D3.3 Description of the studied scenarios for each case

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Acronyms table

Acronym	Definition
xxxx	

Executive summary

- → ……
- → ….
- → ….

Introduction

This research aims to enhance the techno-economic model of Arteria by integrating studied scenarios that align with the objectives of Positive Energy Districts. Through an integrated collaborative effort, selected scenarios have been incorporated into the four living labs: Kahlenbergdorf, Usquare, La Rue and Bari.

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 technoeconomic model has been crucial. The current project aims to expand and refine this model by integrating efficiency and sufficiency scenarios for the district heating network and/or energy planning on the living labs.

Living Labs

Kahlenbergdorf

Scenario 1: Heat supply via district heating network

Figure 1: Scenario 1 of Kahlenbergdorf modelled in Arteria

In this scenario, a centralized heating plant efficiently generates thermal energy, which is then distributed to various buildings throughout the district via an insulated pipe network. The heating network serves residential buildings and commercial spaces ensuring optimal temperature control and energy efficiency. The energy planner utilizes advanced software tools to monitor energy consumption and adjust production levels based on real-time demand and weather forecasts. In this scenario buildings have no PV, but they get it from a neighbor PV installation. This integrated approach minimizes energy wastage and reduces operational costs, while promoting sustainable energy use within the community. Additionally, the system's design allows for future scalability, accommodating new buildings and potential expansions of the district heating network.

Simulation results of Scenario 1

In figure 2 are visualized power simulation results of district heating network at producer, for a yearly simulation.

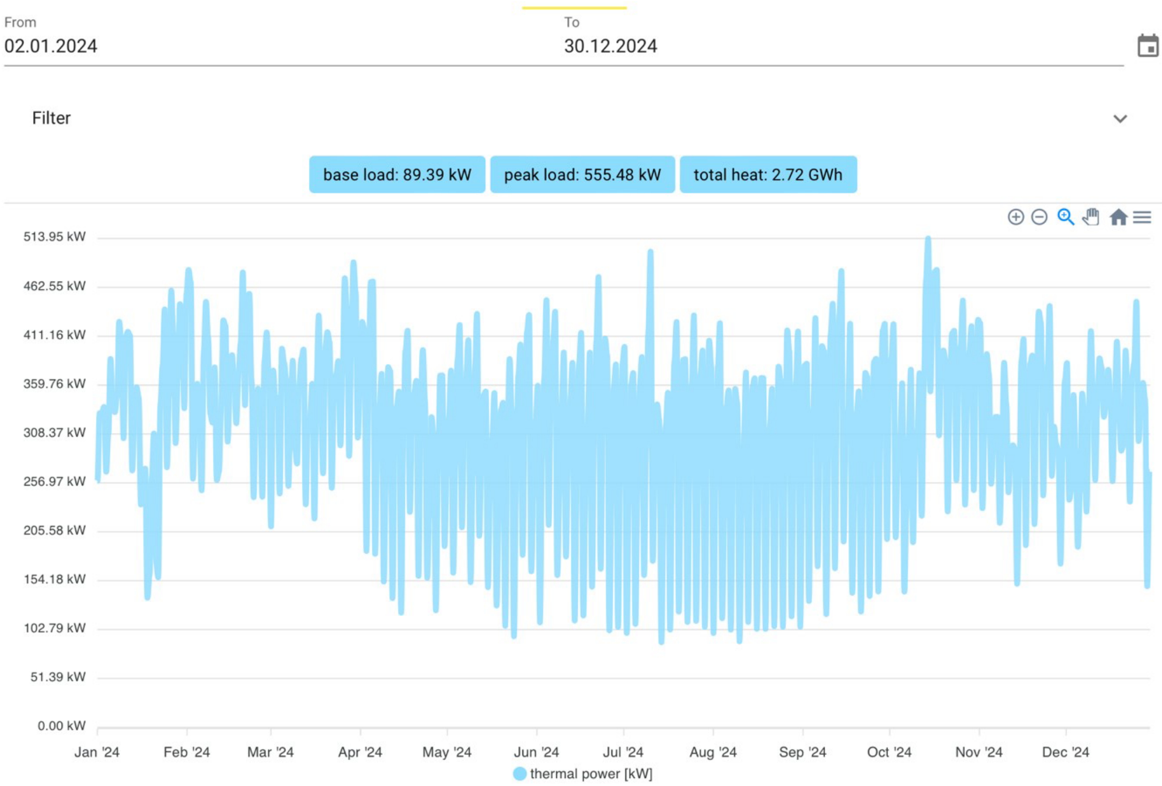

Figure 2: Simulation results at the producer of Kahlenbergdorf DH

In the figure 3 are shown the total power consumption, total production consumption, grid withdrawal, grid feed-in and the electricity consumption which is mostly provided by the neighboring PV due to the fact that in this scenario the buildings have no PV installed.

