D3.4: Report on the Final Simulation Results M25

CITIZENS4PED

24/11/2024

Deliverable No.	04
Deliverable Name	REPORT ON FINAL SIMULATION RESULTS
Version	01
Release date	24/11/2024
Dissemination level	XXX
Status	Draft:final
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Document history:

Version	Date of issue	Content and changes	Edited by
1.0	xx/xx/xxxx	First version	
2.0		Second version	
3.0		Third version	
4.0		Fourth version	

Peer reviewed by:

Partner	Reviewer
XXXX	XXXXXX

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5. Introduction

The D3.4 deliverable provides a comprehensive analysis of various energy strategies aimed at achieving Positive Energy District (PED) goals across four distinct living labs: Kahlenbergdorf, Usquare, La Roue, and Bari. Each living lab represents unique urban, environmental, and social challenges, and the report delves into evaluating tailored scenarios and strategies to address these differences effectively. PEDs aim to create districts that generate more energy than they consume annually, significantly reducing carbon emissions and reliance on non-renewable energy sources. To achieve this, several key scenarios have been explored.

These scenarios include the use of district heating networks, which optimize heat distribution across multiple buildings, and individual heat pumps combined with photovoltaic (PV) systems, which promote decentralized renewable energy generation. Behavioral modifications, such as lowering the comfort temperature in individual apartments, were also assessed to explore the impact of human behavior on energy conservation. Other scenarios focus on reducing energy demand at the building level and varying participation rates in district heating networks, ranging from 50% of buildings connected to partial participation (25% of buildings connected). A renewable energy scenario, replacing gas-based systems with heat pumps and PV, further examines the potential of fully decarbonizing the heat supply.

The goals of implementing these PED strategies are multifold: to reduce overall energy consumption, to significantly lower carbon emissions, and to enhance the energy self-sufficiency of urban districts. By reducing the reliance on fossil fuels and integrating renewable energy sources, PED strategies aim to create sustainable and resilient urban environments capable of addressing climate change and improving energy efficiency. Additionally, these strategies are designed to enhance occupant comfort and lower energy costs over the long term.

The simulations conducted across the living labs offer a comparative understanding of how these energy-saving and renewable energy strategies perform in varying climates, building typologies, and levels of participation. This allows for a better assessment of their feasibility and effectiveness in real-world settings. The results highlight the importance of tailoring energy solutions to local contexts to maximize their impact.

Furthermore, these results were implemented using the Arteria Technologies software platform, a sophisticated tool designed for planning and optimizing district heating networks. The platform integrated these strategies, providing valuable insights into how district heating and renewable energy technologies can be optimized for maximum efficiency. By simulating real-world applications of these strategies, Arteria Technologies demonstrated the practical benefits of PED strategies in achieving energy and environmental goals. This approach not only showcases the potential of PEDs but also contributes to the broader understanding of how innovative technologies can drive the sustainable transformation of urban districts.

6. Living lab Kahlenbergdorf

Arteria tool has integrated two scenarios for Kahlenbergdorf living lab. First scenario represents the district heating network via heat supply and second scenario represents heat supply via individual heat pumps including PV. These scenarios are simulated using Arteria calculation package which aims to optimize the district heating network.

6.1. Scenario 1: Heat supply via district heating network

Figure 1: Kahlenbergdorf, scenario 1 modelled in Arteria Platform.

Figure 1 visualizes scenario 1 of Kahlenbergdorf in Arteria Platform. The grid consists of 36 consumers, 1 producer, 144 connecting pipes and 146 junctions. A pipe dimension-sizing algorithm is applied to provide real-world scenario. This algorithm is implemented in Python and consists of graph ordering, geometry and peak demand distribution. On the other hand, PV panels are integrated in this scenario. There is only one main PV in a nearby area which generates power in terms of electricity for all the units in the village. This PV has a roof area of 200 m^2, 18041,54 m^2 ground area, and 200 kWp assumed power. It is configured that in each unit, to produce hot water and thermal heat usage, biomass boilers will be used. These settings provide the results below.

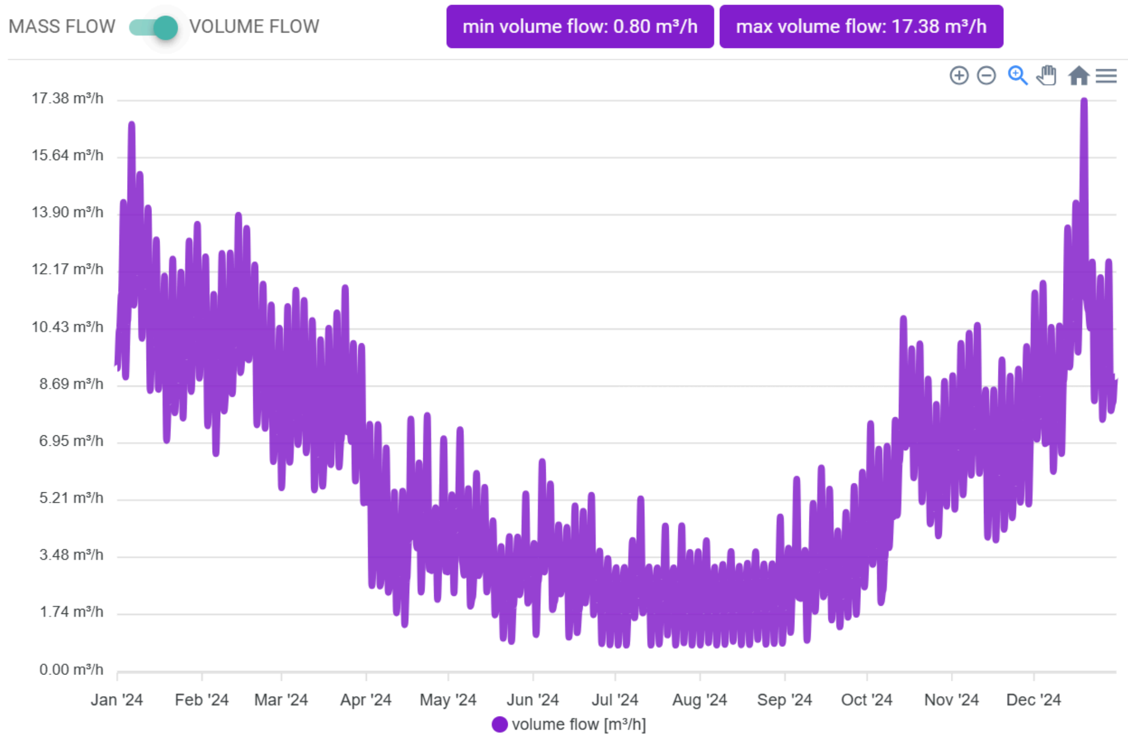

Figure 2: Producer mass flow rates in a yearly simulation.

In figure 2 are shown hourly mass flow rates over one year simulation at a producer in the district heating network calculations. Values reduce during summer months and increase during other seasons by achieving a peak during the month of December and January.

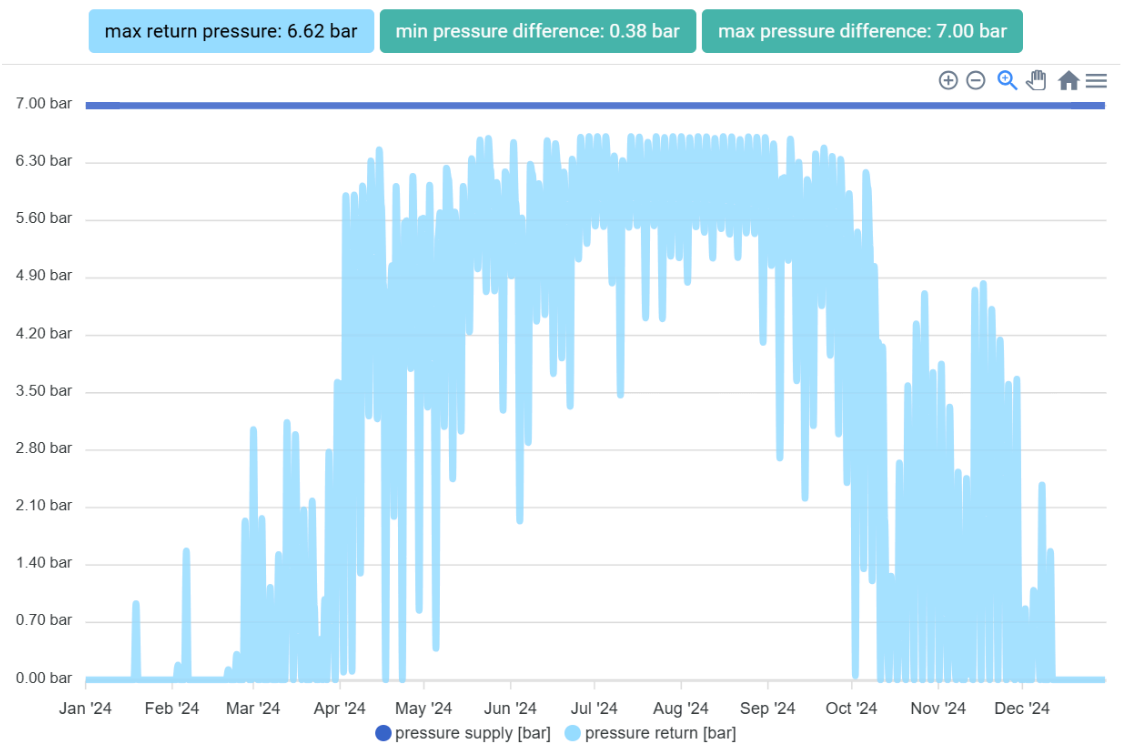

Figure 3: Producer pressure drop in a yearly simulation.

In figure 3 are shown pressure drop values at the producer during year 2024. The smallest pressure drops are during summer and the largest during other seasons.

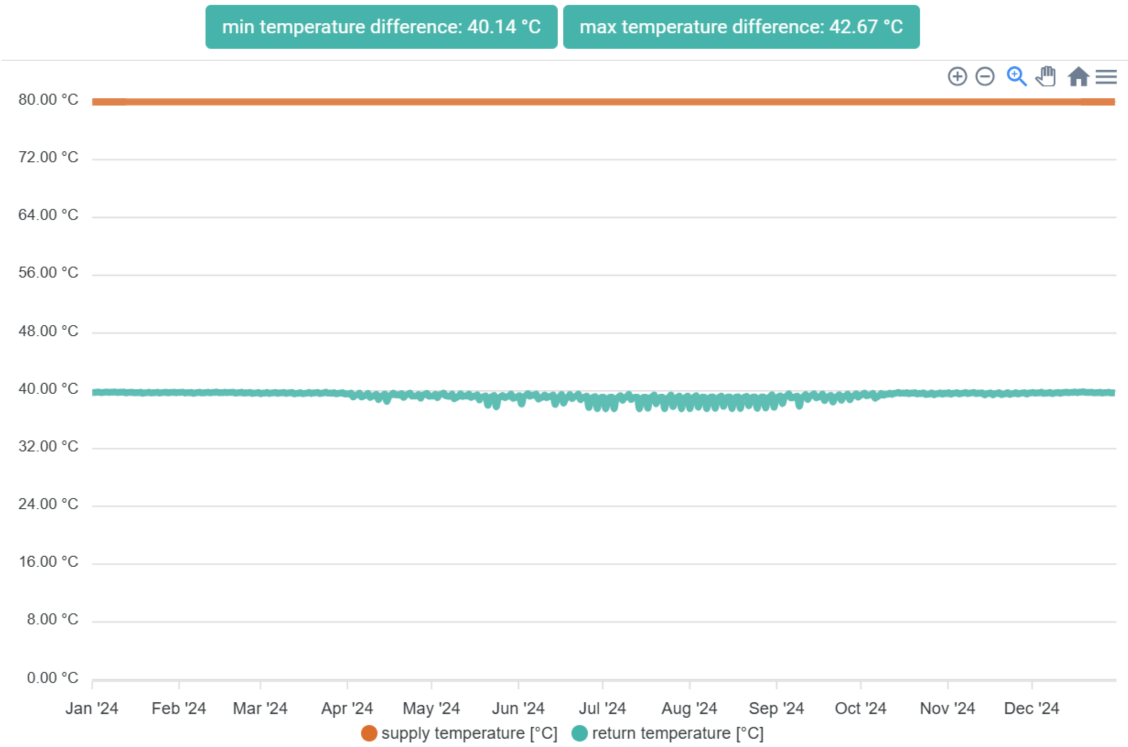

Figure 4: Producer temperature difference in a yearly simulation.

In figure 4 are shown temperature supply and temperature return values in degree Celsius, throughout a year. Around 80 degrees is what the producer feeds to the grid and values around 40 degrees is what the producer receives from the grid.

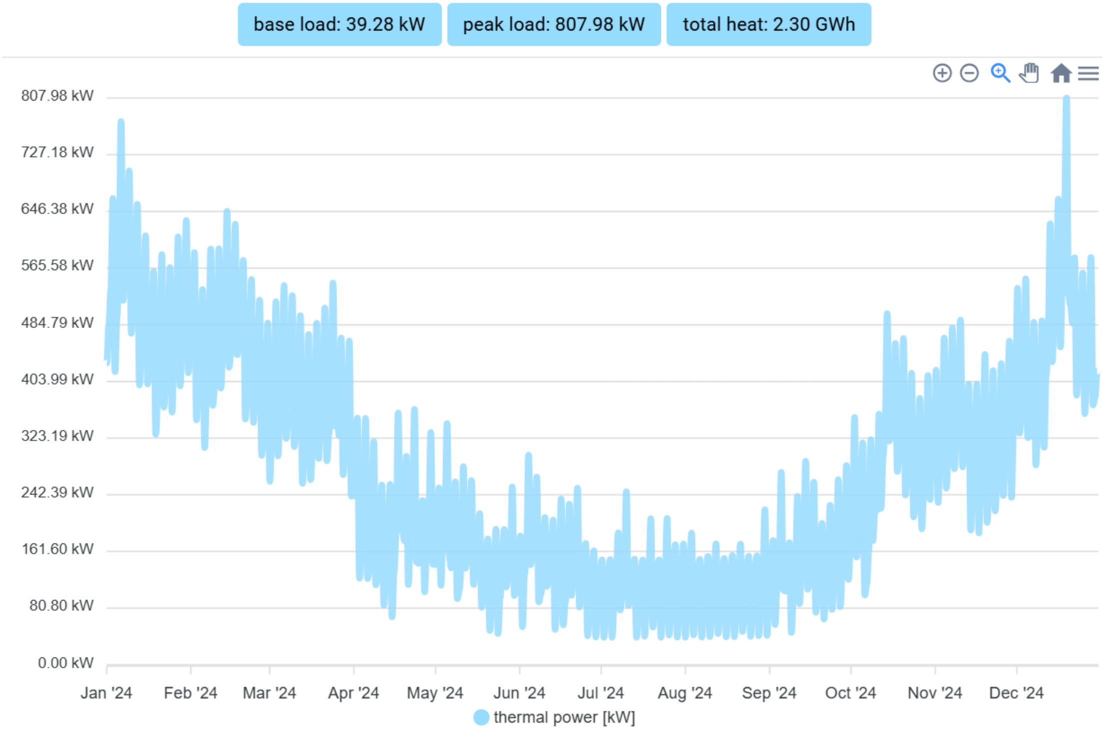

Figure 5: Producer power produced in a yearly simulation.

In figure 5 is shown power generation from the producer throughout the year and the most generation is provided during winter and autumn months, which is a result to be expected.

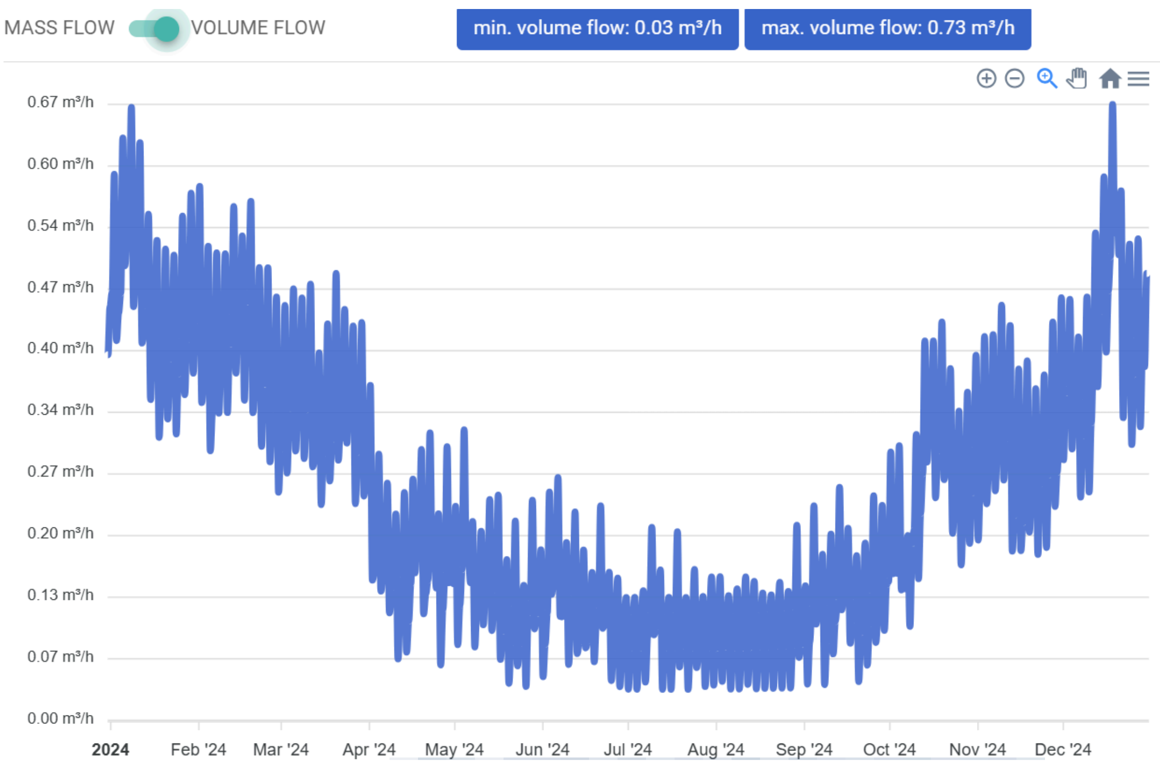

Figure 6 shows mass flow rates curve of a consumer of the grid. This mass flow rate has its peak at 0.67 m3/h on the month of December. During summer months, mass flow values drop at about 0.05 till 0.07 m3/h.

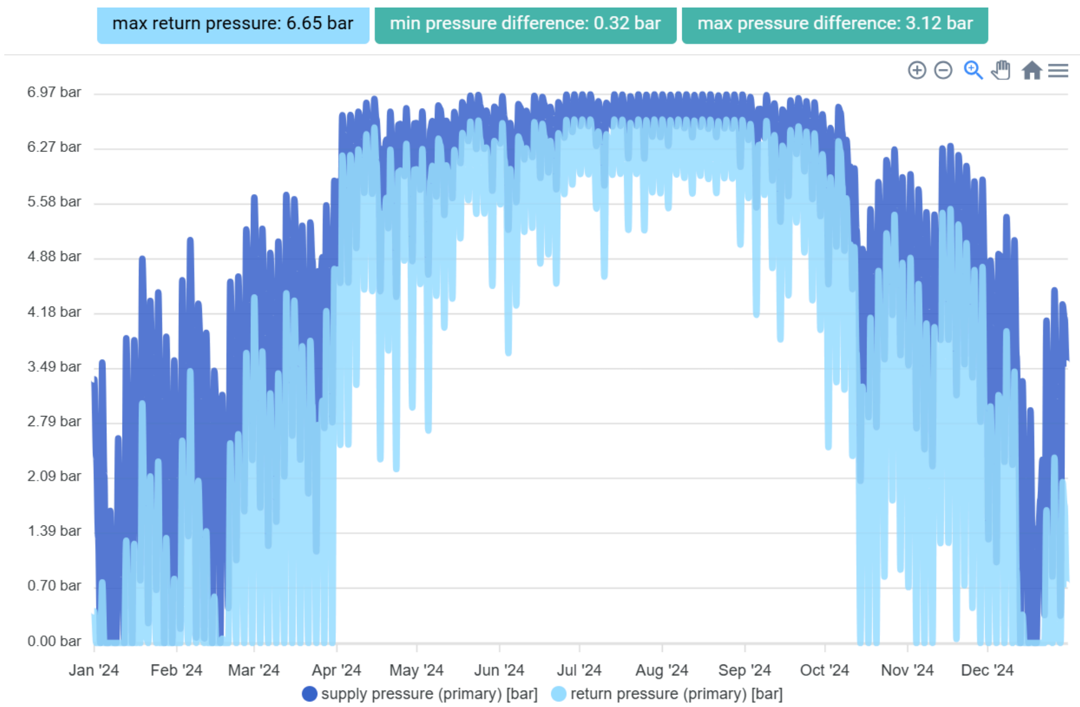

Figure 7: Consumer pressure drop yearly simulation results.

