration (II) involves identifying essential preparatory measures to initiate the Smart City process, where a collaborative local governance model is imperative to begin the transformation procedure, connect ecosystem stakeholders, and align their interests and priorities. In the case of PEDs, essential preparatory measures become more complex as they transition from a local governance model to a multilevel governance model and aim to integrate and make energy infrastructures flexible. For such a challenging goal, a shared national, regional, and local energy strategy among stakeholders is required.

Emerging impacts (III) pertain to the direct/indirect repercussions associated with both Smart Cities and PEDs and reside in both the reduction in energy consumption, the implementation of energy efficiency, the decrease in dependence on fossil fuels, and the improvement of system flexibility. Since what changes between the Smart City and PEDs is the scale of the dimension, it follows that the incentives to mobilize the participation of stakeholders must differentiate according to the specific stakeholder system. However, a fundamental and strategic role is played, in the case of PEDs, by the introduction of regulatory and legislative provisions that are able to guide macro decisions.

The ability to integrate (IV) technical and non-technical capabilities is an important factor. Integrated planning serves as a mechanism for harmonizing efforts across governance layers and for realizing a unified urban vision, in the case of Smart Cities. Consequently, collaboration between local authority, external stakeholders and multilevel governance becomes critical for PEDs. Municipal administrations must embed PED projects across operational, tactical, and strategic tiers, supported with administrative initiatives such as the City Climate Contract adopted by some municipalities in Mission 100 Climate Neutral Cities. The evolution towards citizen energy communities elevates citizens from participants to stakeholders with vested ownership in the PED's energy landscape.

Key structural aspects (V) for the Smart City and PEDs necessitate an integrated approach encompassing technological, social, economic, financial, and regulatory dimensions to realize a sustainable urban energy transition effectively.

3. Published Papers Highlights

This editorial article summarizes the Special Issue of Energies titled "Smart Cities and Positive Energy Districts: Urban Perspectives in 2022–2023" which includes published papers [1–8] covering both the topics of Smart Cities and Positive Energy Districts (PEDs). The aim of this section is to connect with Section 2, "Exploring the Nexus between Smart Cities and Positive Energy Districts", to identify the connections among the papers that address topics related to the Smart City concept or the PED concept, highlighting commonalities.

The analysis on the following papers determines the topic addressed by each paper, which can be synthesized as follows:

Paper 1: "A Systematicity Review on Residential Electricity Load-Shifting at the Appliance Level". This paper delves into residential electricity load-shifting, a strategy for managing demand and optimizing grid efficiency during peak periods. It highlights the necessity of studying appliance-level load-shifting for accurate load-profile analysis, despite the limited literature. Current research predominantly employs load-shifting algorithms, yielding benefits like reduced costs and peak consumption. The paper's systematic review process and findings underscore the significance of appliance-level load-shifting for energy efficiency enhancement. This contribution aids decision-makers and policymakers by elucidating new dynamics in load-shifting, informing strategies for energy efficiency and demand-side management.

Paper 2: "Comparative Analysis of Renewable Energy Community Designs for District Heating Networks: Case Study of Corticella (Italy)". Ancona et al.'s study examines renewable energy community models in district heating networks, aligned with EU directives on energy transition. It assesses an Italian energy community's potential, showcasing benefits like increased self-sufficiency through internal energy sharing and heat pump integration. The research evaluates cost-effective investment options using incentive tariffs, demonstrating significant reductions in energy demand, emissions, and costs. The results show that integrating photovoltaics reduces primary energy demand by 11%, while the energy community setup lowers emissions by 12% without extra investment, compared to a reference case. This study informs strategies for enhancing energy-economic performance in district heating networks.

Paper 3: "Classifying Regional and Industrial Characteristics of GHG Emissions in South Korea". Kang et al.'s study addresses South Korea's goal of a 40% carbon emission reduction by 2030, complicated by its carbon-dependent manufacturing sector and diverse regional industries. Regional emission analysis is crucial due to varying mitigation capacities. Existing methodologies often overlook regional differences. The study proposes a quantitative approach using shift-share analysis and the Log Mean Divisia Index method to classify emissions. Shift-share analysis links industry and regional traits, while the Index method dissects economic and technological impacts. By combining these, the study offers four classifications to evaluate regional and industrial carbon neutrality potential, focusing on mining and manufacturing sectors in South Korea.