Figure 3: Building power calculations of Kahlenbergdorf DH

Scenario 2: Heat supply via individual heat pumps inclusive PV

Figure 4: Second scenario of Kahlenbergdorf modelled in Arteria

In this scenario, each building in the district is equipped with an individual heat pump system, complemented by photovoltaic (PV) panels installed on rooftops to harness solar energy. The energy planner incorporates smart algorithms to optimize the balance between the electricity generated by the PV panels and the energy demands of the heat pumps. Real-time data from the PV installations allows for precise adjustments in heat pump operation, maximizing the use of solar power and significantly reducing reliance on external energy sources. This decentralized approach not only improves energy autonomy for each building but also encourages broader participation in renewable energy utilization.

Usquare (Anderlecht)

Scenario 1: Lowering comfort temperature of individual apartments by a certain degree

Figure 5: First scenario of Usquare modelled in Arteria

In this scenario, standard timeseries temperature profiles are modified by lowering set points across different times of the day. This adjustment aims to simulate the effects of reduced heating demand on energy consumption and system performance. The calculation analyzes the impact of these lower temperature settings on overall energy usage, peak load demands, and operational efficiency of heating systems. Predictive models integrate these adjusted profiles to forecast long-term energy savings and potential shifts in energy supply requirements. The results from this scenario help inform decisions on whether such temperature adjustments could be implemented more broadly without compromising occupant comfort in real-world settings.