Figure 8 shows what pressure is supplied to the consumer based on specifics of the grid and it shows as well the return pressure from the consumer to the grid.

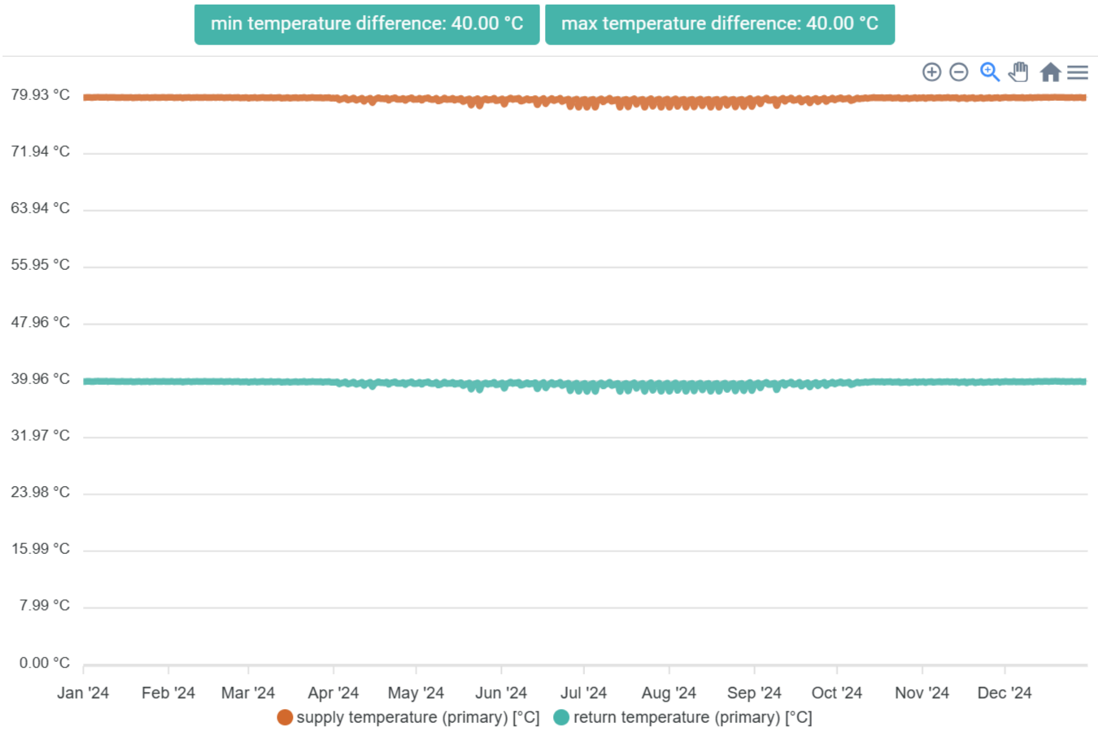

Figure 8: Temperature difference yearly simulation results.

Figure 8 shows the temperature load curve that comes to the consumer from the grid and the temperature load curve that is returned back to the grid from the consumer.

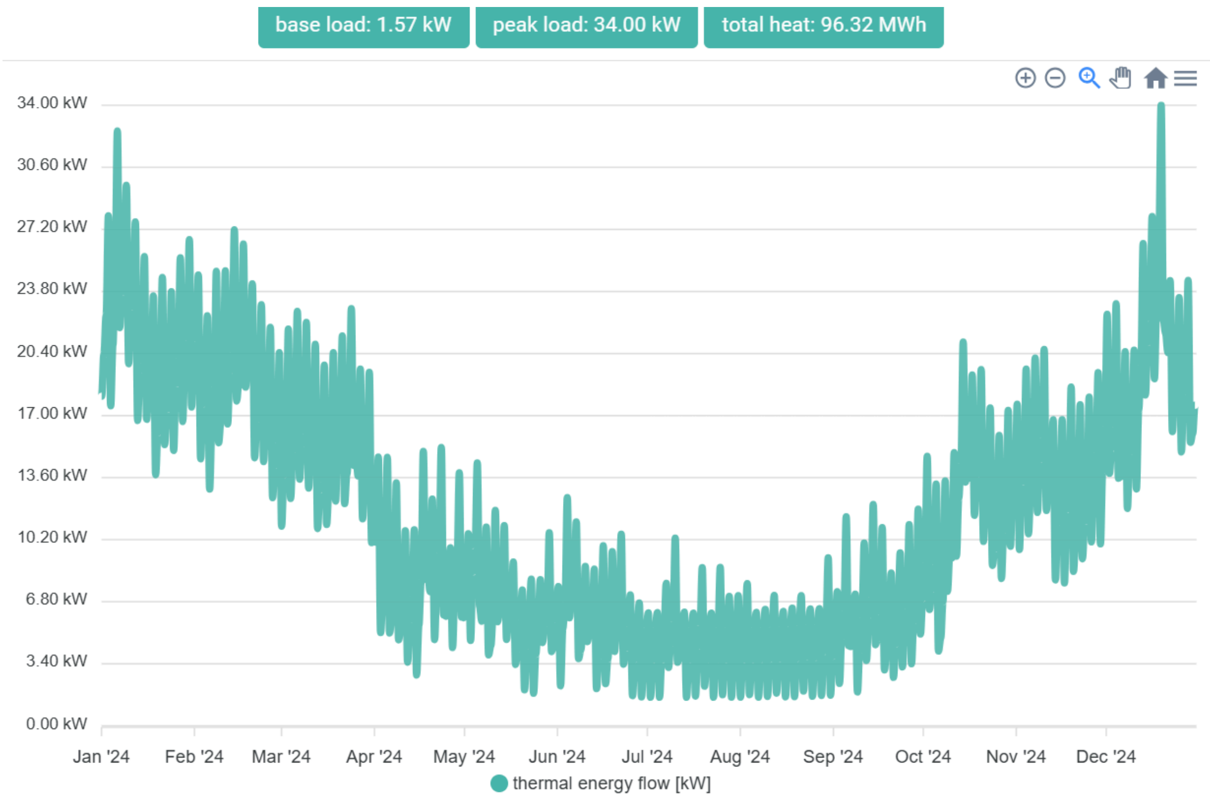

Figure 9: Consumer thermal energy flow yearly simulation results.

Figure 9 represents the energy demand load curve of this specific consumer, that is generated by Arteria platform using a detailed algorithm to produce standard profiles base on a common heating system model and uses the yearly peak demands that each consumer has as an input data.

6.1.1. Energy community, neighbor PV generation

A PV is integrated into a neighboring area which generates a power of 200kWp for 36 buildings. Each building has units or apartments which use biomass boilers for thermal heat usage and warm water usage. The calculation of this scenario in terms of electricity are shown in figure 10.

The energy performance results for Kahlenbergdorf from January 1 to December 31, 2024, highlight significant progress in renewable energy use and cost savings. The project area covered 36.25% of its energy needs through local production, with individual consumption accounting for 43.09%. The use of PV systems contributed to annual cost savings of €25,057.28 and a CO2 emissions reduction of 23,547.12 tons. Total energy consumption was 259.82 MWh, while local production reached 218.58 MWh, with 94.19 MWh consumed directly by the community. Despite importing 165.63 MWh from the grid, the community fed 124.39 MWh back into it, showcasing an efficient balance between energy generation and consumption.

Figure 10: Building power computations.

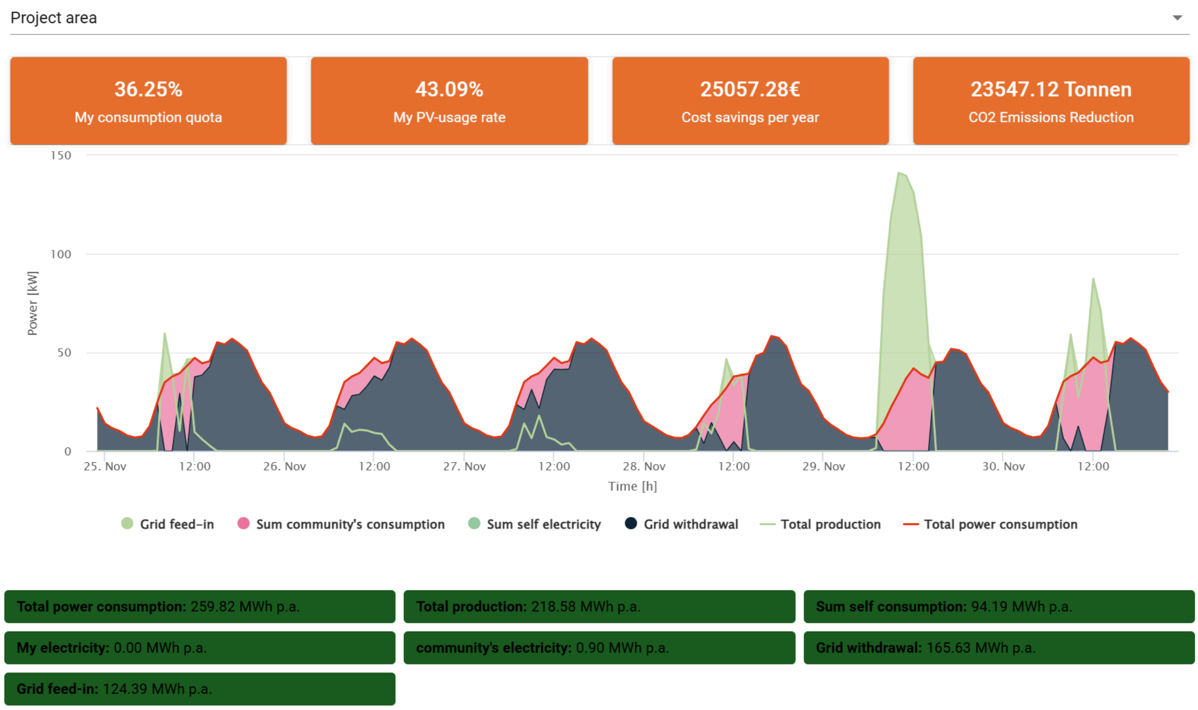

Figure 11: Building power computations within a week.

Figure 11 shows the energy performance results for Kahlenbergdorf from 25th until 30th November of 2024. In the visualized graph the green line represents the grid feed in results, pink line represents the sum community's consumption, the black part represents the grid withdrawal. Total power consumption is 259.82 MWh p.a, total production is 218.58 MWh p.a, sum of self-consumption is 94.19 MWh p.a, self-electricity is 0 MWh p.a, community's electricity is 0.90 MWh p.a, grid withdrawal is 165.63 MWh p.a and grid feed-in is 124.39 MWh p.a.

6.2. Scenario 2: Heat supply via individual heat pumps incl. PV

Figure 12: Scenario 2 modelled in Arteria Platform.

Figure 12, shows scenario 2 modelled in Arteria Platform. PVs are installed on building level. For each unit are integrated data such as power usage (MWh p.a) in terms of electricity, and for thermal power usage and hot water are integrated heat pumps. The standard profiles to visualize load curves are generated considering two different unit types: residential or commercial.

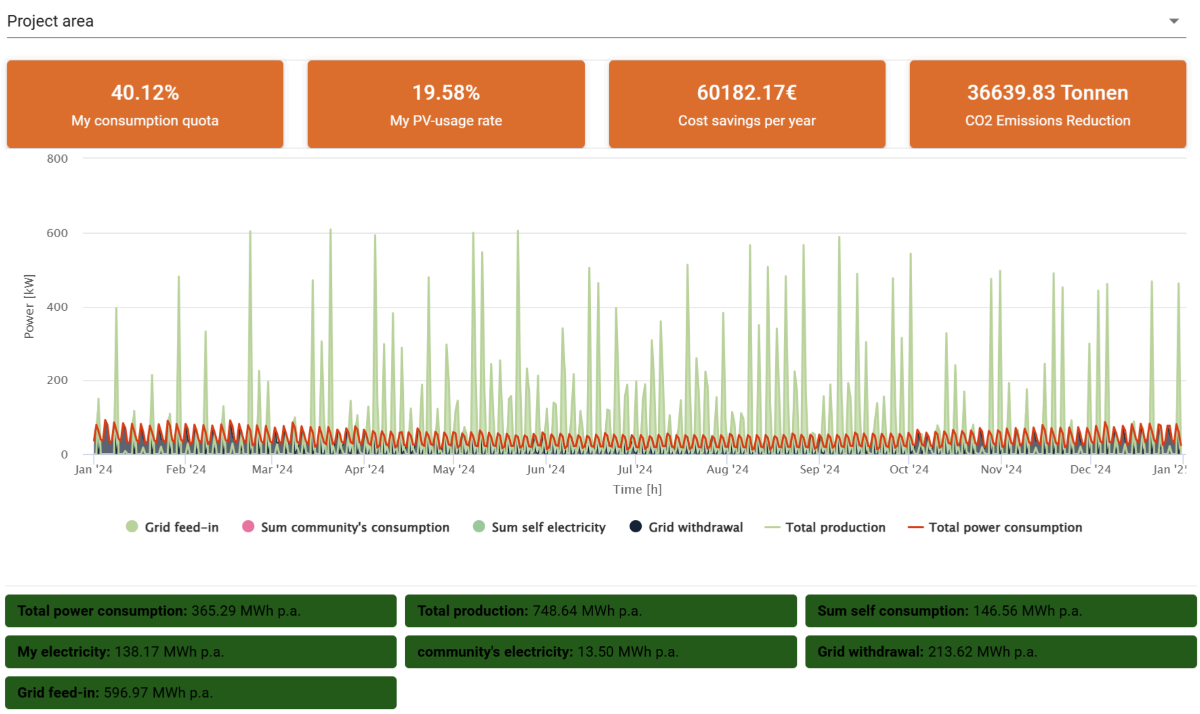

Figure 13: Building power computations.

In figure 13, the energy results shown for Kahlenbergdorf from January 1 to December 31, 2024, reflect significant advancements in renewable energy integration, particularly for apartments using heat pumps for thermal power and warm water. The project area achieved 40.12% coverage of its energy needs through local production, with individual consumption accounting for 19.58%. The use of PV systems resulted in substantial annual cost savings of €60,182.17 and a CO2 emissions reduction of 36,639.83 tonnes. Total energy consumption was 365.29 MWh, while local production reached an impressive 748.64 MWh. The community consumed 146.56 MWh of this energy, with 138.17 MWh directly used by individual apartments and 13.50 MWh by communal systems. Despite withdrawing 213.62 MWh from the grid, the project fed 596.97 MWh back into it, demonstrating a high level of renewable energy surplus. This efficient use of heat pumps and PV systems significantly reduces both energy costs and environmental impact.

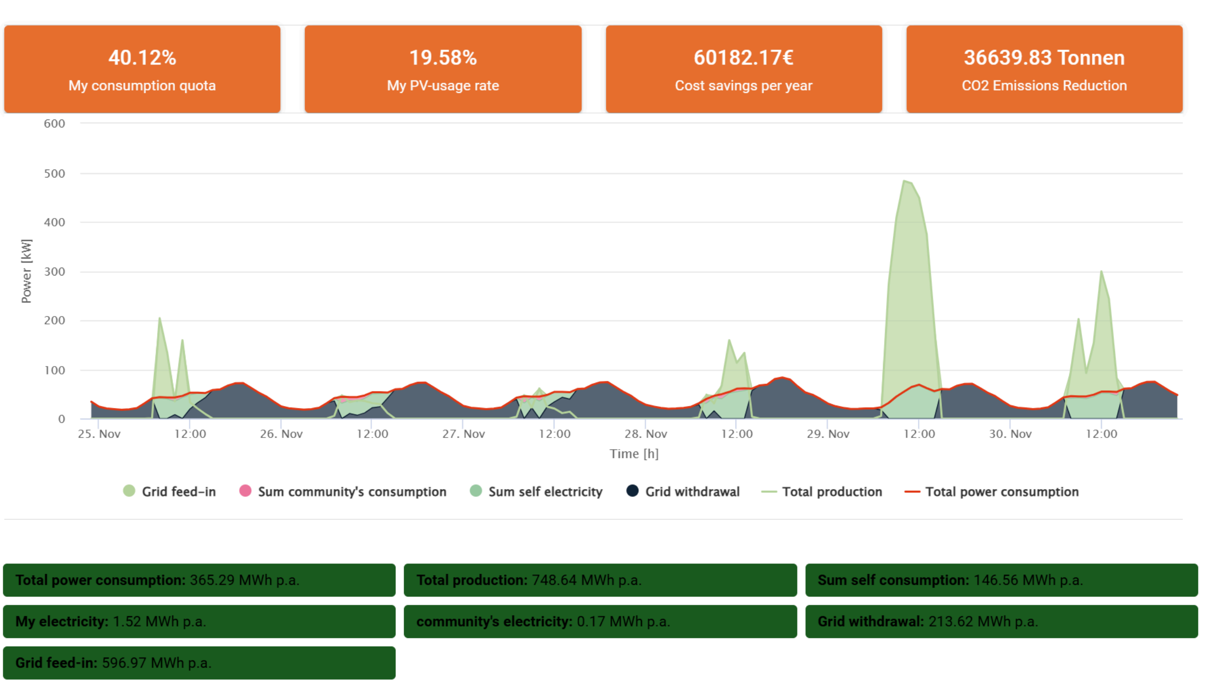

Figure 14: Building power computations within a week.

Figure 14 shows power computations within a week. Total power consumption is 365.29 MWh p.a, total production is 748.64 MWh p.a, sum of consumption is 146.56 MWh p.a, self-electricity is 1.52 MWh p.a, community's electricity is 0.17 MWh p.a, grid withdrawal is 213.62 MWh p.a, grid feed-in is 596.97 MWh p.a.

7. Living lab La Roue

Arteria has implemented participation scenarios of La Roue living lab. In Python we have implemented a module which randomizes the buildings based on a certain percentage of 25 or 50% based as well on peak demand data of each consumer.

7.1. Scenario 1: Participation scenario, 25% of consumers.

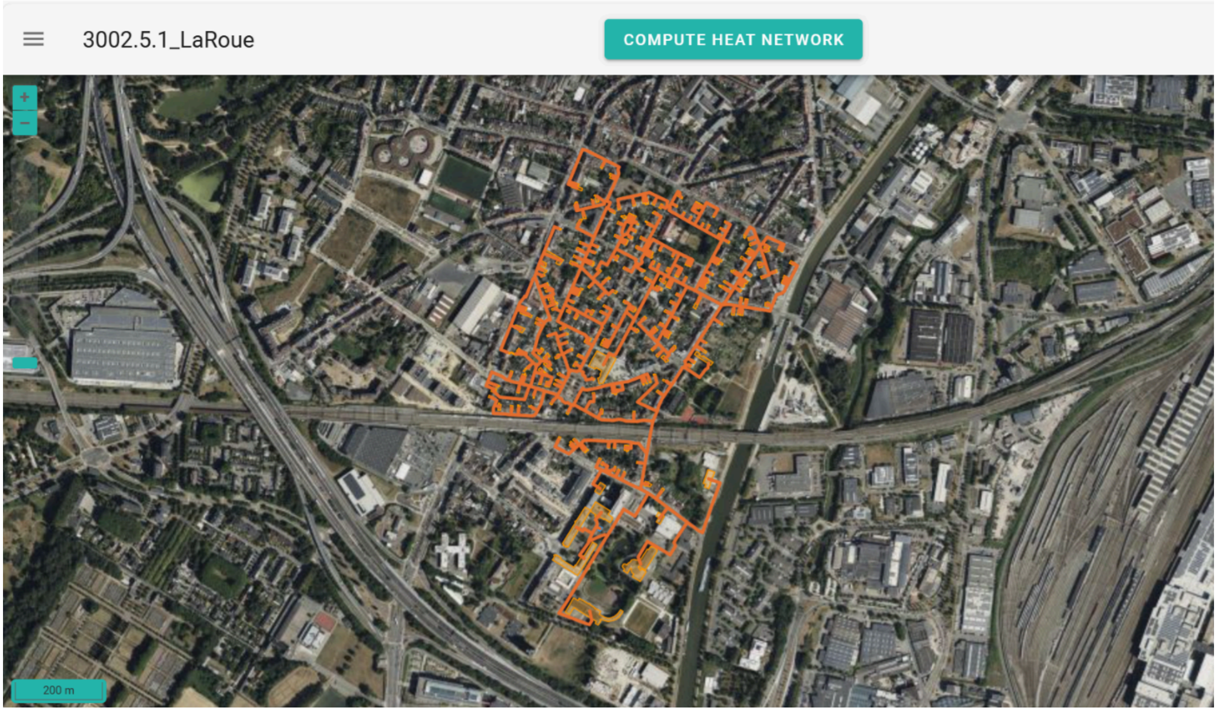

Figure 15: Scenario 1 of La Roue modelled in Arteria Platform.