Paper 4: "From Buildings to Communities: Exploring the Role of Financial Schemes for Sustainable Plus Energy Neighborhoods". Kerstens et al.'s paper delves into financial schemes' role in fostering sustainable plus energy neighborhoods (SPENs), vital for carbon-neutral built environments. Examining Austria, The Netherlands, Norway, and Spain, the study analyzes how these schemes support SPEN development. Through mixed methods, including case studies and interviews, it uncovers barriers such as insufficient incentives for collective energy sharing and bias towards individuals with upfront investments, hindering broad accessibility. By identifying these limitations, the study underscores the necessity for policy adjustments and innovative financial mechanisms to facilitate SPEN implementation, contributing to global sustainable urban development efforts and aiding policymakers and stakeholders encountering similar challenges.

Paper 5: "An Indicator Framework for Evaluating Building Renovation Potential". Danielsen et al.'s paper discusses the impact of a new EU directive on energy renovation in Denmark and presents an indicator framework to assess renovation potential in a specific municipality. Four indicators—energy consumption, CO_2 emissions, heating costs, and current energy labels—were used for detached dwellings. Physical renovation potential was quantified based on these indicators, providing an average score for 10,228 dwellings; equal weighting was applied to all indicators. While the method is applicable beyond this study, it highlights the need for more detailed data to accurately determine renovation potential, suggesting that municipalities increase their data collection efforts for improved precision in analysis.

Paper 6: "Operational Insights and Future Potential of the Database for Positive Energy Districts". Civiero et al. introduce the Positive Energy District Database (PED DB), a collaborative web tool aligned with international initiatives like JPI Urban Europe and IEA EBC Annex 83. The PED DB facilitates knowledge sharing, collaboration, and decision-making for Positive Energy Districts (PEDs), crucial for sustainable urban development in line with the EU's climate-neutral goals by 2050. It maps and disseminates information on PEDs across Europe, detailing collaborative implementation processes, current functionalities, and future developments. The interactive platform offers customizable visualizations, filters, and detailed case study information, enhancing the understanding and comparison of PED projects, and consequently advancing sustainable urban development efforts.

Paper 7: "Improving the Energy Performance of Public Buildings in the Mediterranean Climate via a Decision Support Tool". Gouveia presents the application of the PrioritEE Decision Support Tool in Portuguese public buildings to improve energy efficiency, cut carbon emissions, and save costs. Analyzing energy performance certificate data from 22 public buildings across three regions, the tool's adaptability allows thorough assessments and customized energy solutions. The study emphasizes the significance of user-friendly tools in aiding policymakers and local technicians to achieve national renovation goals and advance broader energy transition objectives in Europe.

Paper 8: "Implementation of Positive Energy Districts in Euro-pean Cities: A Systematic Literature Review to Identify the Effective Integration of the Concept into the Existing Energy Systems". Clerici Maestosi et al.'s review scrutinizes the integration of Positive Energy Districts' (PEDs) into European cities' energy systems via a systematic literature review. Employing open access bibliometric software and content analysis, it assesses research and innovation program support for PEDs and their actual implementation. While PEDs attract scientific attention and research funding, their implementation remains limited, with less than half of analyzed documents featuring case studies; moreover, there is an uneven adoption among countries. To overcome barriers, the study recommends increased ad hoc funding and improved accessibility, especially for municipalities less engaged in European projects and networks, aiming to foster PED diffusion and implementation.

The topic addressed in each paper, in accordance with the factors outlined in Section 2, are seen in Table 1.

Table 1. Topic addressed by each paper, as outlined in Section 2.