Scenario 2: Lowering energy demand/load, on building level

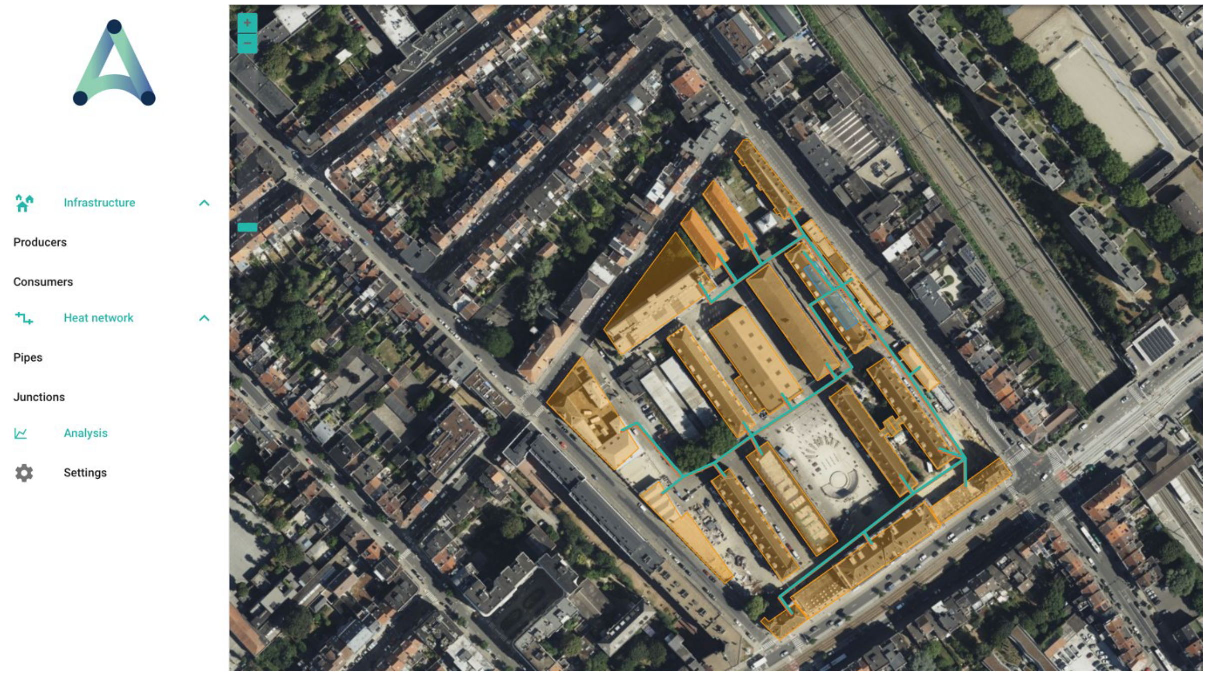

Figure 6: Second scenario of Usquare modelled in Arteria

In this scenario, the maximum heat load supply to each building in the district is reduced by 10% to evaluate potential energy savings and system resilience. Advanced simulation tools are used to predict how this lower heat supply impacts the thermal comfort inside the buildings during peak demand periods. The findings will help determine the feasibility of applying similar load reductions more broadly as a sustainable energy management strategy.

La Roue

Scenario 1: Participation scenario, 100% of buildings connected to district heating network

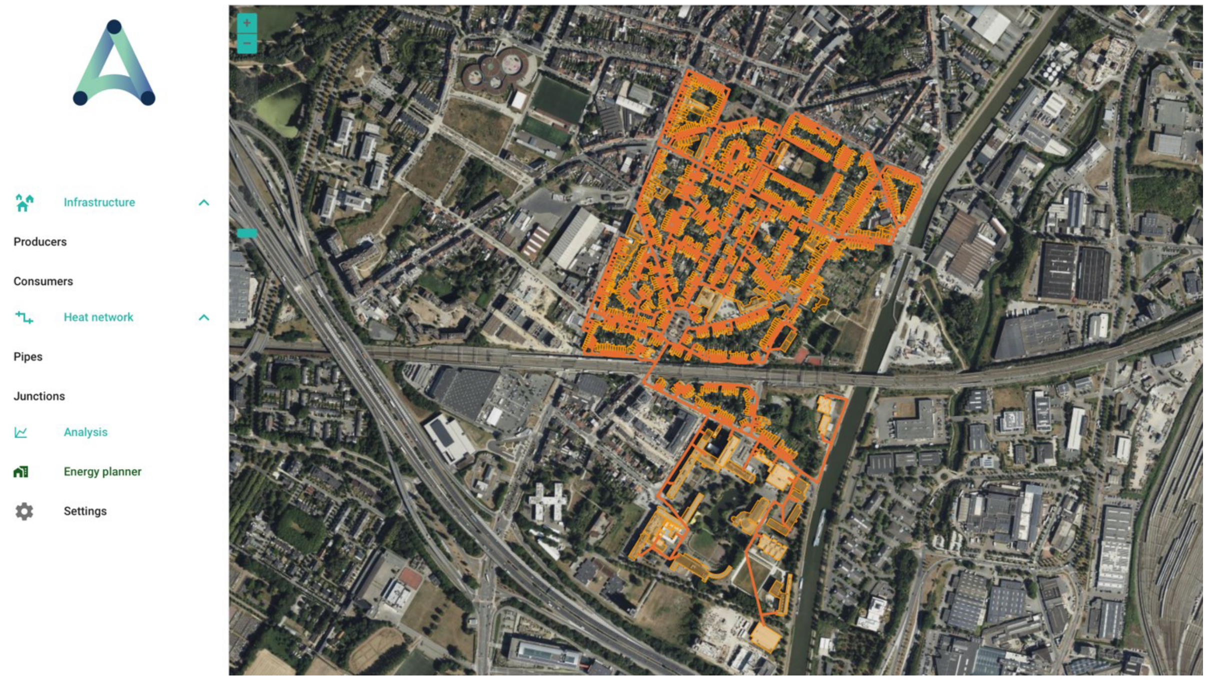

Figure 7: First scenario of La Roue modelled in Arteria

In this scenario, every building within the district is connected to the district heating network, allowing for centralized heat distribution and management. The system is designed to calculate the heating requirements for each connected building, ensuring efficient energy delivery and optimal resource use. Advanced Arteria calculations throughout the network provides real-time data on heat consumption. This unified system calculation approach ensures all buildings receive consistent, reliable DH results, maximizing comfort and energy efficiency. The full integration of the district heating network serves as a model for sustainable urban energy management.