Figure 15 shows 25% of consumers connected to the heating grid. Among those there are 6 big consumers and 255 others that have relatively the same power demands. There is one central producer. All the structures and nodes are connected through pipes. Dimension sizing algorithm is applied here as well. Below are the results for this scenario.

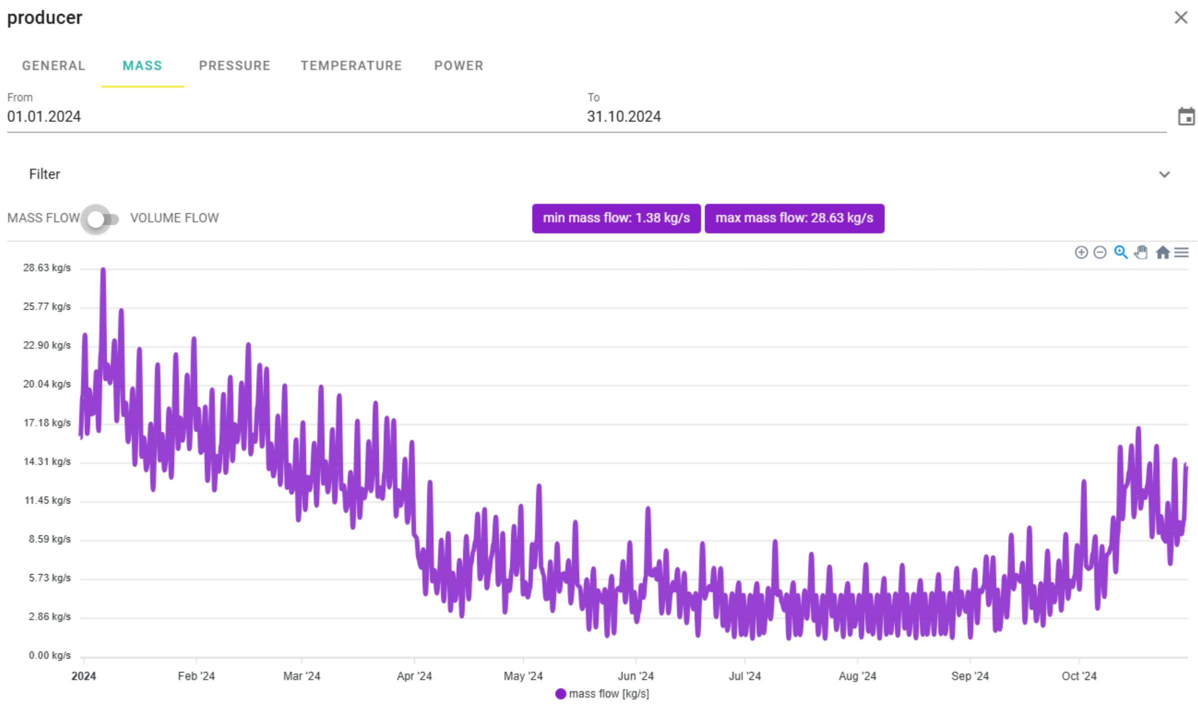

Figure 16: Producer mass flow load curve.

Figure 16 shows mass flow on the producer. This mass flow is calculated as the sum of every consumer mass flow generated by Arteria standard profiles, at each timestamp. Minimal mass flow is 1.38 kg/s and maximal mass flow is 28.63 kg/s.

Figure 17: Producer pressure supply and pressure return curves.

Figure 17 shows pressure return calculation at the producer, after supplying the whole grid. Pressure supply is set at 8 bar as a standard. Minimal return pressure is 6.33 bar, maximal return pressure is calculated at 7.70 bar, minimal pressure difference is calculated at 0.30 bar and maximal pressure difference is calculated at 1.67 bar.

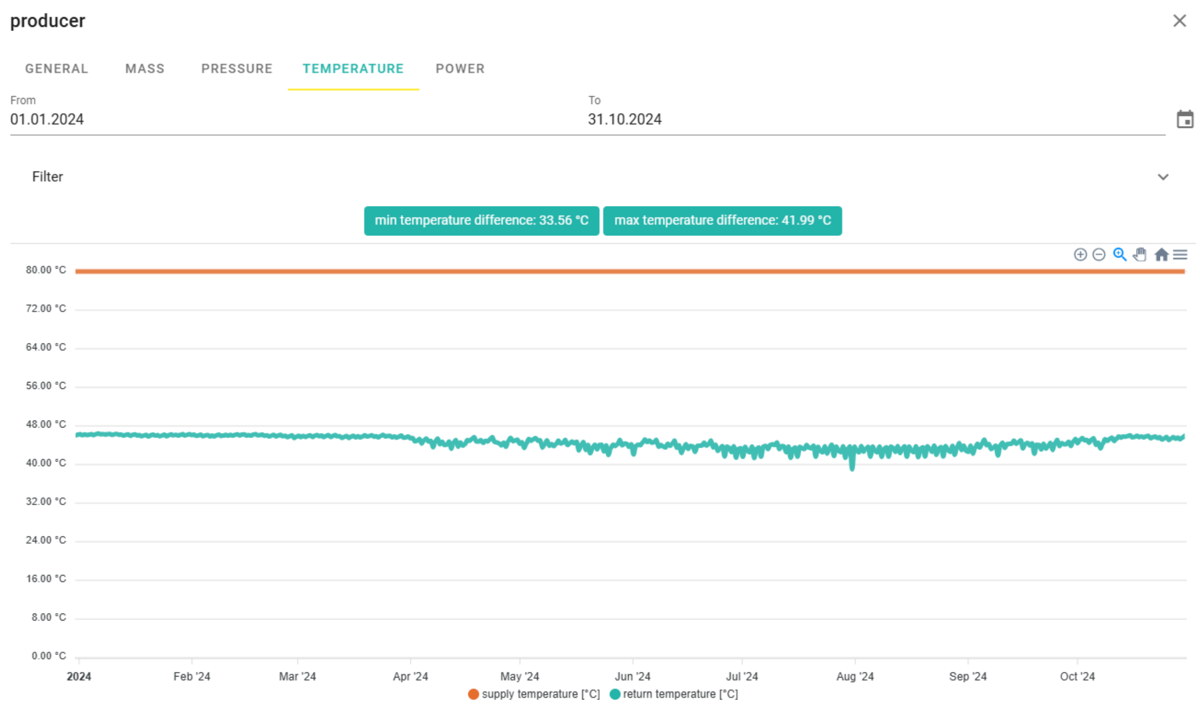

Figure 18: Temperature supply and return curves at the producer.

Figure 18 shows two curves of supply and return temperature at the producer. Standard supply temperature is set at 80 °C. Return temperature showcases the temperature returned at the producer in each timestamp, after supplying to every consumer. This temperature varies mostly at 62°C.

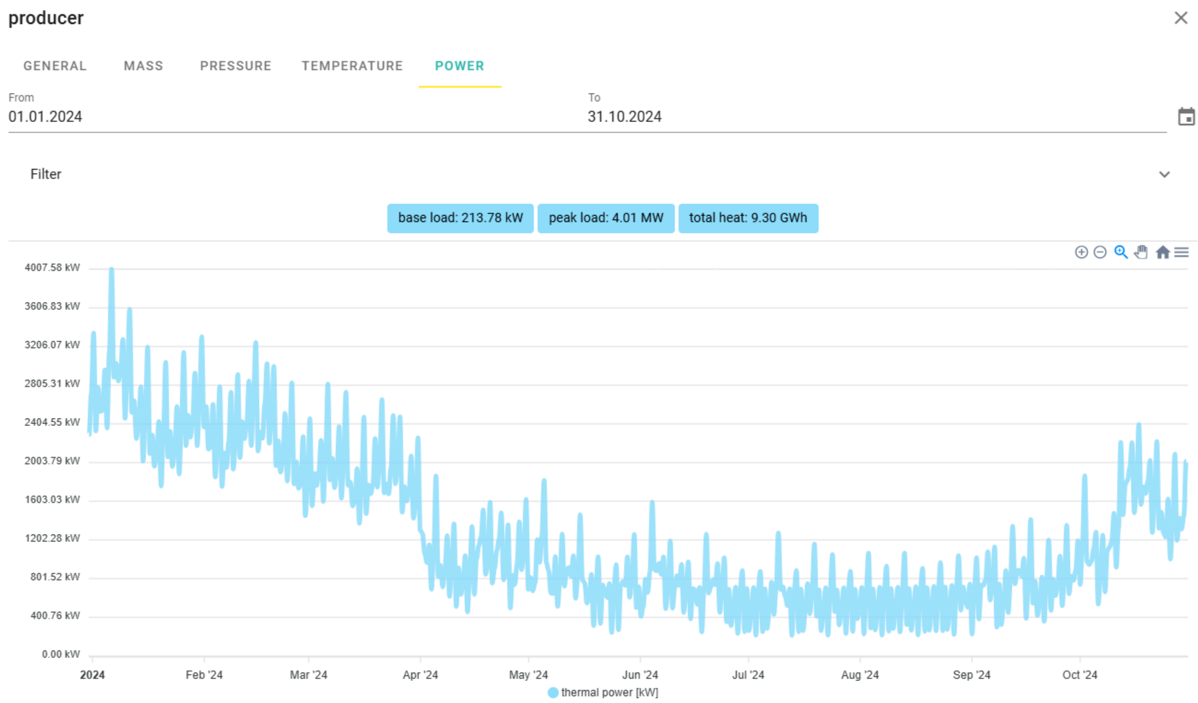

Figure 19: Power generation load curve at the producer.

Figure 19 shows what are the power values that distribute and generate to satisfy the demands of all consumers. Base load is 213 kW, peak load during winter season is at 4.01 MW and total heat is at 9.39 GWh.

Figure 20: Mass flow standard curves at one consumer.

Figure 20 shows Arteria standard load curve generated for a consumer which has the peak demand of 334 kW. One of the features of Arteria is to show the mass flow as a volume flow. Minimal volume flow is 0.40 m^3/h and the maximal volume flow is 8.30 m^3/h.

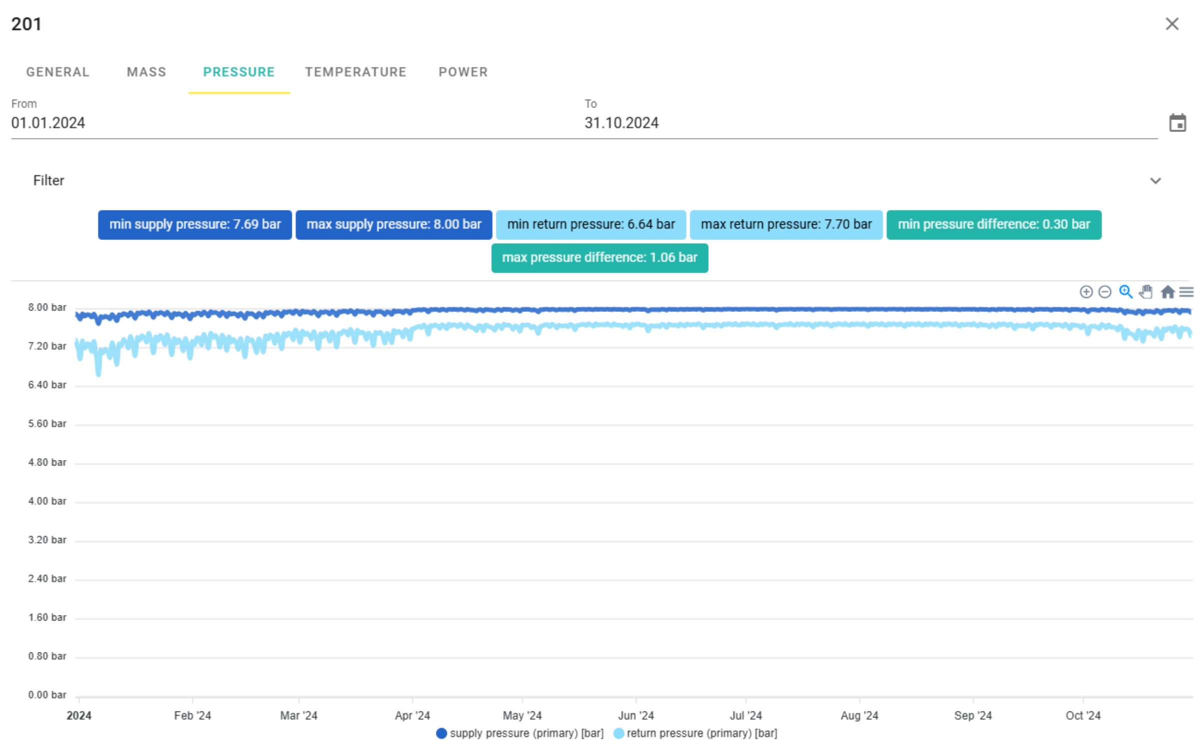

Figure 21: Pressure return and supply in consumer.

Figure 21 shows the calculated pressure supply and return in one of the biggest consumers of the grid. Minimal pressure supply is 7.6 bar, maximal pressure supply is 8 bar, minimal pressure return is 6.64 bar, maximal pressure return is 7.7 bar, minimal pressure difference is 0.3 bar and maximal pressure difference is 1 bar.

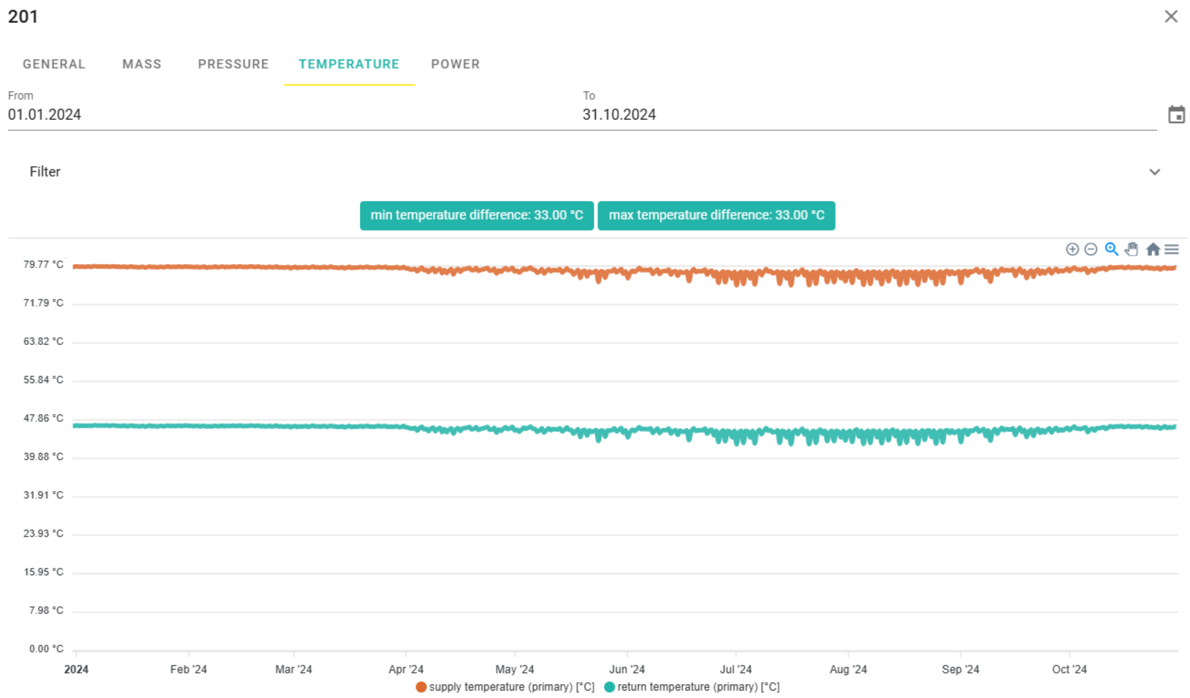

Figure 22: Supply and return temperature load curves.

Figure 22 shows what temperature goes into the consumer and what comes back out in the grid for each timestamp. Temperature supply values vary in 79°C and return values vary in 47°C.

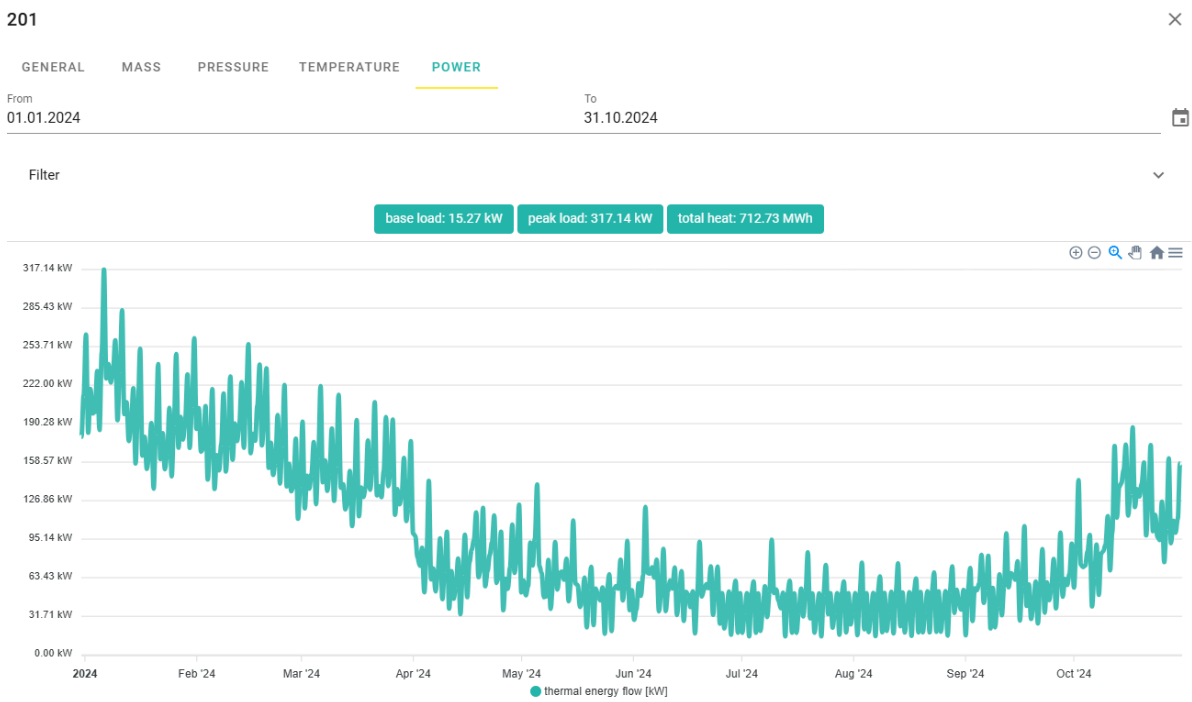

Figure 23: Power curve at one consumer.

Figure 23 shows power on one of the consumers based on the peak power demand of the building. Base load is 15.27 kW, peak load is 317.14 kW, and total heat is 712.73 MWh.

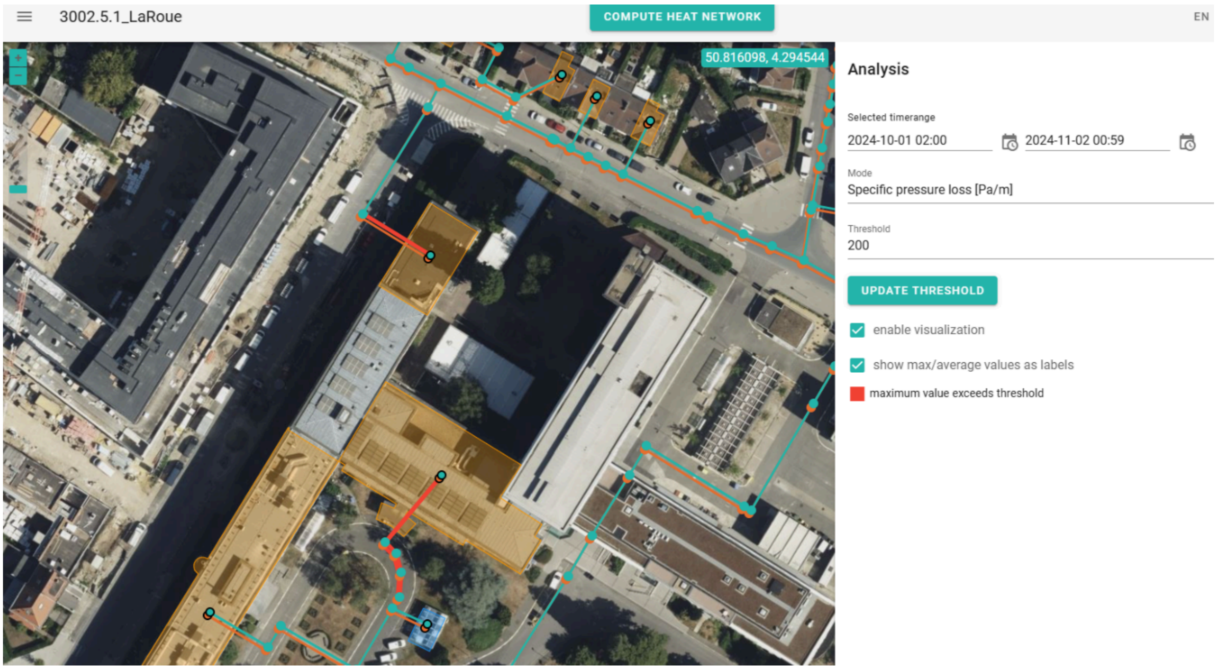

Figure 24: Pipe analysis feature in Arteria.