No	Reference	Topic Addressed in the Paper Related to Smart Cities Concept	Topic Addressed in the Paper Related to Positive Energy Districts
1	Manembu, P.D.K.; Kewo, A.; Bramstoft, R.; Nielsen, P.S. A Systematicity Review on Residential Electricity Load-Shifting at the Appliance Level. Energies 2023, 16, 7828. https://doi.org/10.3390/en16237828	energy efficiency smart cities (*IV technical capabilities*)	energy efficiency (*IV technical capabilities*)
2	Ancona, M.A.; Baldi, F.; Branchini, L.; De Pascale, A.; Gianaroli, F.; Melino, F.; Ricci, M. Comparative Analysis of Renewable Energy Community Designs for District Heating Networks: Case Study of Corticella (Italy). Energies 2022, 15, 5248. https://doi.org/10.3390/en15145248		energy production (*IV technical capabilities*) energy communities (*III emerging impacts*)
3	Kang, H.; Zoh, H.D. Classifying Regional and Industrial Characteristics of GHG Emissions in South Korea. Energies 2022, 15, 7777. https://doi.org/10.3390/en15207777	smart urban management (*II prefiguration*) energy consumption, energy mixture (*IV technical capabilities*)	
4	Kerstens, A.; Greco, A. From Buildings to Communities: Exploring the Role of Financial Schemes for Sustainable Plus Energy Neighborhoods. Energies 2023, 16, 5453. https://doi.org/10.3390/en16145453		SPENs (*IV technical capabilities*)
5	Danielsen, B.E.; Baxter, M.N.; Nielsen, P.S. An Indicator Framework for Evaluating Building Renovation Potential. Energies 2024, 17, 846. https://doi.org/10.3390/en17040846		European Union directive on energy renovation in Denmark, energy consumption, CO_2 emissions, heating costs, and current energy labels (*II prefiguration*) (*III emerging impacts*) (*V key structural aspects*)
6	Civiero, P.; Turci, G.; Alpagut, B.; Kuzmic, M.; Soutullo, S.; Sánchez, M.N.; Seco, O.; Bossi, S.; Haase, M.; Massa, G.; et al. Operational Insights and Future Potential of the Database for Positive Energy Districts. Energies 2024, 17, 899. https://doi.org/10.3390/en17040899		PED database (*II prefiguration*)

Table 1. *Cont.*

No	Reference	Topic Addressed in the Paper Related to Smart Cities Concept	Topic Addressed in the Paper Related to Positive Energy Districts
7	Gouveia, J.P.; Aelenei, L.; Aelenei, D.; Ourives, R.; Bessa, S. Improving the Energy Performance of Public Buildings in the Mediterranean Climate via a Decision Support Tool. Energies 2024, 17, 1105. https://doi.org/10.3390/en17051105	ProritEE Decision Support Tool Portuguese public buildings to enhance energy efficiency, reduce carbon emissions, and achieve financial savings (*II prefiguration*)	
8	Clerici Maestosi, P.; Salvia, M.; Pietrapertosa, F.; Romagnoli, F.; Pirro, M. Implementation of Positive Energy Districts in European Cities: A Systematic Literature Review to Identify the Effective Integration of the Concept into the Existing Energy Systems. Energies 2024, 17, 707. https://doi.org/10.3390/en17030707		critically examines the development and implementation of Positive Energy Districts (PEDs) within the context of the Energy Union strategy through a systematic literature review (*V key structural aspects*)

4. Discussion

From analyzing the papers in the Special Issue "Smart Cities and Positive Energy Districts: Urban Perspectives in 2022–2023", it is evident that some articles focus on Positive Energy Districts (PEDs) or related topics like energy communities, while others concentrate on Smart Cities. Only one article integrates both categories, analyzing aspects present in both approaches. For instance, Paper 1, titled "A Systematic Review on Residential Electricity Load-Shifting at the Appliance Level" by Manembu, P.D.K. et al., conducts a structured literature review emphasizing systematicity and transparency. The findings indicate efficiency gains in installed capacity, cost reduction (including emissions), and peak consumption reduction. Load-shifting algorithms, particularly for multi-appliance scenarios, are commonly used, with Air Conditioners (AC) and Electric Water Heaters (EWH) being frequently discussed shiftable loads. Most studies provide high-resolution simulation data, crucial for near-real-time load-shifting. A basic data-quality score is created, with ten attributes, recommending ten articles for priority review. Identified limitations include rigid assumptions, limited sample sizes, and less flexible algorithms. Future directions involve analyzing the role of distributed renewable systems and the application of multi-scale controls, with a focus on improving thermodynamic precision and comfort factors.