Scenario 2: Participation scenario, 25-50% of the buildings connected to district heating network

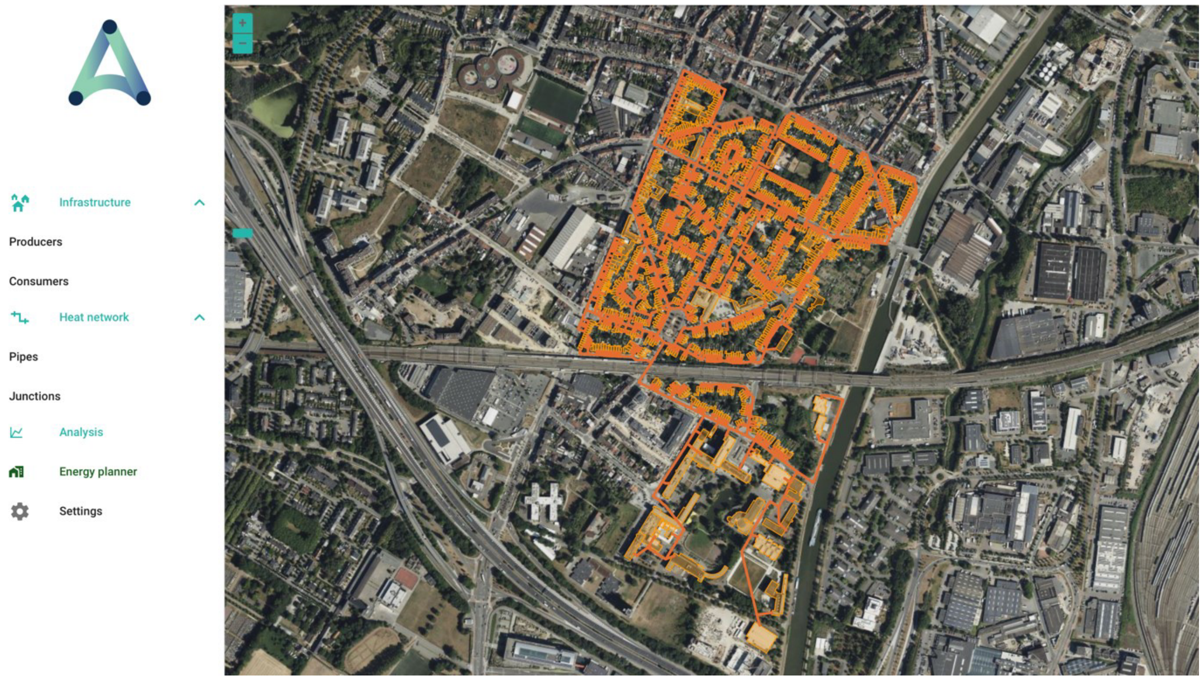

Figure 8: Second scenario of La Roue modelled in Arteria

In this scenario, the connection rate of buildings to the district heating network is incrementally increased from 25% to 100%. The focus is on utilizing predictive calculations to assess how different levels of participation impact the efficiency and functionality of the heating grid. These calculations help forecast the energy distribution needs and system adjustments required as more buildings connect to the network. The model enables planners to simulate scenarios from partial to full integration, providing insights into energy demands, potential bottlenecks, and infrastructure enhancements needed. This approach aids in strategic planning and the phased implementation of district heating, ensuring readiness as network participation grows.

