# DIGITAL POSITIVE ENERGY DISTRICTS: A SCALABLE STRATEGY FOR URBAN HEAT AND POWER TRANSITION?

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## Abstract

The DigiPeQ project (FFG No. 880562) explored the requirements and potentials of digital positive energy districts (PEDs) in contributing to national energy and climate goals.

## Objectives and Methodological Approach

Positive energy districts (PEDs) are neighborhoods or several connected buildings, often with diverse space uses, meeting the highest standards of energy efficiency. They cover their entire energy needs locally from renewable sources, enable flexible operation, and create the highest possible comfort and quality of life on-site through the involvement and participation of users [1], [2]. These districts provide high-quality usable spaces, promote the formation of energy communities, and play a crucial role in local and regional energy supply [3], [4], [5]. In this context, the challenges and opportunities offered by PEDs, including energy flexibility, load shifting, grid services, and sector coupling, as well as aspects of user integration and their requirements for livable districts, were examined, and innovative cooperation and business models were explored.

## Results and Insights

The project demonstrates that PEDs, especially newly built have significant potential due to mixed-use and property-wide consideration of supply and demand curves. The vision of a connected energy system through infrastructural linking (heating/cooling/electricity network) and the establishment of organizational frameworks, such as local energy communities, offers a scalable, efficient way to achieve the energy and climate goals of 100% renewable electricity supply by 2030 and 100% total energy consumption by 2040 in an urban context. However, these challenges are more complex in retrofitting existing buildings.

Special about the project was its execution as an "Innovation Course", developed and conducted for and with all relevant stakeholders of an innovative and integrative planning process, i.e. developers, building and utility operators, architects, participation and communication specialists, building, mobility and energy engineers. This approach enabled the integration of practical insights with current scientific findings, discussing and combining them: Particularly, legal, and administrative conditions and barriers in implementation were successfully identified, and concrete proposals for their elimination were jointly formulated.

### *Energy and Environmental Technical Consideration*

The project investigated how districts' energy and emission flows can be modeled and simulated to make dynamic assessments about the interplay of local renewable energy production and flexible district operation. Furthermore, an energy and emission balance model was examined as a quantitative evaluation system for positive energy districts and applied considering energy services for operation, everyday mobility, construction, and maintenance, and also the urban context [6].

### *Energy Economic, Legal, and Technical Environment*

From an energy economic perspective, the contributions of Positive Energy Districts to balancing load and consumption imbalances in general and to grid services in particular were primarily examined. One

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objective was to actively motivate users to grid-friendly operating modes, thereby providing energy flexibility resources.

***Information Management and Use of Participative Design Approaches***

Another objective of the contributions was to enable users to develop sustainable awareness through gamification approaches and attractive information provision, aiming to promote community-friendly climate behavior at the district level.

***Consideration and Application Possibilities of New Digital Technologies***

Especially considering the increasing popularity of last decade's technologies (Web3 technologies like Blockchain, Machine Learning for data processing, AI-based generators for image or text), the challenges, prerequisites, and rationale of deploying various technologies in the context of PEDs were elaborated. Novel approaches to improve service to users in terms of involvement and information exchange, or transparent billing mechanisms in PEDs were welcomed.

***Final Considerations and Outlook***

In a "PEQathon" format, the complex topic was finally successfully tested in an interdisciplinary planning workshop using concrete urban development areas in Vienna as examples. The results were adopted by the City of Vienna: The PED consideration and the resulting balance goals for energy supply and emissions in operation, mobility, and the establishment of a climate-neutral district are now incorporated into the development and implementation plan of the "WieNeu+" and "RausAusGas" district “Am Tabor”.

The added value of the PED consideration lies in the context-specific, but holistic assessment of building operation, everyday mobility, and embodied energy at the district level, thus bridging the gap between individual building code and assessments to overarching climate and energy goals of municipalities and cities. This also includes important questions of "Effort Sharing" and how the burdens and responsibilities of the transition can be distributed.

In conclusion, DigiPeQ demonstrates that the development of PEDs is a promising strategy for urban energy and heat transition. The results provide important insights into the design of future districts and the role of digital technologies in this process.

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