Figure 24 shows a new feature implemented in Arteria Platform that gives more information regarding pipe analysis. In the analysis dialog side menu you can pick up a date and time, and you can check specific pressure loss, temperature loss, mass flow and velocity for each connection point. In the figure above, in the network two pipes are colored red signaling that they have exceeded the specified threshold of 200 Pa/m.

7.2. Scenario 2: Participation scenario, 50% of consumers.

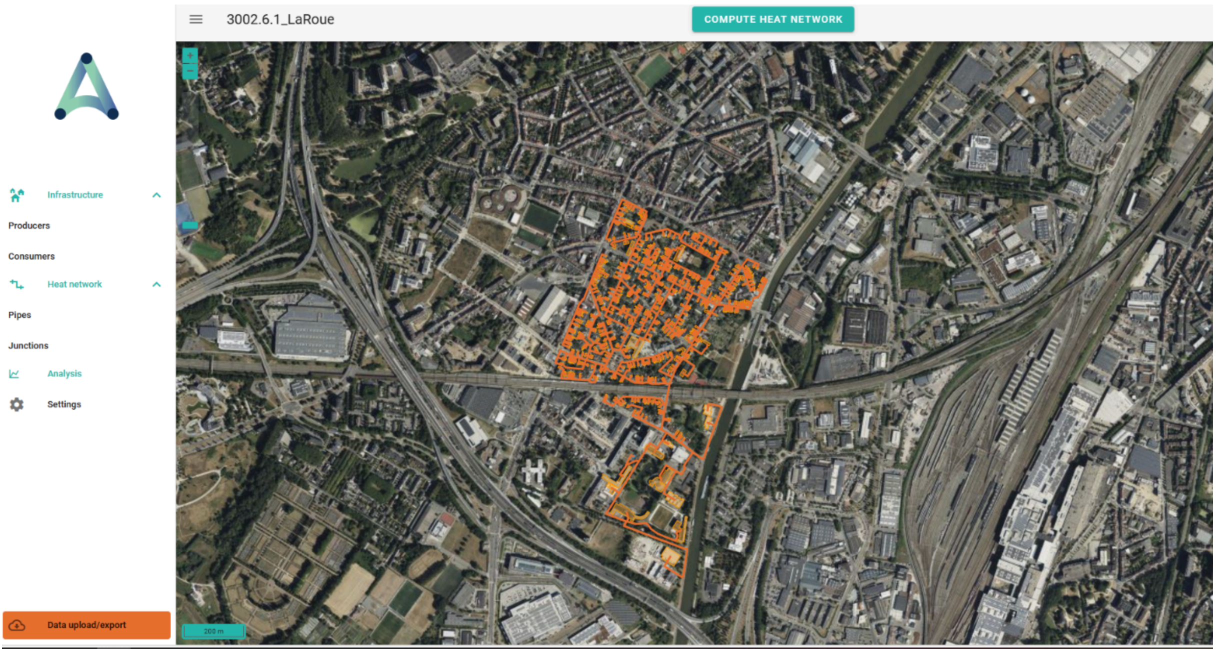

Figure 25: 50% of consumers of La Roue district heating network integrated in Arteria Platform.

Figure 25 shows the second participation scenario of La Roue living lab. There are 14 bigger consumers, 1 producer and 523 consumers in total. This represents 50% of randomly selected buildings. This scenario is simulated for one year and calculation results are shown in the figures below.

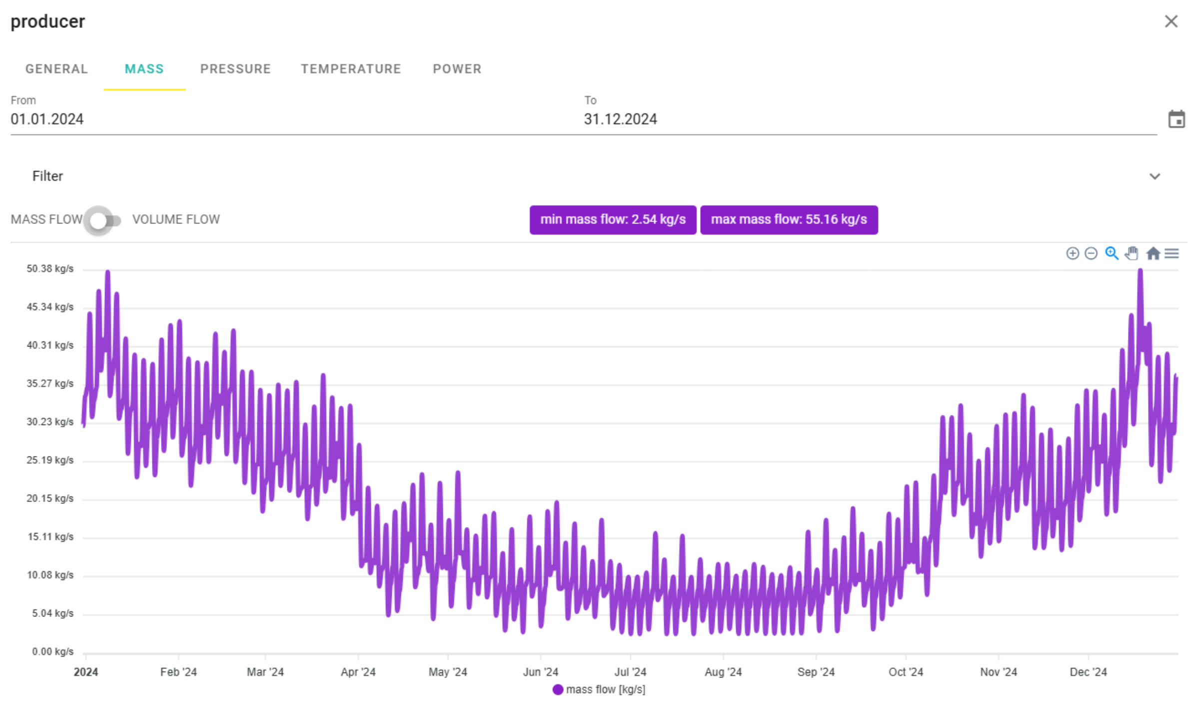

Figure 26: Mass flow curve at the producer.

Figure 26 shows the calculated mass flow curve at the producer. Maximal mass flow is 55.16 kg/s and minimal mass flow is 2.54 kg/s.

Figure 27: Pressure supply and return load curves at the producer.

Figure 27 shows pressure return and supply load curves at the producer. Minimal return pressure is 2.5 bar, maximal return pressure is 7.69 bar, minimal pressure difference is 0.31 bar during summer time and maximum pressure difference is 5.5 bar during winter time.

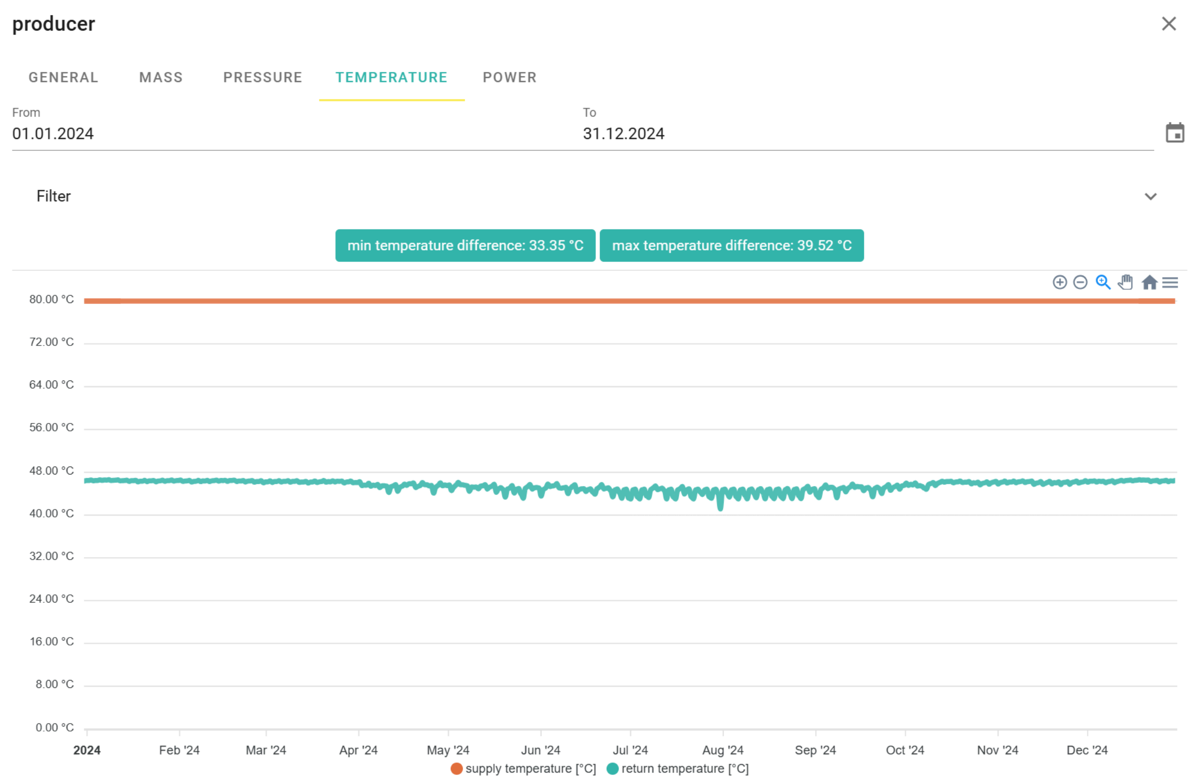

Figure 28: Temperature load curve on the producer.

Figure 28 shows temperature supplied and temperature that is returned to the producer after supplying all the grid. Temperature supply is set as a standard at 80°C and temperature return varies in 48°C.

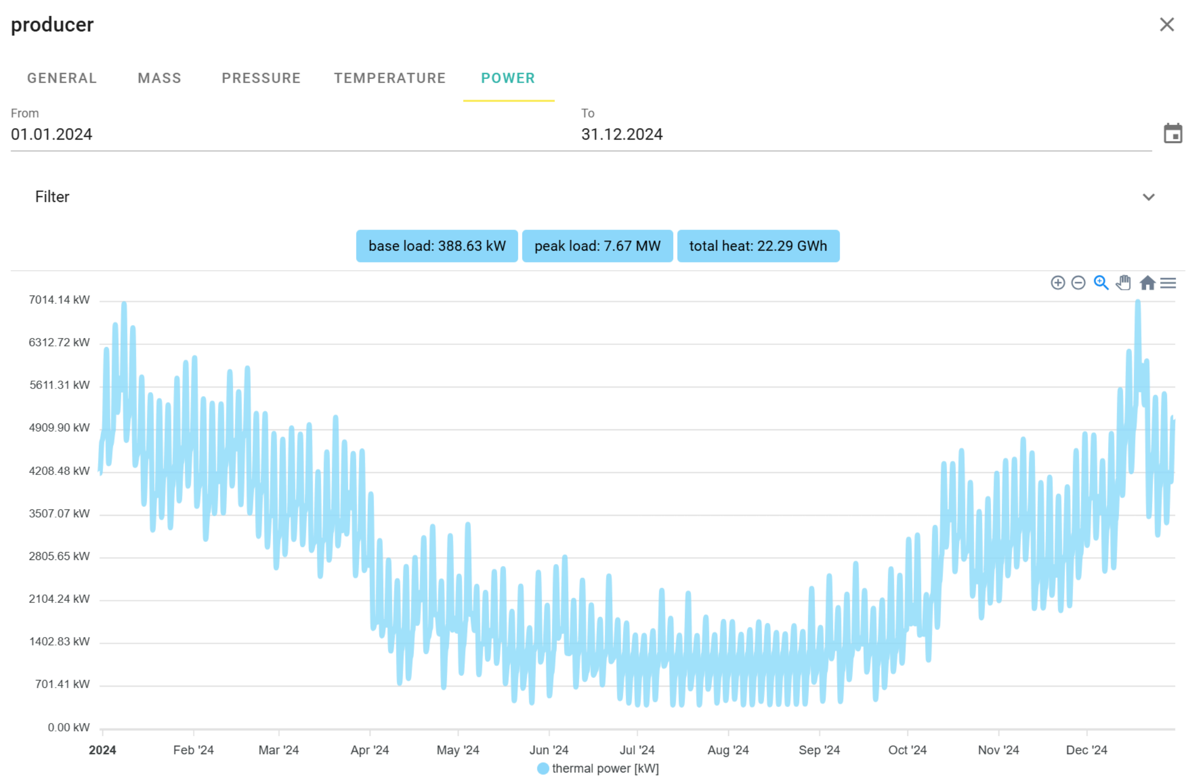

Figure 29: Power generation load curve at the producer.

Figure 29 shows power generation at the producer for each timestamp. To satisfy the needs of the grid bas load is 388.63 kW, peak load is 7.67 MW and total heat is 22.29 GWh.

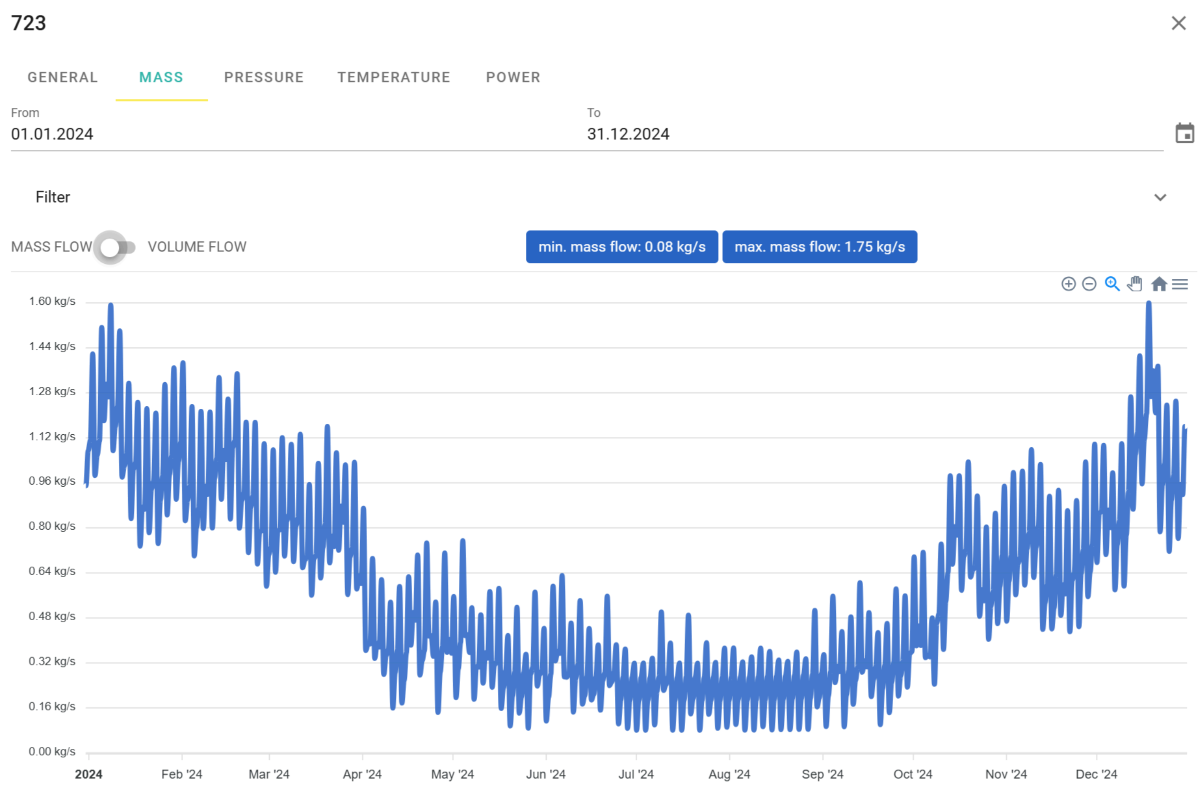

Figure 30: Mass flow load curves at one consumer.

Figure 30 shows Arteria standard mass flow curves for one consumer of La Roue with a specific power demand value. Minimal mass flow is 0.08 kg/s and maximal mass flow is 1.75 kg/s.

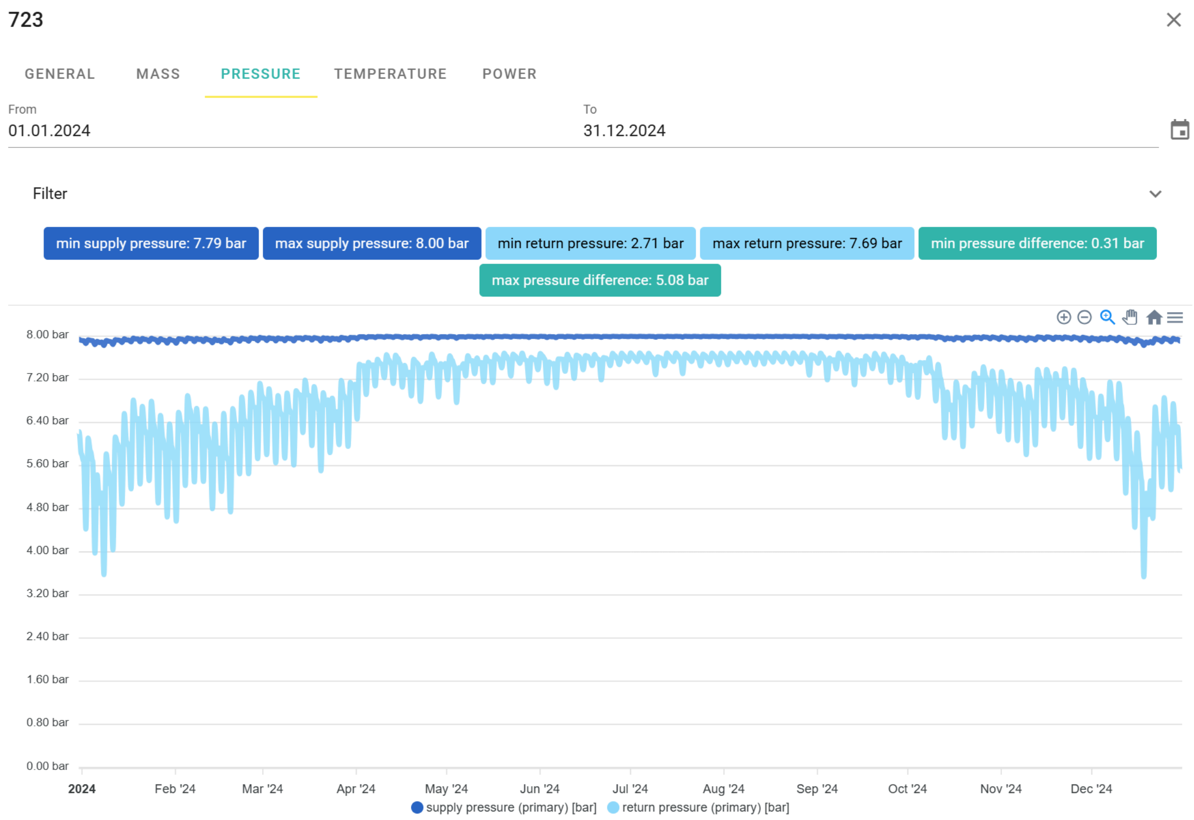

Figure 31: Pressure return and supply at one consumer.

Figure 31 shows pressure return and supply load curves at one consumer of La Roue. Minimal supply pressure is 7.79 bar, maximal supply pressure is 8 bar, minimal return pressure is 2.71 bar, maximal return pressure is 7.69 bar, minimal pressure difference is 0.31 bar and maximal pressure difference is 5.08 bar.