Bari

Scenario 1: Renewable energy scenario with heat pumps and PV instead of gas

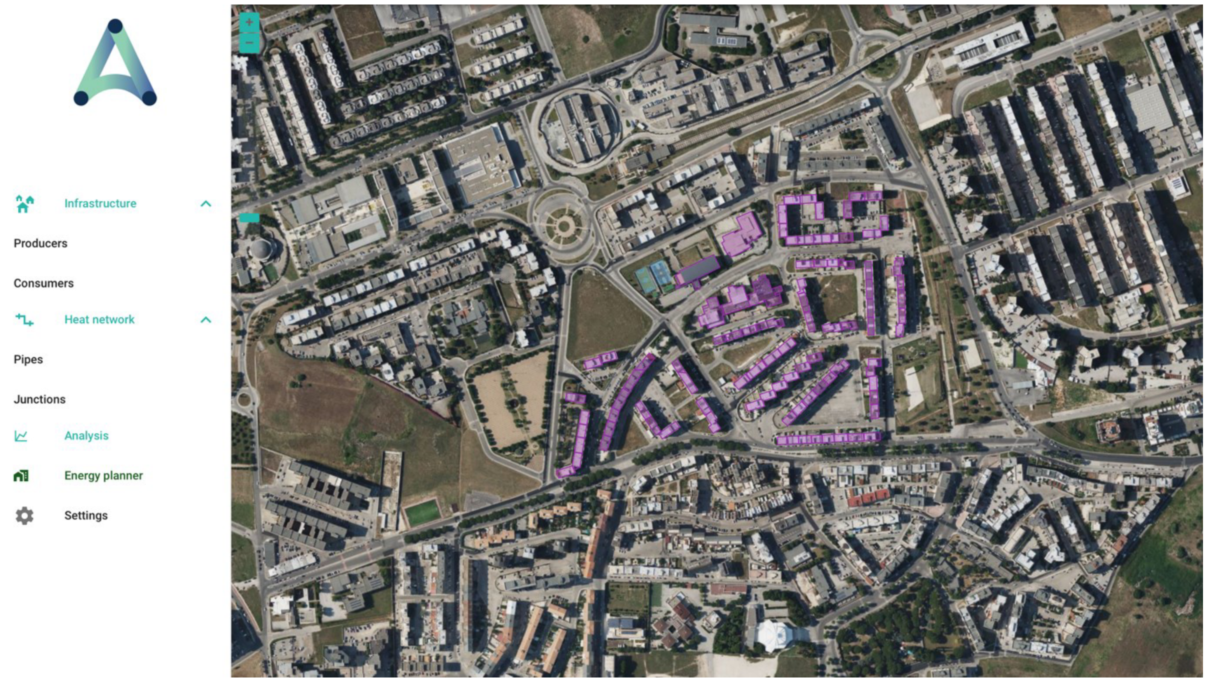

Figure 9: First scenario of Bari modelled in Arteria

In this scenario, buildings without access to district heating transition to a renewable energy model using heat pumps and photovoltaic (PV) panels, replacing traditional gas heating systems. The combination of heat pumps and PV panels significantly reduces the reliance on fossil fuels, lowering carbon emissions and enhancing energy sustainability. Energy storage systems are integrated to capture excess solar energy during peak production hours, ensuring a steady supply of electricity even during low sunlight periods. This scenario demonstrates how buildings can achieve energy independence and sustainability by leveraging modern renewable technologies.

Scenario 2: Create model for retrofitting of buildings to lower heat/cold demand

Figure 10: Second scenario of Bari modelled in Arteria

In this scenario, a comprehensive model is developed to guide the retrofitting of existing buildings to reduce their demand for heating and cooling. The model focuses on enhancing the buildings' insulation, upgrading window and door systems, and incorporating advanced HVAC technologies that improve energy efficiency. Through these retrofits, buildings are expected to maintain interior comfort with significantly lower energy input, leading to reduced operational costs and environmental impact. The model provides a step-by-step approach, offering tailored solutions based on the specific characteristics and needs of each building. By implementing these upgrades, the scenario aims to demonstrate substantial reductions in energy consumption and an increase in the sustainability of the building stock.

Indicators	1st criteria	2nd criteria
First indicator		
Second indicator		
Third indicator		

Conclusion and recommendation

Collaborative efforts have significantly contributed to ensuring the scenarios' implementation and integration into the Arteria Platform. Consequently, some results have already been achieved for the specific scenarios of some of the living labs. Some living labs are in the process of gathering the comprehensive data needed for full integration into the Arteria Platform and are expected to complete this soon. The enhanced techno-economic model of Arteria not only facilitates the planning and management of Positive Energy Districts but also serves as a pivotal framework for evaluating various energy scenarios, including those involving district heating networks, renewable energy integration, and building retrofits. The implementation and analysis of these scenarios across the four living labs: Kahlenbergdorf, Usquare, La Rue, and Bari, enable stakeholders in these diverse demos to optimize energy production, consumption, and sustainability within urban environments. This adaptive model accommodates varying degrees of building participation and technology adoption, from partial to full integration, allowing for detailed assessments of scalability and impact. Moreover, by incorporating real-time data and predictive analytics, the model enhances decision-making processes, helping urban planners to foresee potential challenges and opportunities in energy management. This project represents a significant advancement in software development and underscores the impact of collaborative, interdisciplinary efforts in pushing the boundaries of sustainable urban planning. Ultimately, the Arteria project highlights the crucial role of innovative technologies and strategic planning in transforming urban centers into resilient, energy-positive community.

References

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