When considering the focus on PED and the related topic of energy communities, the main findings discuss the following:

- Paper 2 delves into utilizing surplus solar energy for district heating networks (DHNs) in Corticella, Italy. It compares scenarios including absorption chillers and simple PV panel installations; the results show that rooftop PV panels offer the highest economic and environmental benefits, with a EUR 273,000 net present value (NPV) over 20 years and an 11% emissions reduction. Incorporating heat pumps boosts NPV to EUR 398,000–521,000, driven by improved efficiency and community incentives. The study underscores heat pumps' cost-effectiveness in decarbonizing DHNs and leveraging shared energy incentives. Future work will optimize system design and integrate storage to enhance energy community applications in DHNs.
- Paper 4 emphasizes that existing financial schemes in Europe and at federal levels primarily focus on individual buildings rather than neighborhood-wide solutions. This approach hinders collaborative investments for comprehensive sustainable plus energy neighborhoods (SPENs). In the studied countries, a lack of coordination

between stakeholders was found to pose a significant barrier, leading to bureaucratic challenges. Fragmented knowledge and a limited utilization of financial schemes, along with the absence of viable business models for SPEN innovations, further impede progress. Overcoming these barriers requires a shift towards collective approaches and addressing challenges within the current financial landscape and market conditions to advance SPEN development.

- Paper 5 introduces an indicator framework for assessing energy-efficient renovation potential in Rudersdal municipality, Denmark. Four indicators—energy consumption, CO_2 emissions, heating costs, and energy labels—were analyzed across three scenarios. The results show that the most effective method involves improving the building's envelope and switching heating suppliers, particularly in regard to district heating or a heat pump. This approach significantly reduces CO_2 emissions and heating costs. Many buildings lack valid energy labels, indicating a high potential for renovation; most would receive a grade of five, emphasizing the urgent need for energy-efficient renovations in the municipality.
- Paper 6 discusses the Positive Energy District Database (PED DB), a collaborative web tool advancing sustainable urban environments through promoting knowledge sharing and collaboration. It aims to map and disseminate information on Positive Energy Districts (PEDs) across Europe, supporting the EU's climate-neutral objectives by 2050. With a focus on interconnected buildings and energy communities, PEDs achieve net zero greenhouse gas emissions. The PED DB enables data visualization and analysis, offering insights into PED case studies and projects. Future developments include automating dashboard population and enhancing stakeholder engagement through a Decision Support System (DSS). The PED DB empowers stakeholders to replicate successful strategies and drive progress towards sustainable urban development.
- Paper 8 reviews the implementation of Positive Energy Districts (PEDs) in European cities, aiming to identify effective integration into existing energy systems. To overcome barriers, the study recommends increased ad hoc funding and enhanced accessibility, especially for municipalities less engaged in European projects and networks.

When considering the focus on the Smart Cities approach, the main findings relate to the following:

- Paper 3 delves into smart urban management and the interplay between urban economic structure and greenhouse gas (GHG) emissions in South Korea. It examines how diverse industrial structures in regions affect local carbon emissions, aiming to provide a comprehensive understanding of GHG emission patterns at the regional and industrial levels.
- Paper 7 underscores the importance of energy renovation for public buildings in the Mediterranean climate to achieve energy savings and decarbonization goals, aligning with European legislation like Sustainable Energy and Climate Plans (SEAP/SECAP). It introduces the PrioritEE Decision Support Tool (DSTool), an interactive online calculator designed to assist local authorities in prioritizing energy efficiency measures based on potential savings, costs, and return on investment. The study applies the DSTool to 22 buildings across three Portuguese locations, demonstrating the significant potential for energy and financial savings and CO_2 emission reductions. Further research should focus on building-level renovation solutions to align with deep energy renovation plans and city-level strategies.

The main results/findings and future research activities highlighted by the papers can be synthesized as follows (Table 2).

Table 2. Main results/findings and future research activities highlighted by papers.

