Citizens4PED: D3.2 Report on the multidisciplinary inputs considered in the model

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1 Abstract

This deliverable presents a comprehensive analysis of multidisciplinary inputs integrated into the modeling of Positive Energy Districts (PEDs). Leveraging four distinct living labs models (Kahlenbergdorf, La Roue, Usquare and Bari), the study aims to optimize district heating networks and accurately calculate buildings power demand through Arteria Platform. Key inputs include environmental data, power and energy consumption patterns, socioeconomic factors, and technological advancements. By synthesizing these inputs, the project enhances the precision of energy distribution and promotes sustainability in urban districts, contributing to the broader goal of creating PED communities.

2 Introduction

Positive Energy Districts (PEDs) are at the vanguard of the sustainable urban transition, aiming to produce more energy than they consume. To optimize energy management and infrastructure planning within these districts, the Arteria techno-economic model has been crucial. This deliverable focuses on the development and validation of such models through the use of four living lab models (Kahlenbergdorf, La Roue, Usquare and Bari). These labs serve as experimental urban spaces where innovative solutions for district heating and electricity demand can be tested in real-world conditions.

The multidisciplinary inputs considered in the model range from environmental conditions, such as temperature, to human factors like energy consumption behaviors and economic variables. Technological inputs, including advancements in renewable energy sources, are also integral to the model. By combining these varied inputs, the project aims to refine energy management strategies, ensuring efficient energy use and contributing to the sustainability goal of PEDs.

3 Methodology

In collaboration with our partners, we have evaluated the current model's capabilities and the prerequisites of all living labs and decided on the multidisciplinary inputs that should be gathered from each living lab. Arteria Model for buildings is visualized in the figure below:

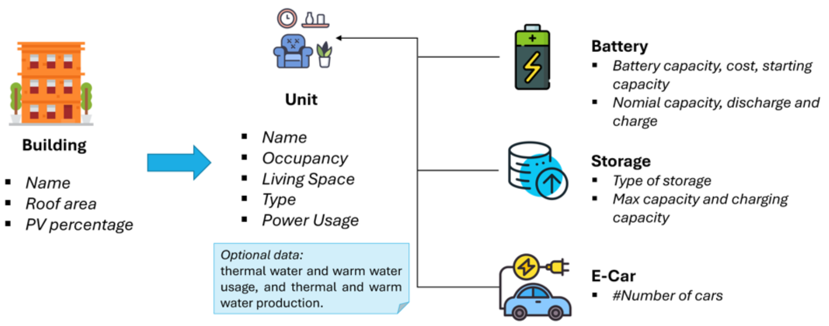

Figure 1: Model setup

Multidisciplinary inputs have considered the technical specifications of Arteria Model as well as the broader objectives of PEDs. The decision is made at meetings with all the project members. Each living lab collects specific data pertinent to its unique environment, ensuring that the model is adaptable and robust across various scenarios.

4 Living Lab: Kahlenbergdorf

Figure 2: Kahlenbergdorf modelled in Arteria Platform

4.1 Inputs description

The input data for the Kahlenbergdorf living lab comprises detailed information essential for district heating and electricity planning. It includes the topology of the district heating networks, specifying the layout of pipes, junctions, and heat exchangers, along with the strategic placement of the heating plant to efficiently serve the heating needs of the buildings. Building locations within the living lab area are also provided, delineating where heat demand originates and aiding in understanding spatial distribution. Additionally, peak power data (kW) for each building offers insights into maximum power demand, facilitating sizing of equipment and infrastructure design for reliable heat supply during peak periods. Electricity demand data (MWp) is available for select buildings. Power demand at the building level for each timestamp is generated by Arteria tool using yearly standard profiles which are integrated given the peak demand and ambient temperature. Collaborative efforts may be necessary to collect and integrate this power demand data for the buildings over yearly timestamps, ensuring the effectiveness of district heating planning within the living lab. Supplementing the provided data with power demand information for all buildings will enhance the accuracy of modeling and optimization efforts, contributing to the success of the living lab project in promoting sustainable energy practices.