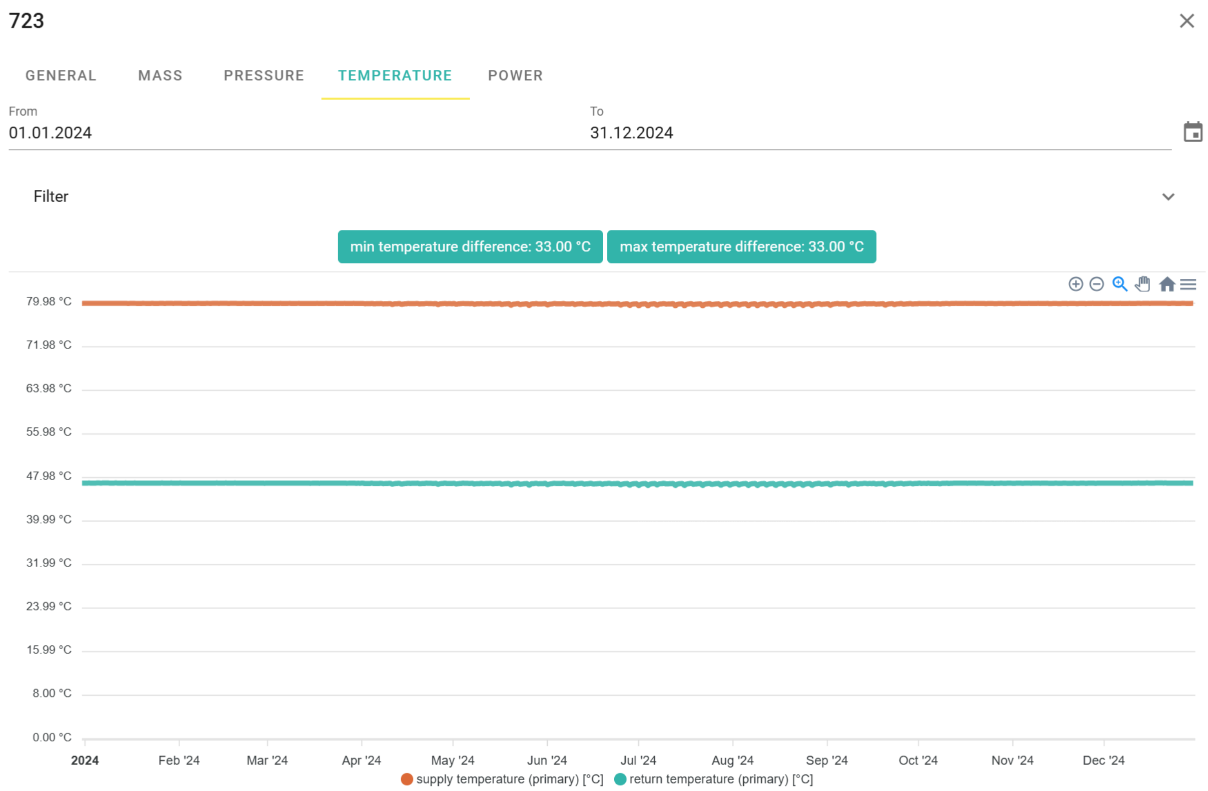

Figure 32: Temperature load curves at one consumer.

Figure 32 shows two load curves of temperature supply and temperature return at the consumer with id 723. Supply temperature varies at 79°C and temperature supply at 47°C.

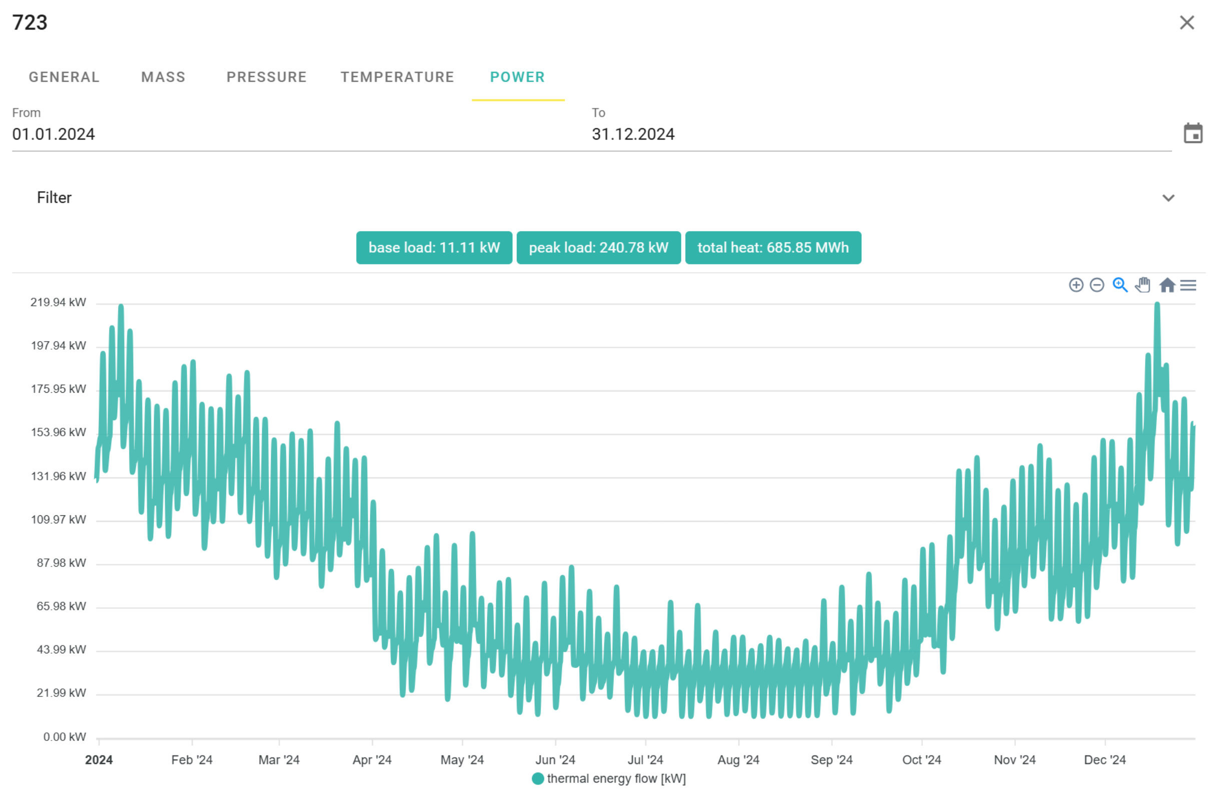

Figure 33: Thermal energy flow at one consumer.

Figure 33 shows thermal energy flow at one consumer with id 723. These load curves are based on the demand of the building. Base load is 11.11kW, peak load is 240.78 kW and total heat is 685.85 MWh.

8. Living lab Usquare

Arteria has implemented sufficiency scenarios for Usquare Living Lab. We have collaborated with other project partners within WP3 to provide lower degree temperature load curves from our standard load curves. We sent standard power demand load profiles to VUB partners and using Pareto Fronte tool they provided us with new power demand profiles based on lowering temperature profiles. Our simulation model requires mass flow and power as input in every consumer, therefore using a delta temperature, a constant of 4.17 and the provided new load curves, we have calculated the necessary mass flows that will serve as an input to our simulation.

8.1. Scenario 1: Lowering comfort temperature to 15°C.

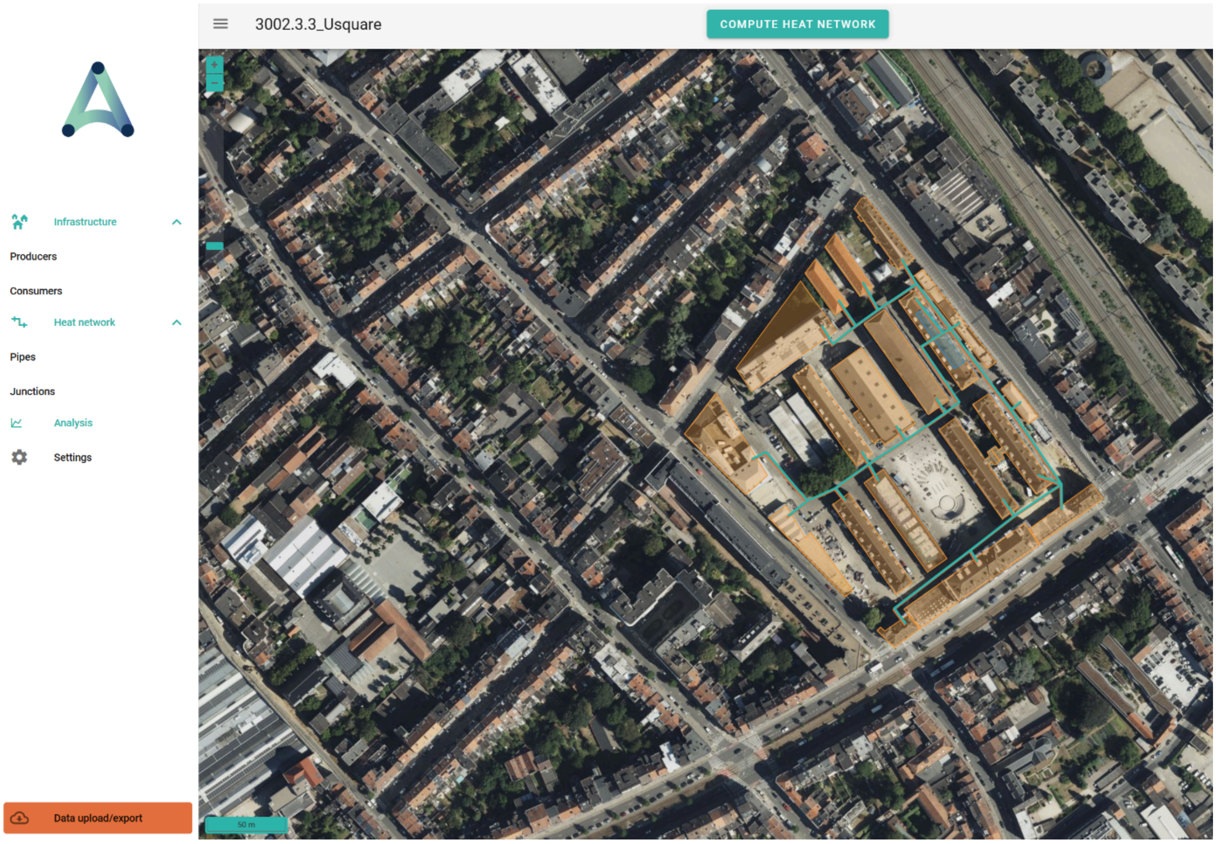

Figure 34: Scenario 1 of Usquare integrated in Arteria Platform.

Figure 34 visualizes Usquare building geometry and district heating network. Arteria generated standard load profiles for each building based on peak power demand of each building and then Pareto Fronte tool made it possible to generate the same profiles but when the comfort temperature is set to 15°C. Below are the results from this scenario.

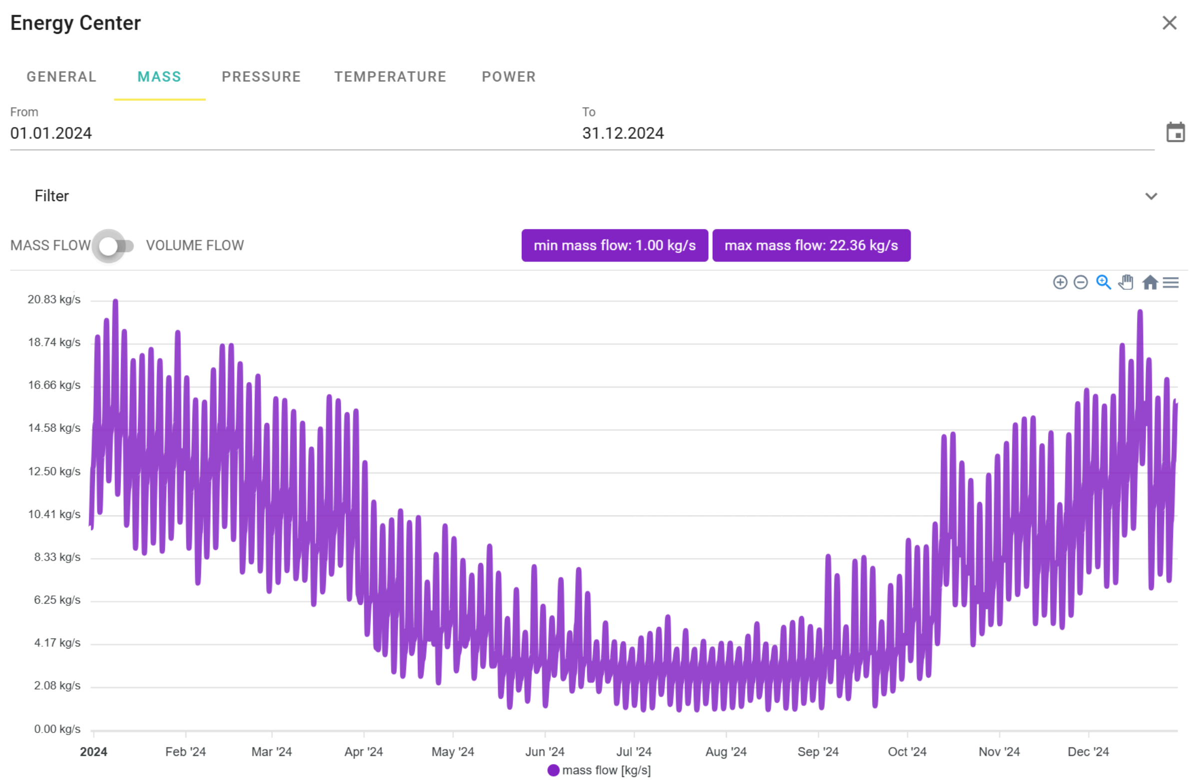

Figure 35: Mass flow load curve at the producer.

Figure 35 shows mass flow calculated load curve at the producer. Minimal mass flow is 1 kg/s and maximal mass flow is 22.36 kg/s during winter and fall season.

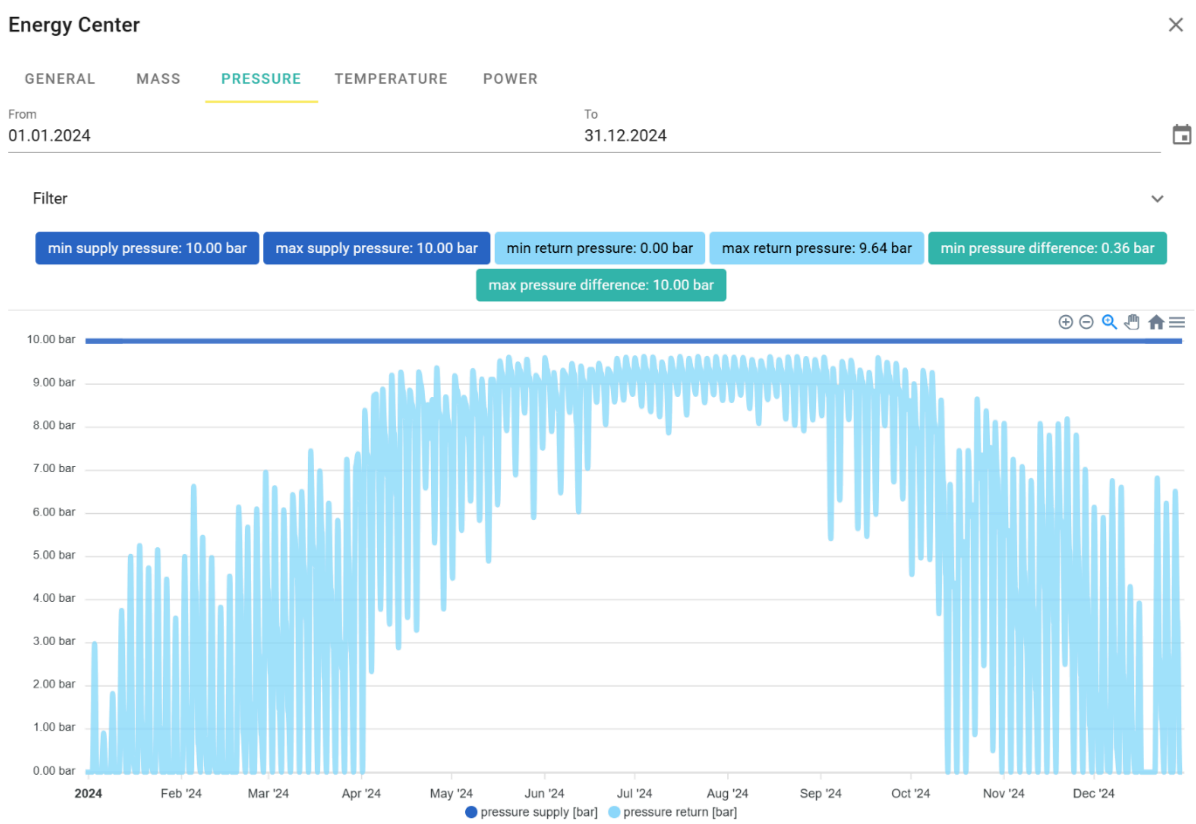

Figure 36: Pressure return and supply load curves at the producer.

Figure 36 shows pressure supply set at 10 bar and pressure return at the producer for each timestamp. Minimal return pressure is at 0 bar, maximal return pressure is 9.64 bar, minimal pressure difference is 0.36 bar and maximal pressure difference is 10 bar.

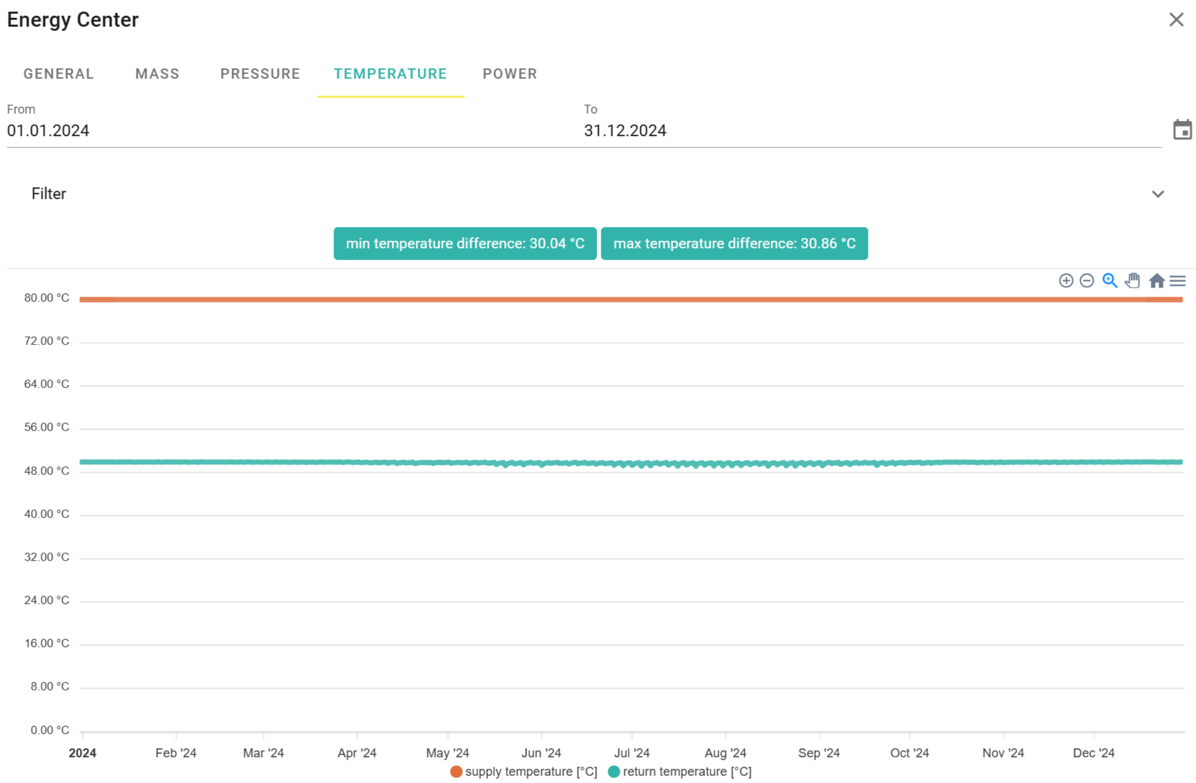

Figure 37: Temperature supply and return load curves at the producer.

Figure 37 shows temperature supply set at 80°C and temperature which gets returned after feeding the grid, that varies in 48°C.