No	Reference	Results/Findings	Future Research Activities
1	Manembu, P.D.K.; Kewo, A.; Bramstoft, R.; Nielsen, P.S. A Systematicity Review on Residential Electricity Load-Shifting at the Appliance Level. Energies 2023, 16, 7828. https://doi.org/10.3390/en16237828	Structured literature review emphasizing systematicity and transparency. The findings indicate efficiency gains in installed capacity, cost reduction (including emissions), and peak consumption reduction.	Future directions involve analyzing the role of distributed renewable systems and the application of multi-scale controls, with a focus on improving thermodynamic precision and comfort factors.
2	Ancona, M.A.; Baldi, F.; Branchini, L.; De Pascale, A.; Gianaroli, F.; Melino, F.; Ricci, M. Comparative Analysis of Renewable Energy Community Designs for District Heating Networks: Case Study of Corticella (Italy). Energies 2022, 15, 5248. https://doi.org/10.3390/en15145248	The study underscores heat pumps' cost-effectiveness in decarbonizing DHNs and leveraging shared energy incentives.	Future work will optimize system design and integrate storage to enhance energy community applications in DHNs.
3	Kang, H.; Zoh, H.D. Classifying Regional and Industrial Characteristics of GHG Emissions in South Korea. Energies 2022, 15, 7777. https://doi.org/10.3390/en15207777	Smart urban management and the interplay between urban economic structure and greenhouse gas (GHG) emissions in South Korea. Diverse industrial structures in regions affect local carbon emissions	
4	Kerstens, A.; Greco, A. From Buildings to Communities: Exploring the Role of Financial Schemes for Sustainable Plus Energy Neighborhoods. Energies 2023, 16, 5453. https://doi.org/10.3390/en16145453	Lack of coordination among stakeholders, collaborative investments, fragmented knowledge and limited utilization of financial schemes, along with the absence of viable business models. Overcoming these barriers requires a shift towards collective approaches and addressing challenges within the current financial landscape and market conditions.	
5	Danielsen, B.E.; Baxter, M.N.; Nielsen, P.S. An Indicator Framework for Evaluating Building Renovation Potential. Energies 2024, 17, 846. https://doi.org/10.3390/en17040846	Indicator framework for assessing energy-efficient renovation potential in Rudersdal municipality, Denmark. (energy consumption, CO_2 emissions, heating costs, and energy labels). Most effective method involves improving the building's envelope and switching heating suppliers, particularly to district heating or a heat pump. This approach significantly reduces CO_2 emissions and heating costs.	
6	Civiero, P.; Turci, G.; Alpagut, B.; Kuzmic, M.; Soutullo, S.; Sánchez, M.N.; Seco, O.; Bossi, S.; Haase, M.; Massa, G.; et al. Operational Insights and Future Potential of the Database for Positive Energy Districts. Energies 2024, 17, 899. https://doi.org/10.3390/en17040899	Collaborative web tool.	Knowledge sharing and collaboration.

Table 2. *Cont.*

No	Reference	Results/Findings	Future Research Activities
7	Gouveia, J.P.; Aelenei, L.; Aelenei, D.; Ourives, R.; Bessa, S. Improving the Energy Performance of Public Buildings in the Mediterranean Climate via a Decision Support Tool. Energies 2024, 17, 1105. https://doi.org/10.3390/en17051105	PrioritEE Decision Support Tool (DSTool) Focus on building-level renovation solutions to align with deep energy renovation plans and city-level strategies.	Further research should focus on building-level renovation solutions to align with deep energy renovation plans and city-level strategies.
8	Clerici Maestosi, P.; Salvia, M.; Pietrapertosa, F.; Romagnoli, F.; Pirro, M. Implementation of Positive Energy Districts in European Cities: A Systematic Literature Review to Identify the Effective Integration of the Concept into the Existing Energy Systems. Energies 2024, 17, 707. https://doi.org/10.3390/en17030707	Cognitive framework on implementation of Positive Energy Districts (PEDs) review. To overcome barriers, the study recommends increased ad hoc funding and enhanced accessibility, especially for municipalities less engaged in European projects and networks through a systematic literature review.	Further research will adopt more formal methodologies to analyze the effective consistency of 76 case studies aspiring to become PEDs. Further results on funding sources, the distribution of case studies, the types of funding and stakeholders involved, and the characterization of PEDs will be presented in a follow-up article matching the PED concept with "long-term climate goals towards climate neutrality".