5 Living Lab: Usquare (Anderlecht)

Figure 3: Usquare (Anderlecht) modelled in Arteria Platform

5.1 Inputs description

In this living lab scenario, the predominant feature is the presence of retrofitted buildings, indicating a proactive approach to energy efficiency and sustainability. Previously, the buildings relied on gas boilers for heating, and currently, there are no photovoltaic systems installed. To assess energy demand and potential future scenarios, a consulting company is tasked with modeling the energy demand data, offering insights into consumption patterns and optimization opportunities. Regarding future heat supply, a combination of deep geothermal energy, combined heat and power (CHP) systems, and gas boilers is being considered, highlighting a diversified approach to energy sourcing. Additionally, there is a strategic focus on expanding the heat network, with ongoing construction efforts aimed at connecting neighboring buildings. This expansion aims to enhance energy efficiency and foster collaboration among residents. Another option under consideration is to integrate the heat network with wastewater heat recovery systems, further optimizing energy utilization and minimizing waste. As the living lab progresses, leveraging retrofitted buildings and exploring innovative energy solutions will be crucial for achieving sustainability goals and promoting resilience within the community. Peak power demand data is provided for every building and based on that standard profiles over yearly timestamps have been generated. Project partners from this living lab also provided an analysis on one of the scenarios defined for the project, as an input for Arteria to evaluate the model against these results. In the figure below are shown the demand load curves based on lower comfort temperature levels. The blue curve is the standard load curve for heating at XX degrees, the red curve is the load curve for heating at 18 degrees and the green curve is the load curve for heating at 15 degrees.