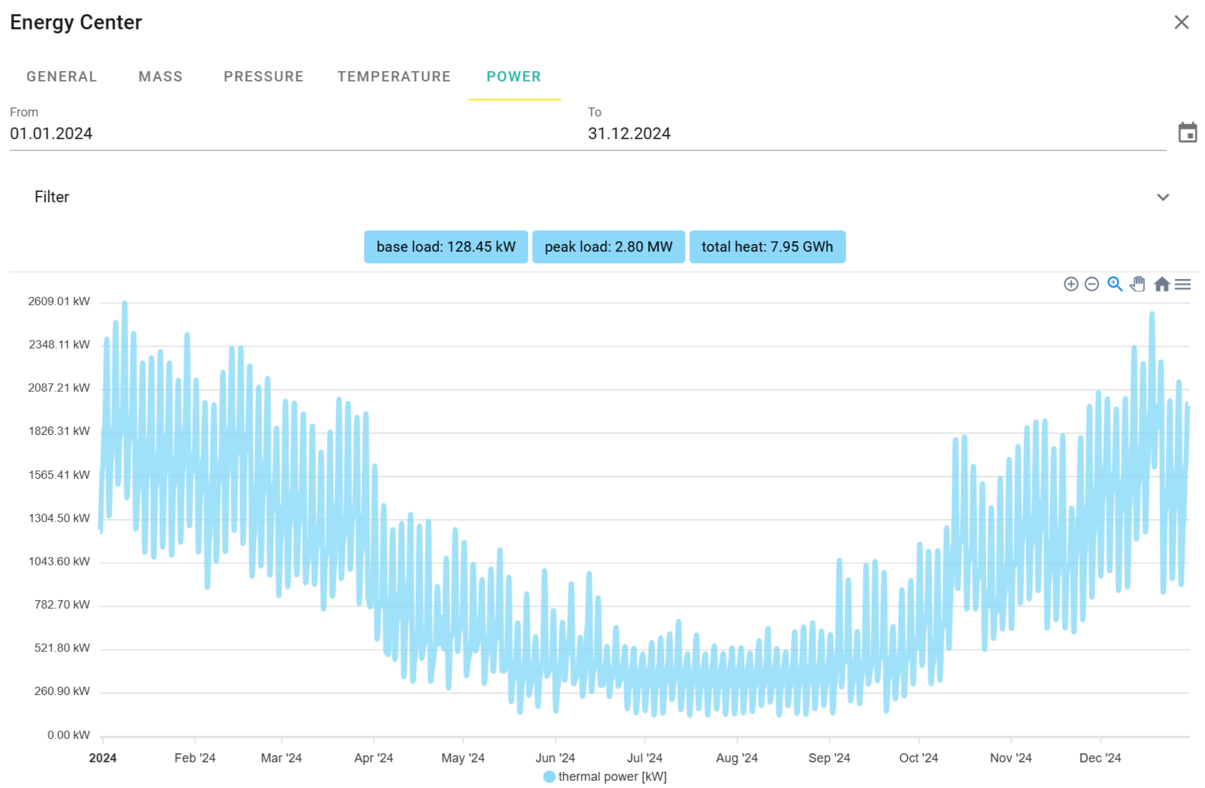

Figure 38: Thermal power calculated at the producer.

Figure 38 shows thermal power generation at the producer to satisfy the needs the grid. Base load is 128.45 kW, peak load is 2.80 MW during winter and fall season, and total heat is 7.95 GWh.

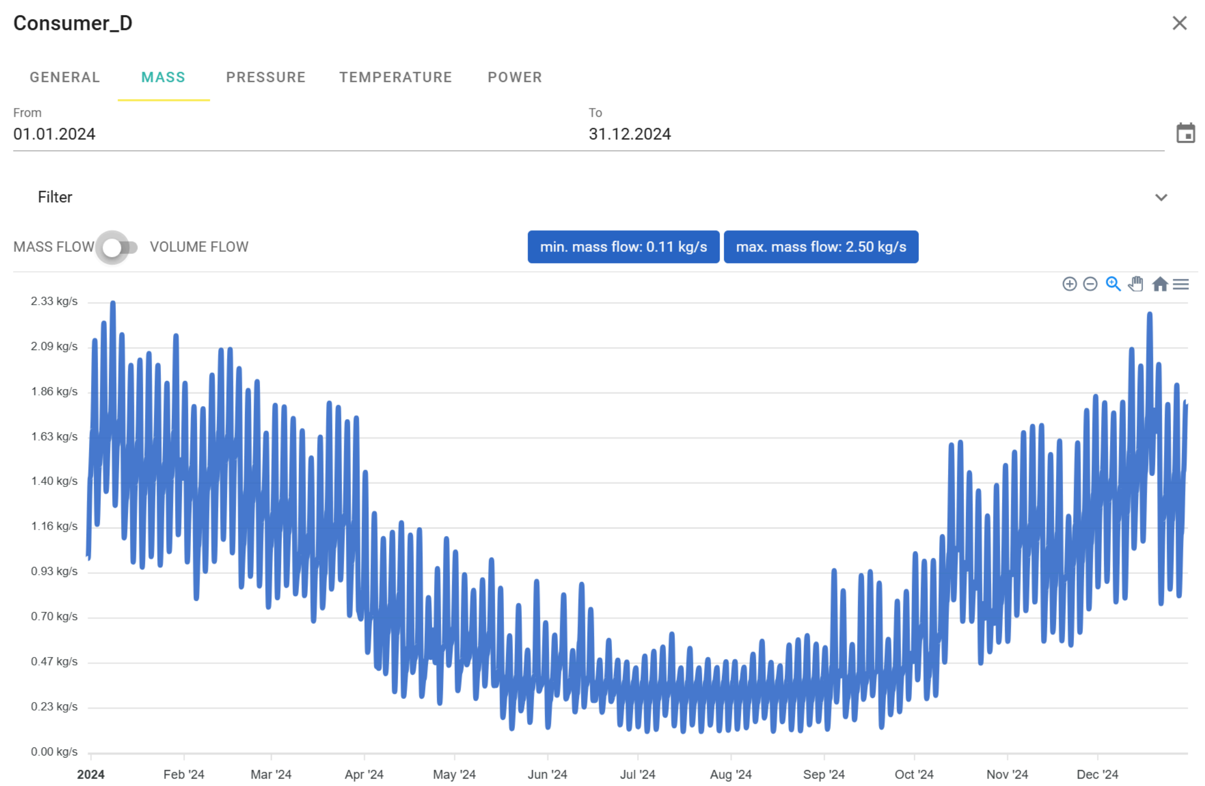

Figure 39: Mass flow load curve of one consumer.

Figure 39 shows the visualization of demand low curves, when comfort temperature is lowered to 15°C. This is a sufficiency scenario, and these results are essential to understand how a decision of inhabitants to lower the comfort temperature can have impact on PED goals. Minimal mass flow is 0.11 kg/s during summer and spring season, whereas maximal mass flow is 2.5 kg/s during winter and fall season.

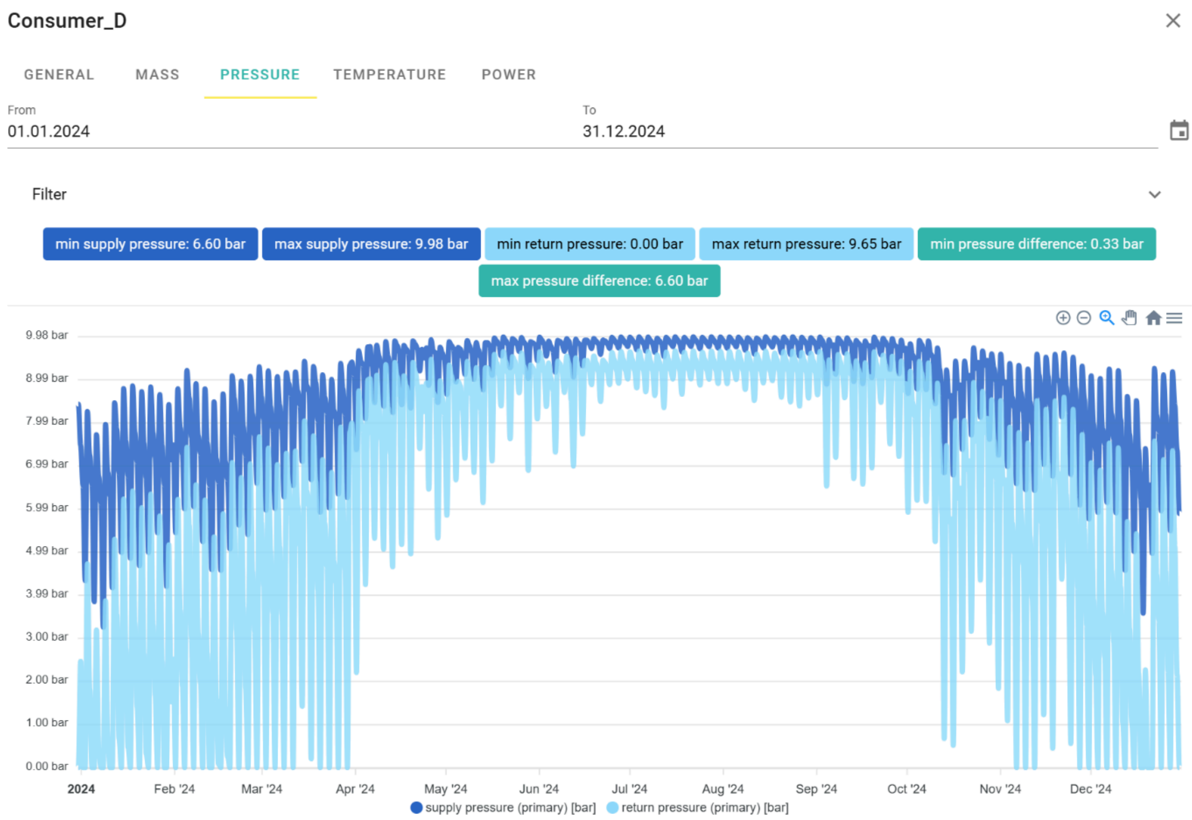

Figure 40: Pressure supply and return load curves of one consumer.

Figure 40 shows pressure that is supplied from the grid to this one consumer and the pressure return represents the pressure that returns to the grid pipes. Minimal supply pressure is 6.60 bar, maximal supply pressure is 9.98 bar, minimal return pressure is 0 bar, maximal return pressure is 9.65 bar, minimal pressure difference is 0.33 bar and maximal pressure difference is 6.60 bar.

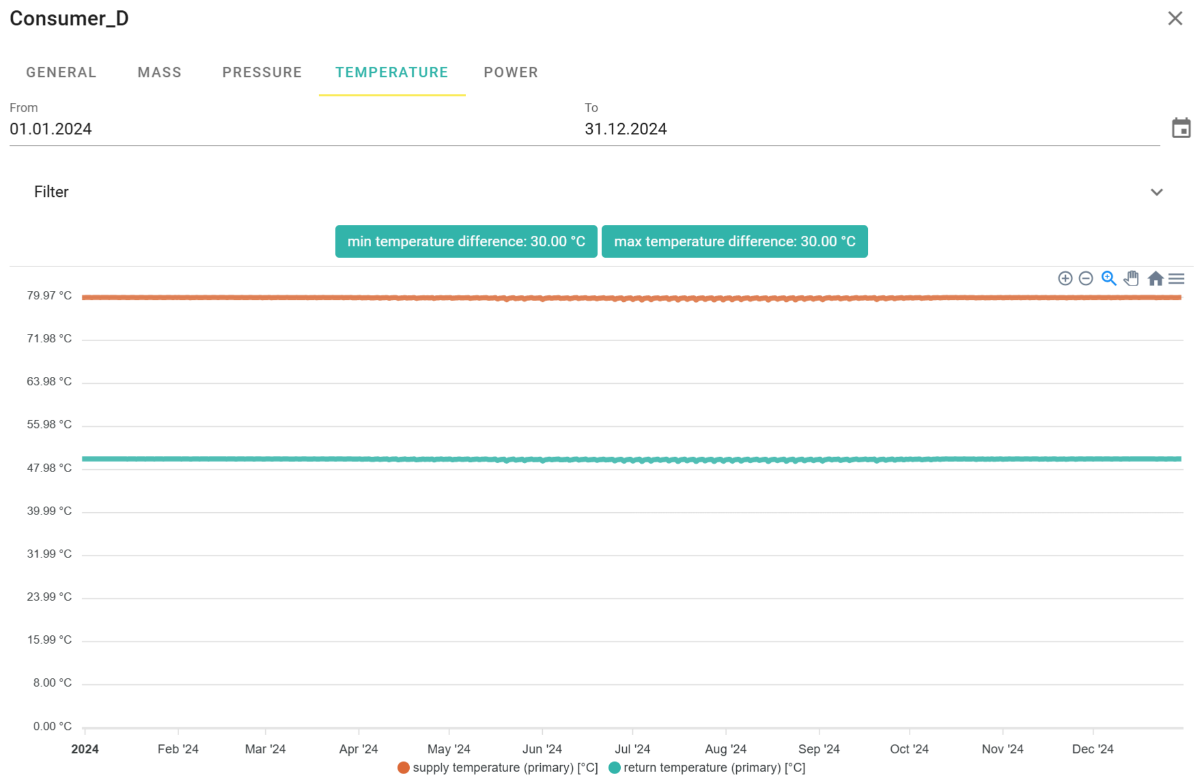

Figure 41: Temperature supply and return of one consumer.

Figure 41 shows supply and return temperature of one consumer. Temperature difference is 30°C.

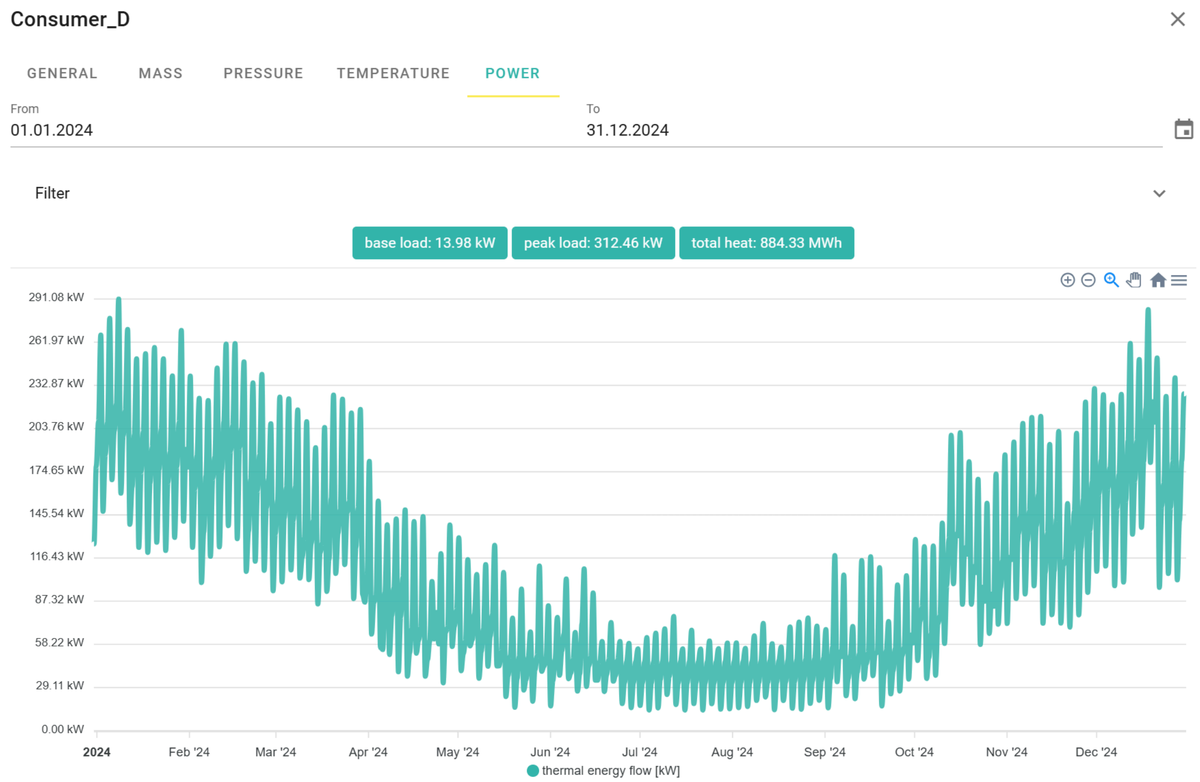

Figure 42: Thermal energy flow of one consumer.

Figure 42 shows thermal energy during year 2024 in one of the consumers. Base load is 13.98 kW, peak load is 312.46 kW and total heat is 884.33 MWh.

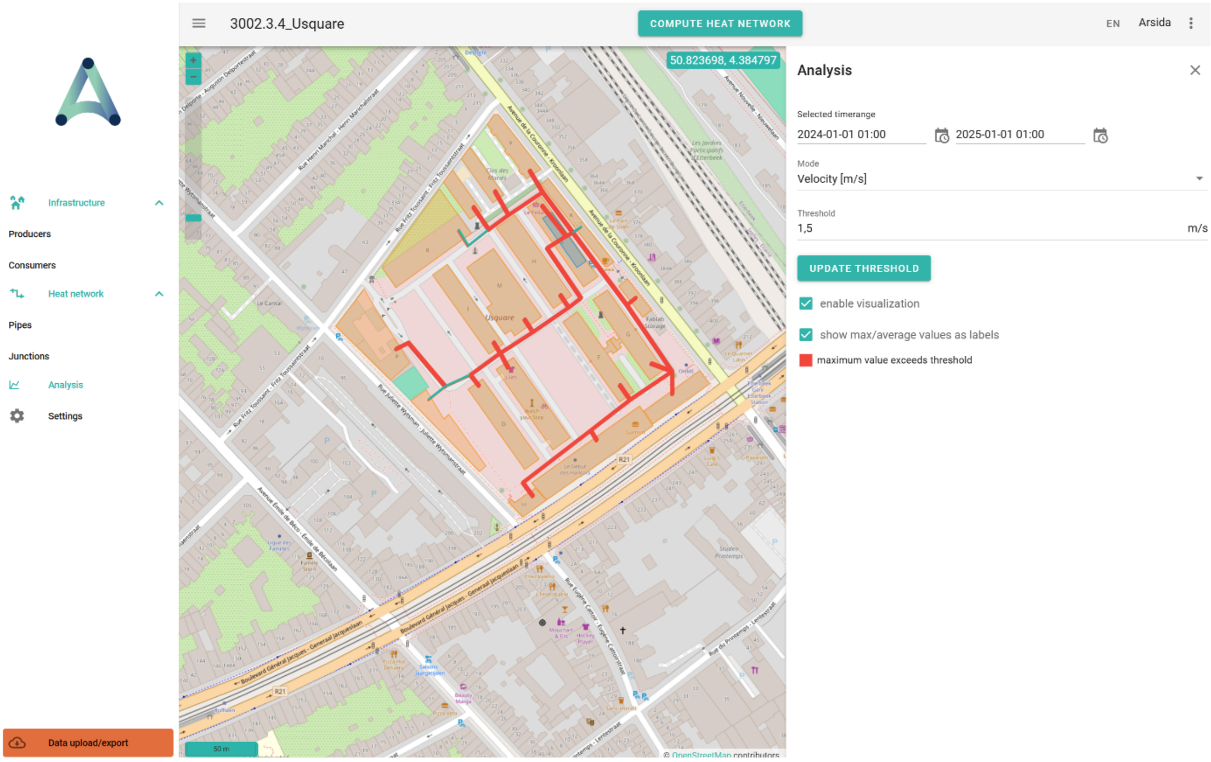

Figure 43: Pipe velocity in the grid.

In figure 43 is shown the analysis section with a yearly timeframe represents the velocity threshold. If I set the velocity threshold to 1.5 m/s, then as it can be seen in the figure the pipe velocity in Usquare exceeds this threshold. However, this can be set by the user in Arteria Platform, depending on what analysis on the district heating network needs to be done.