5. Conclusions

The realization of a Smart City or Positive Energy District (PED) vision in the urban landscape embodies the next step of urban governance. It signifies the culmination of various strategies and actions, culminating in the transition of the existing built environment into a carbon-neutral ecosystem. These endeavors demand innovative solutions to streamline authorization processes, develop sustainable business models, and forge robust collaborative agreements among stakeholders. Such transitions demand concerted efforts from diverse urban communities, bolstered by institutional backing and regulatory stability, ensuring clear policy direction as they aim for their objectives. Ultimately, the evolution of PEDs parallels that of Smart Cities, necessitating a blend of technological ingenuity and non-technological innovations tailored to each unique urban context. Contextual understanding illuminates feasible strategies, sustainable economic frameworks, and co-operative agreements to surmount decision-making hurdles, providing a roadmap for urban sustainability. These pillars pave the path towards the realization of carbon-neutral, comprehensively sustainable cities for a promising future of urban living.

Funding: This research received no external funding.

Conflicts of Interest: The author declares no conflicts of interest.

References

1. De Guimarães, J.C.F.; Severo, E.A.; Júnior, L.A.F.; Da Costa, W.P.L.B.; Salmoria, F.T. Governance and quality of life in smart cities: Towards sustainable development goals. *J. Clean. Prod.* **2020**, *253*, 119926. [CrossRef]
2. Tsampoulatidis, I.; Komninos, N.; Syrmos, E.; Bechtsis, D. *Universality and Interoperability Across Smart City Ecosystems*; Springer: Cham, Switzerland, 2022. [CrossRef]
3. Chan, M.; Estève, D.; Escriba, C.; Campo, E. A review of smart homes—Present state and future challenges. *Comput. Methods Programs Biomed.* **2008**, *91*, 55–81. [CrossRef] [PubMed]
4. Balta-Ozkan, N.; Amerighi, O.; Boteler, B. A comparison of consumer perceptions towards smart homes in the UK, Germany and Italy: Reflections for policy and future research. *Technol. Anal. Strateg. Manag.* **2014**, *26*, 1176–1195. [CrossRef]
5. Alam, M.; Reaz, M.; Ali, M. Statistical Modeling of the Resident's Activity Interval in Smart Homes. *J. Appl. Sci.* **2011**, *11*, 3058–3061. [CrossRef]
6. Arunvivek, J.; Srinath, S.; Balamurugan, M.S. Framework development in home automation to provide control and security for home automated devices. *Indian J. Sci. Technol.* **2015**, *8*, 1–10. [CrossRef]
7. Dawid, H.; Decker, R.; Hermann, T.; Jahnke, H.; Klat, W.; König, R.; Stummer, C. Management science in the era of smart consumer products: Challenges and research perspectives. *Cent. Eur. J. Oper. Res.* **2017**, *25*, 203–230. [CrossRef]

8. Hong, J.; Shin, J.; Lee, D. Strategic management of next-generation connected life: Focusing on smart key and car–home connectivity. *Technol. Forecast. Soc. Change* **2016**, *103*, 11–20. [CrossRef]
9. Marszal, A.J.; Heiselberg, P.; Bourrelle, J.S.; Musall, E.; Voss, K.; Sartori, I.; Napolitano, A. Zero Energy Building—A review of definitions and calculation methodologies. *Energy Build.* **2011**, *43*, 971–979. [CrossRef]
10. Monti, A.; Pesch, D.; Ellis, K.A.; Mancarella, P. *Energy Positive Neighborhoods and Smart Energy Districts: Methods, Tools, and Experiences from the Field*; Elsevier: Amsterdam, The Netherlands, 2016.
11. Marique, A.-F.; Reiter, S. A simplified framework to assess the feasibility of zero-energy at the neighbourhood/community scale. *Energy Build.* **2014**, *82*, 114–122. [CrossRef]
12. European Union. SET-Plan Working Group, SET-Plan Action No 3.2 Implementation Plan-Europe to Become a Global Role Model in Integrated, Innovative Solutions for the Planning, Deployment, and Replication of Positive Energy Districts. 2018. Available online: https://jpi-urbaneurope.eu/wp-content/uploads/2021/10/setplan_smartcities_implementationplan-2.pdf (accessed on 27 March 2023).
13. Tuerk, A.; Frieden, D.; Neumann, C.; Latanis, K.; Tsitsanis, A.; Kousouris, S.; Llorente, J.; Heimonen, I.; Reda, F.; Ala-Juusela, M.; et al. Integrating Plus Energy Buildings and Districts with the EU Energy Community Framework: Regulatory Opportunities, Barriers and Technological Solutions. *Buildings* **2021**, *11*, 468. [CrossRef]