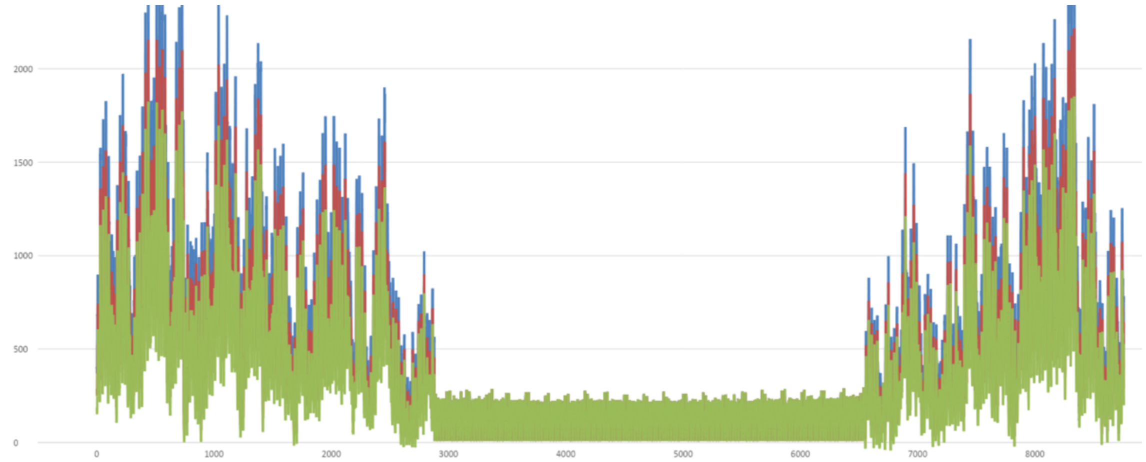

Figure 4: Load curves at lowering comfort temperature in Usquare

6 Living Lab: La Roue

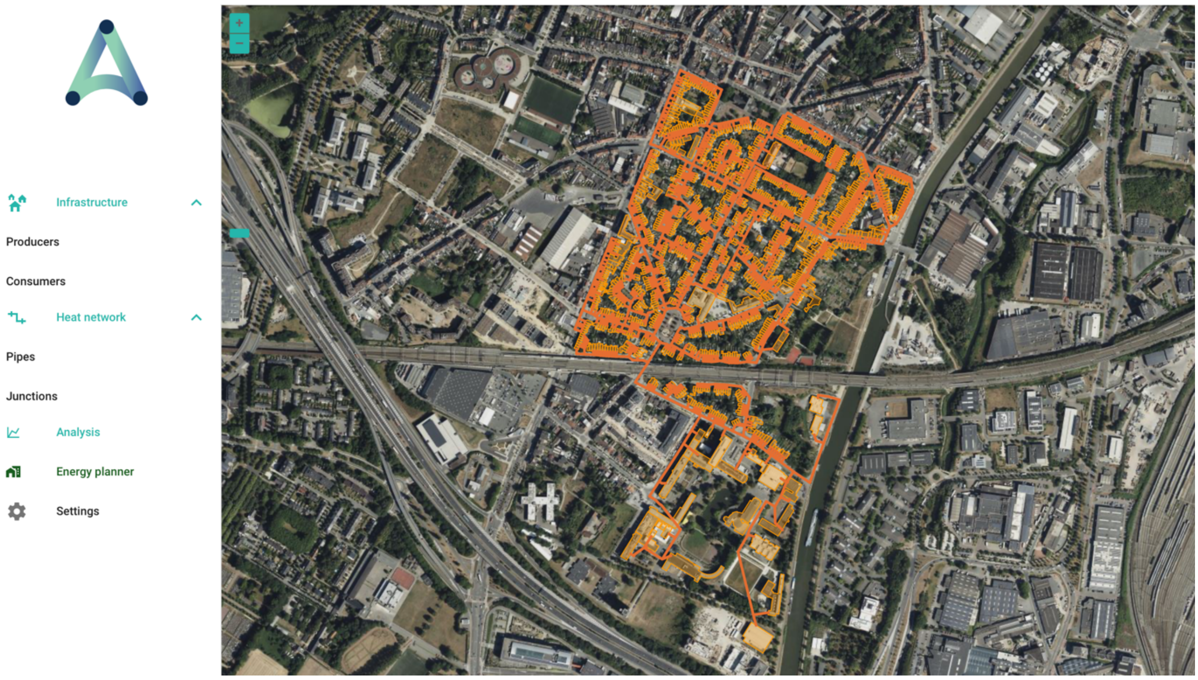

Figure 5: La Roue modelled in Arteria Platform

6.1 Inputs description

The input data for this living lab encompasses several key components crucial for district heating planning and renovation considerations. Firstly, the topology of buildings provides insights into the spatial arrangement and distribution of heat demand within the area. Additionally, the pipe connections of buildings to the main distribution of the district heating network offer essential information for optimizing heat distribution and infrastructure design. Peak power demand data for each building aids in determining capacity requirements and sizing equipment to meet heating demands efficiently. However, there are uncertainties regarding the installation of photovoltaic (PV) systems. While it is unclear if and how much PV will be installed, it is noted that 5-10% of rooftop area would be feasible for PV installation, indicating the potential for renewable energy integration. Renovation considerations pose additional complexities, with only 10% of buildings expressing interest in renovation despite 90% of the cost being funded. This highlights the need for targeted strategies to incentivize participation in renovation efforts. Furthermore, the demographic composition of the area, with one-third of the houses being social housing, underscores the importance of equitable and inclusive planning approaches. The district heating development will initially focus on the first big consumers in the area, prioritizing efficient energy distribution and addressing immediate heating needs. Although individual data was requested through a questionnaire, only 20 buildings responded, indicating potential challenges in gathering comprehensive data for planning purposes. Despite these uncertainties, the available input data provides a foundation for developing strategies to optimize district heating systems and integrate renewable energy sources, fostering sustainable and resilient environments.

7 Living Lab: Bari

Figure 6: Bari modelled in Arteria Platform

7.1 Inputs description

For this living lab focused on energy planning, several key inputs provide insights into the current state and potential alternatives for energy supply and demand within the target area. Firstly, the target area encompasses various buildings, including public amenities such as a park and a church, along with 27 residential buildings, housing approximately 2000 inhabitants. Despite initial plans for renovation, the process has stalled, leaving the current energy supply reliant on gas boilers for heating and hot water in apartments. However, alternatives such as heat pumps are being considered, suggesting a potential shift towards more sustainable heating solutions. Additionally, the presence of air conditioning (AC) cooling devices in older apartments necessitates modeling of electricity demand for cooling, with the possibility of using AC units for heating as well. Despite the lack of a clear renovation plan at the moment, data is available on a household level, providing opportunities for targeted interventions and energy management strategies. Notably, solar photovoltaic (PV) emerges as the primary source of local renewable energy, highlighting its potential for integration into the energy supply mix. As the living lab navigates the complexities of energy planning and renovation, leveraging available data and exploring alternative energy sources such as solar PV will be essential for promoting sustainability and resilience within the target area.

8 Collaboration

Collaboration has been a cornerstone of the project, leveraging the expertise and resources of project partners to enhance the development and implementation of the Arteria models for Positive Energy Districts (PEDs).

9 Conclusions

The integration of multidisciplinary inputs from all four living labs has been pivotal in achieving the aims of this project, which focuses on optimizing district heating networks and calculation electricity demand for Positive Energy Districts (PEDs).

Environmental data, socioeconomic factors, technological advancements, and energy consumption patterns have collectively provided a comprehensive understanding of energy dynamics within these districts. This holistic approach has significantly enhanced the precision of the models, making them more reflective of real-world energy systems. Validation and calibration through living labs have ensured the models' accuracy and reliability. Continuous feedback from these labs has facilitated ongoing refinement, addressed discrepancies, and improved predictive capabilities. Cross-disciplinary collaboration has enriched the models, bringing together expertise from various fields to address diverse factors influencing energy demand and supply.