8.2. Scenario 2: Lowering comfort temperature to 18°C

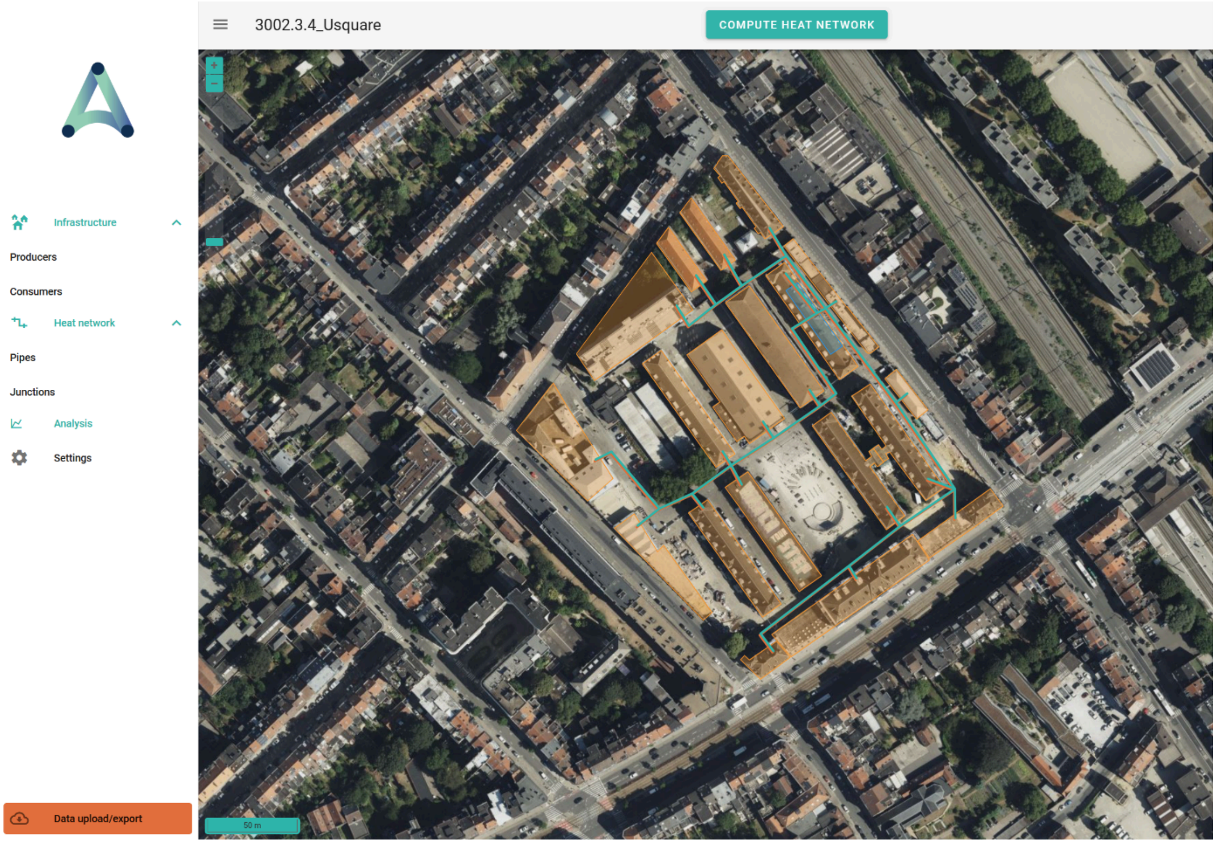

Figure 44: Sufficiency second scenario modelled in Arteria Platform.

Figure 44 represents the second sufficiency scenario modelled in Arteria Platform. New power demand profiles and mass flows are used as input to Arteria simulation model. Below are visualized results on this specific scenario.

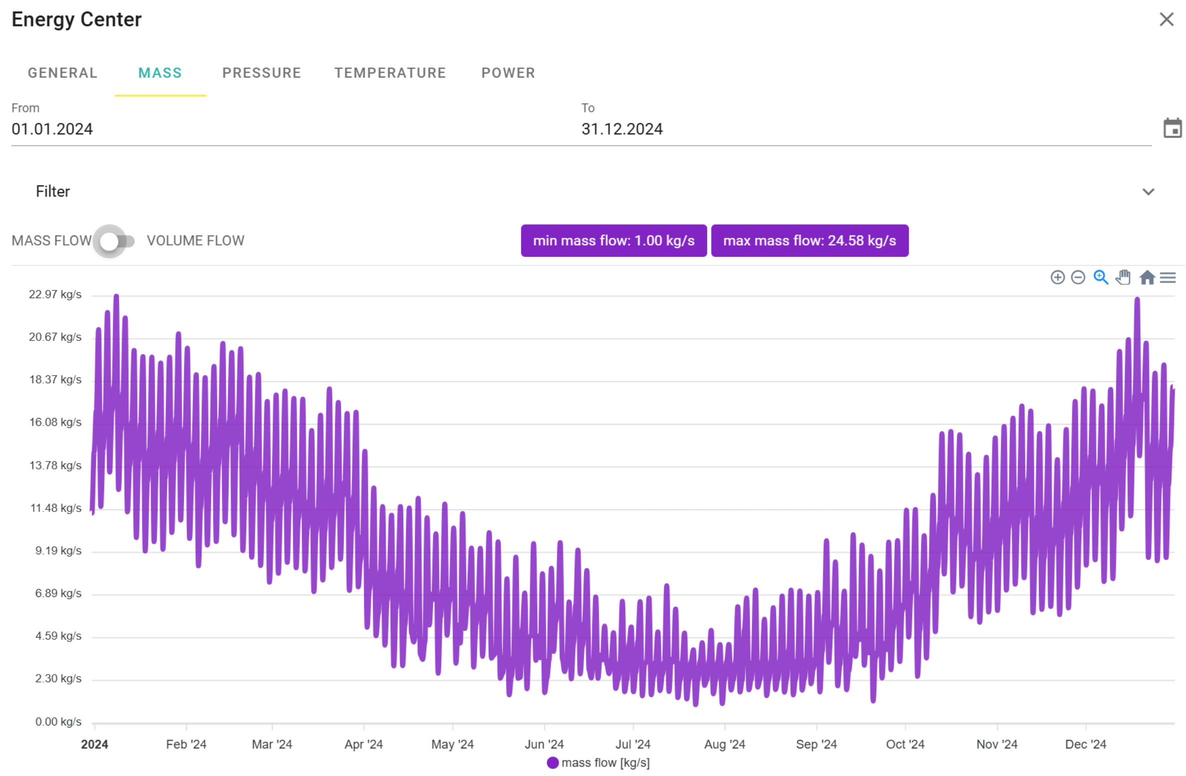

Figure 45: Mass flow at the producer.

Figure 45 shows the mass flow load curve at the producer. In comparison to the previous scenario, the maximum mass flow here is around 3 kg/s higher. Minimal mass flow is the same as the one in the previous scenario, 1kg/s.

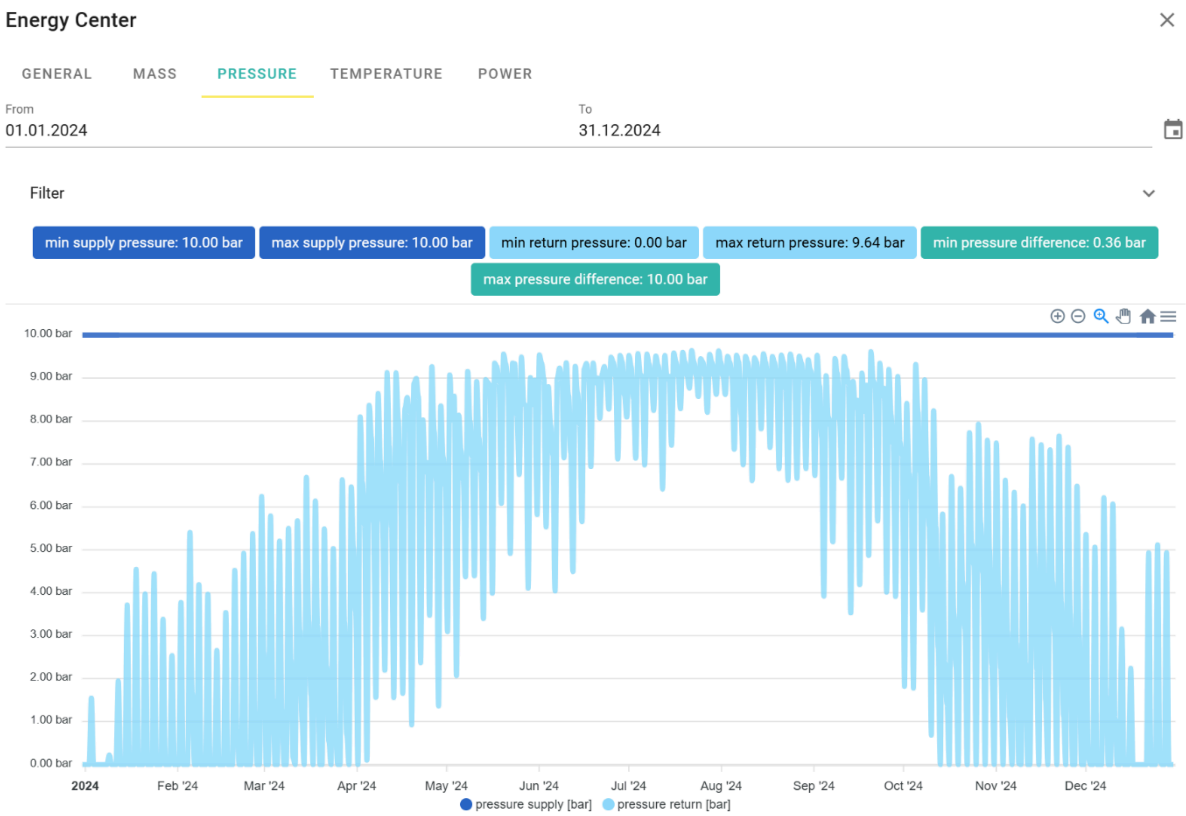

Figure 46: Pressure supply and return load curves at the producer.

Figure 46 shows pressure load curves at the producer. Default pressure supply is set at 10 bar. Minimal pressure return in 0 bar, maximal pressure return is 9.64 bar, minimal pressure difference is 0.36 bar and maximal pressure difference is 10 bar.

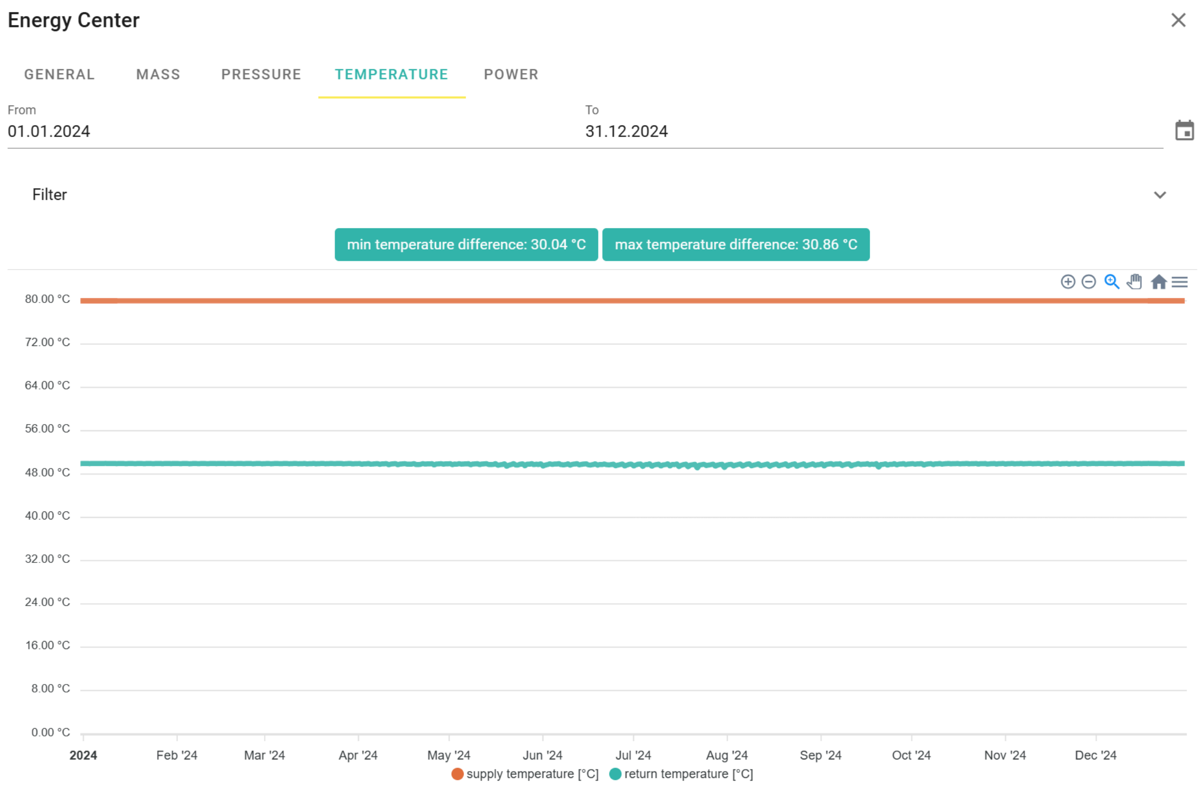

Figure 47: Temperature supply and temperature return at the producer.

Figure 47 shows temperature supply and temperature return load curves at the producer. The temperature difference is 30°C.

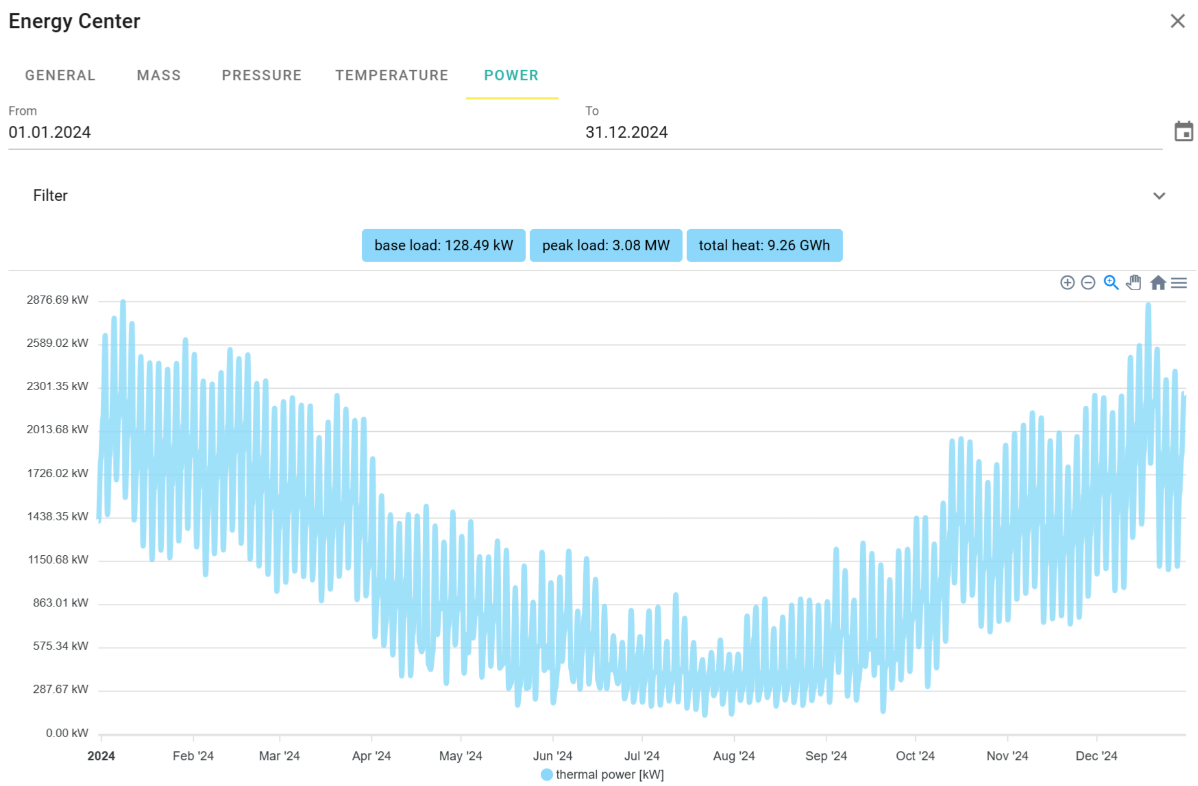

Figure 48: Thermal power generation at the producer.

Figure 48 shows power generation at the producer to satisfy the need of the grid. In comparison to the previous scenario, this scenario has around 2 GWh higher total heat value. This shows the difference as well between the comfort level of 15°C vs. of 18°C.

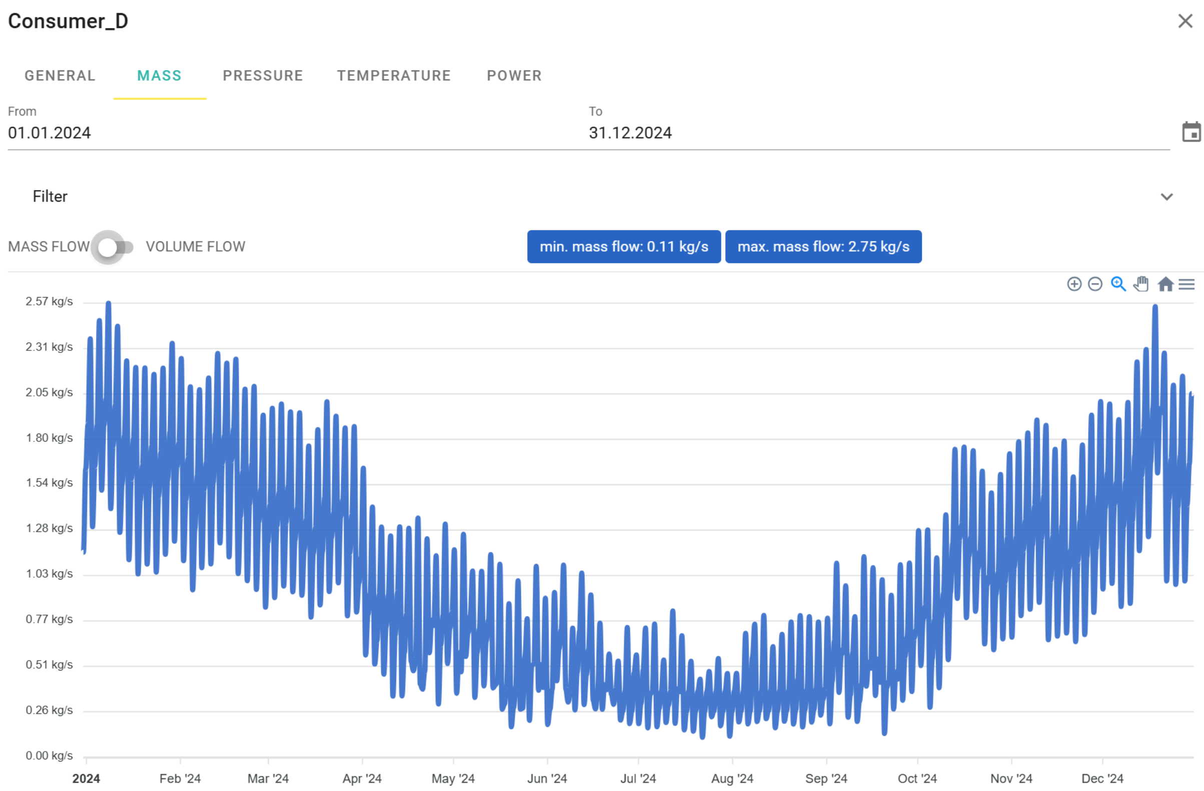

Figure 49:Mass flow load curve at one consumer.

Figure 49 shows the mass flow load curve at consumer "Consumer_D". In comparison to the previous scenario, maximal mass flow is 2.75 kg/s, meaning around 0.30 kg/s higher.

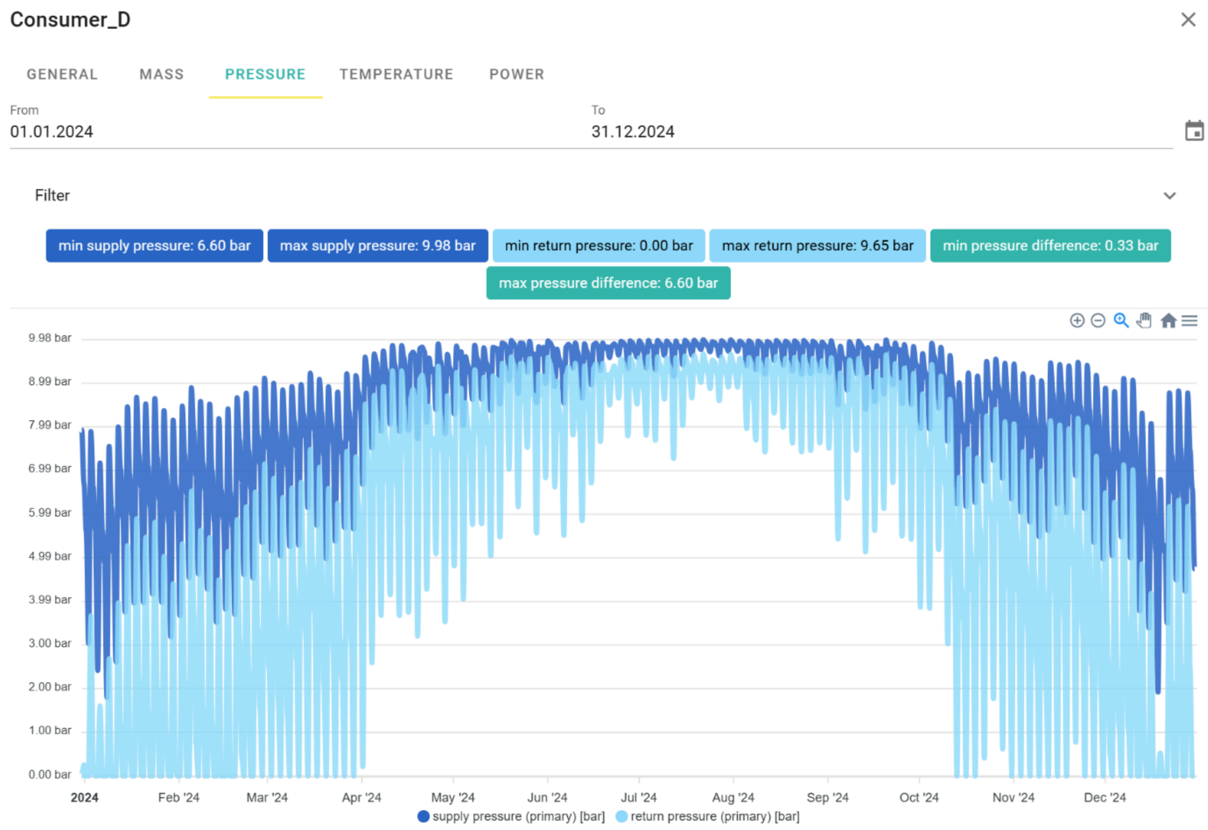

Figure 50: Pressure supply and pressure return load curves at one consumer.

Figure 50 shows pressure supply and pressure return load curves at one consumer. Minimal pressure supply is 6.60 bar, maximal pressure supply is 9.98 bar, minimal return pressure is 0 bar, maximal return pressure is 9.64 bar, minimal pressure difference is 0.33 bar and maximal pressure difference is 6.60 bar.

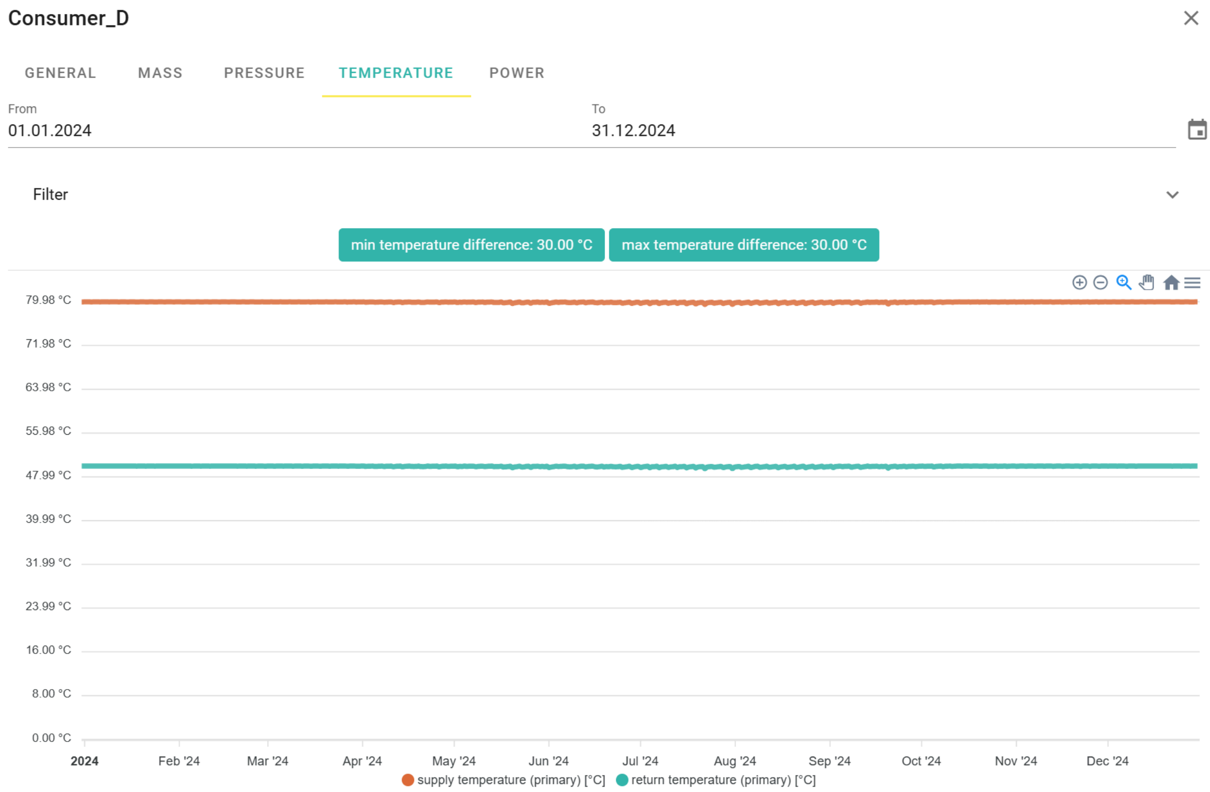

Figure 51: Temperature supply and return load curves at one consumer.

Figure 51 shows temperature supply and return load curves at one consumer, with temperature supply being around 79°C and temperature return being around 47°C.

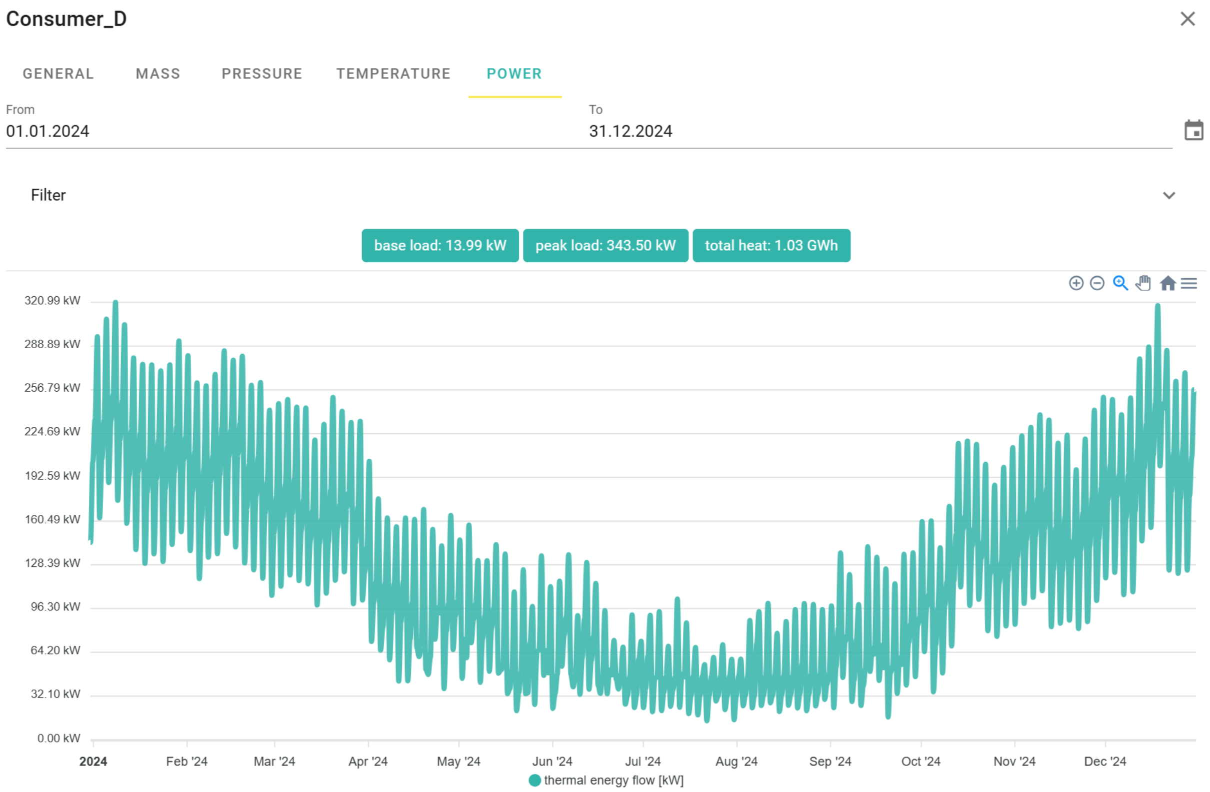

Figure 52: Thermal energy flow at one consumer.

Figure 52 shows the thermal energy flow at one consumer. Base load is 13.99 kW, peak load is 343.50 kW and total load is 1.03 GWh.

8.3. Comparison Analysis Between Two Scenarios

To compare the two scenarios, Arteria has performed an efficiency analysis on the two district heating networks, with the power data generated by our simulation tool. To calculate the efficiency of a district heating network, we have compared the total thermal energy supplied by the producer with the total thermal energy consumed by all the consumers over a given period.

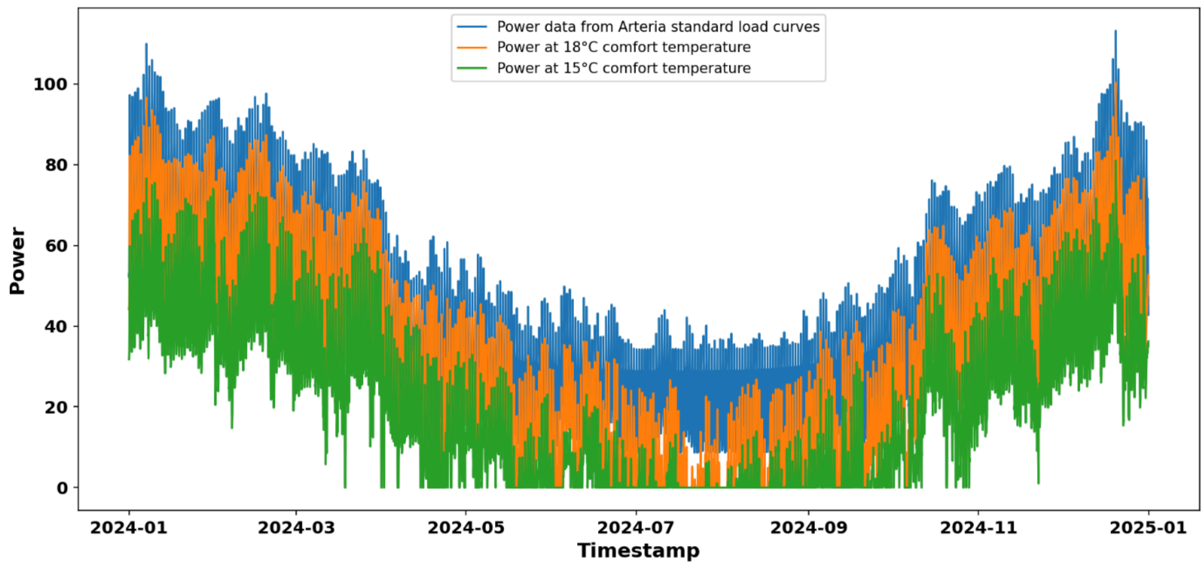

Figure 53: Power data for one consumer at different comfort temperature levels.

Figure 53 shows three power load curves at one consumer of Usquare heating network. Blue line represents Arteria power standard profiles for that specific consumer. Orange line represents power data when comfort temperature is set at 18°C and the green line represents power data when the comfort temperature is set at 15°C.

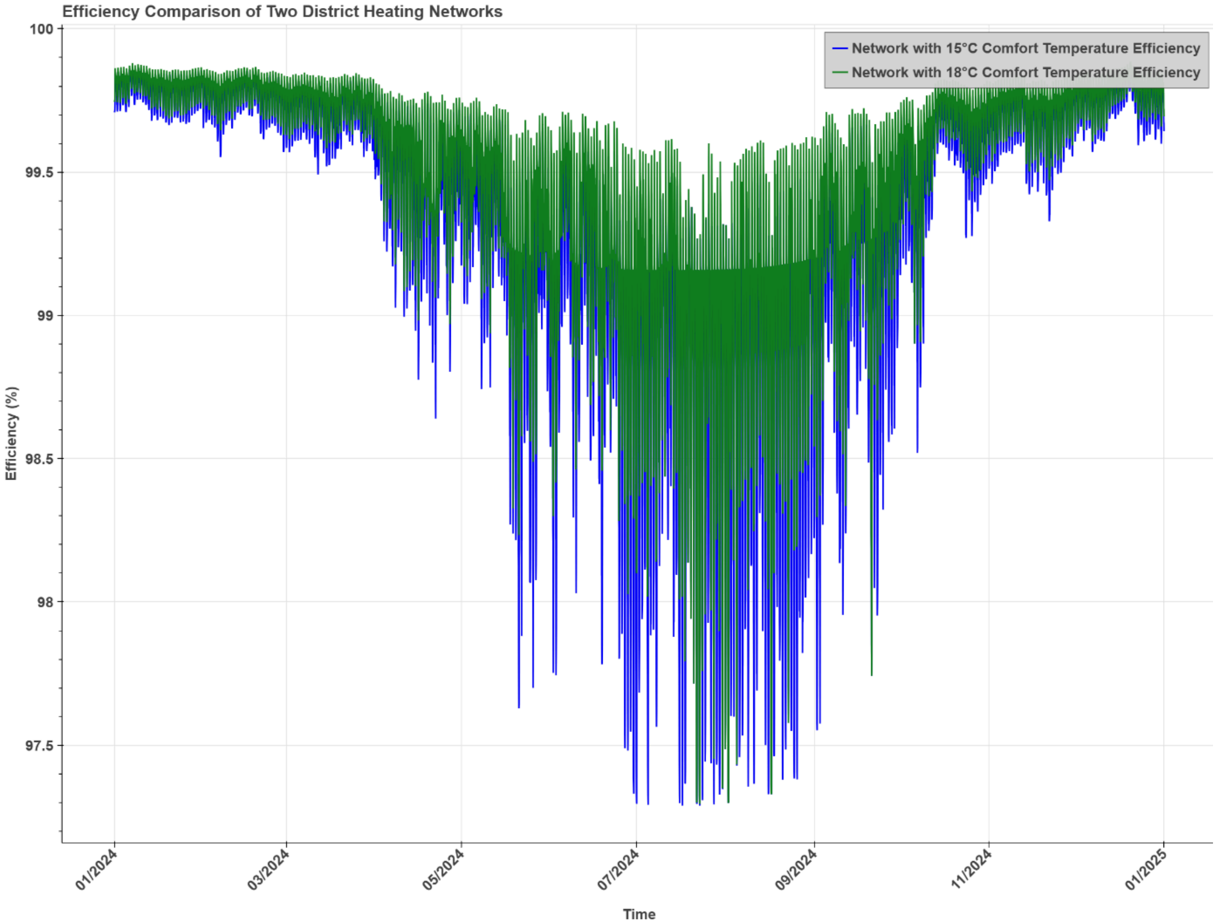

Figure 54: Efficiency plot of two district heating networks.

Figure 54 shows two curves of two district heating networks efficiency throughout the year. As seen from the figure, the network with consumer comfort temperature set at 18 degrees has a slightly higher efficiency and lower loss as the other network which has a lower comfort temperature. This is to be expected as the temperature difference between indoor and outdoor is smaller, system operating in a more stable range and lower distribution losses.

Table 1: Seasonal and overall efficiency table for two district heating networks.

	Overall efficiency	**Efficiency in winter season**	**Efficiency in spring season**	**Efficiency in summer season**	**Efficiency in fall season**
Network 1 at 15°C comfort temperature	99.61%	99.74%	99.32%	99.83%	99.60%
Network 2 at 18°C comfort temperature	99.66%	99.77%	99.44%	99.02%	99.67%

Table 1 shows efficiency values of seasonal and overall efficiency in each network. Network 1 has lower overall efficiency than network 2. In summer season we see another behavior of the grid, where network 1 has a slightly higher efficiency in comparison to the second network. However, this can happen due to factors which as well model real-world scenarios, such as overcompensating with higher comfort temperature in the case of network 2.

Scenario with 18°C comfort temperature has higher power supply at the plant compared to the one at 15°C comfort temperature. Also, efficiency at 15°C is lower as the mass flow rate is higher compared to 18°C. The mass flow values are a bit higher than the ones expected in a real-world scenario. Due to this reason and the fact that the district network of Usquare is small, there is a low thermal loss.

9. Living Lab Bari

Arteria has integrated buildings in a target area in Bari. These buildings all have different characteristics and consist of different types of units. Project partners in Bari collected input data to create a scenario in Arteria. This data consists of roof area, ground area and power demand (MWh p.a) in terms of electricity, as well as thermal heat usage and warm water usage, in each unit. The results of this scenario will be analyzed below.

9.1. Scenario 1: Model in Arteria building profiles of target area and compute building power.

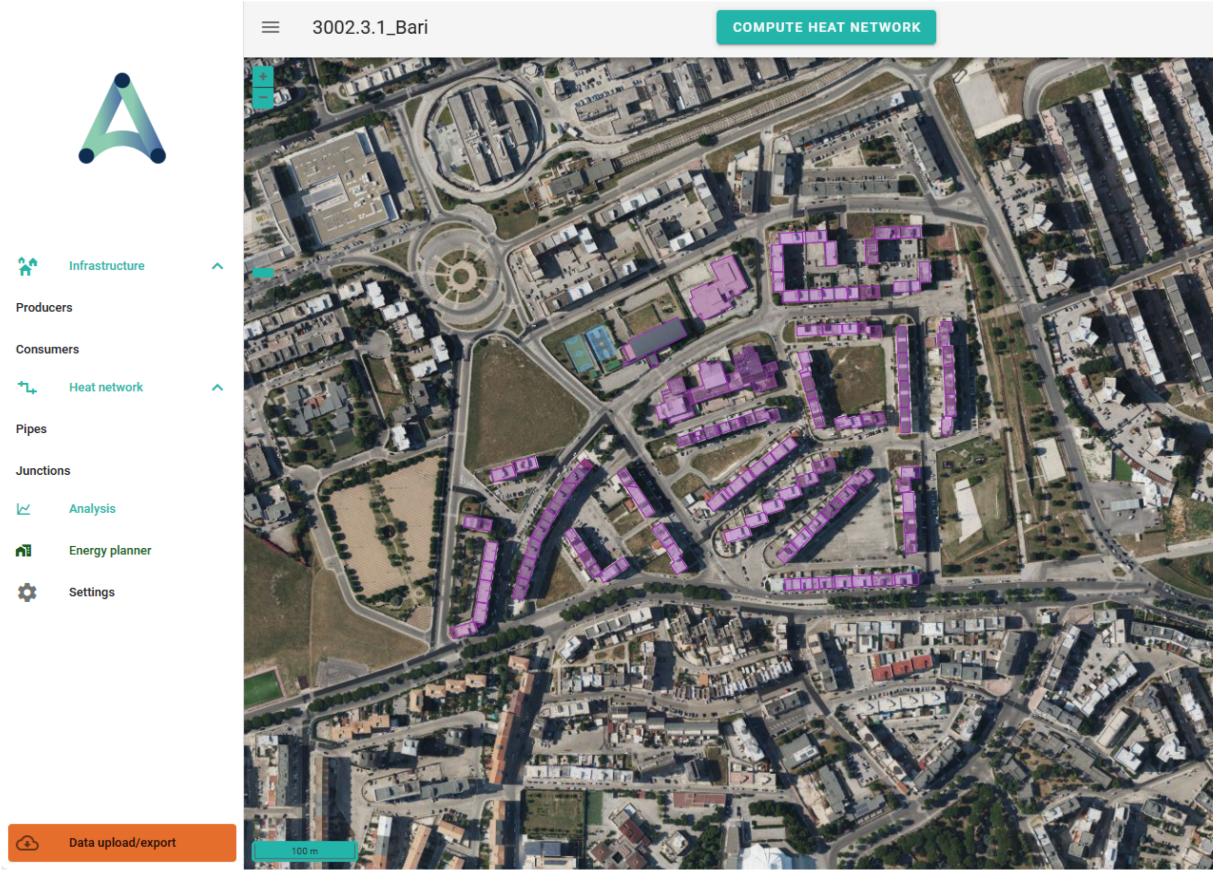

Figure 55: Bari target area scenario modelled in Arteria Platform.

Figure 55 shows target area with buildings in Bari, modelled using Arteria Platform. The data is taken from GIS files and converted into buildings geometries in Arteria. Further input data, which help to calculate the building power are roof area, ground area, power demand, thermal heat usage and warm water usage. In each building there is a PV installed with an assumption of generating 20% of roof area kWp.

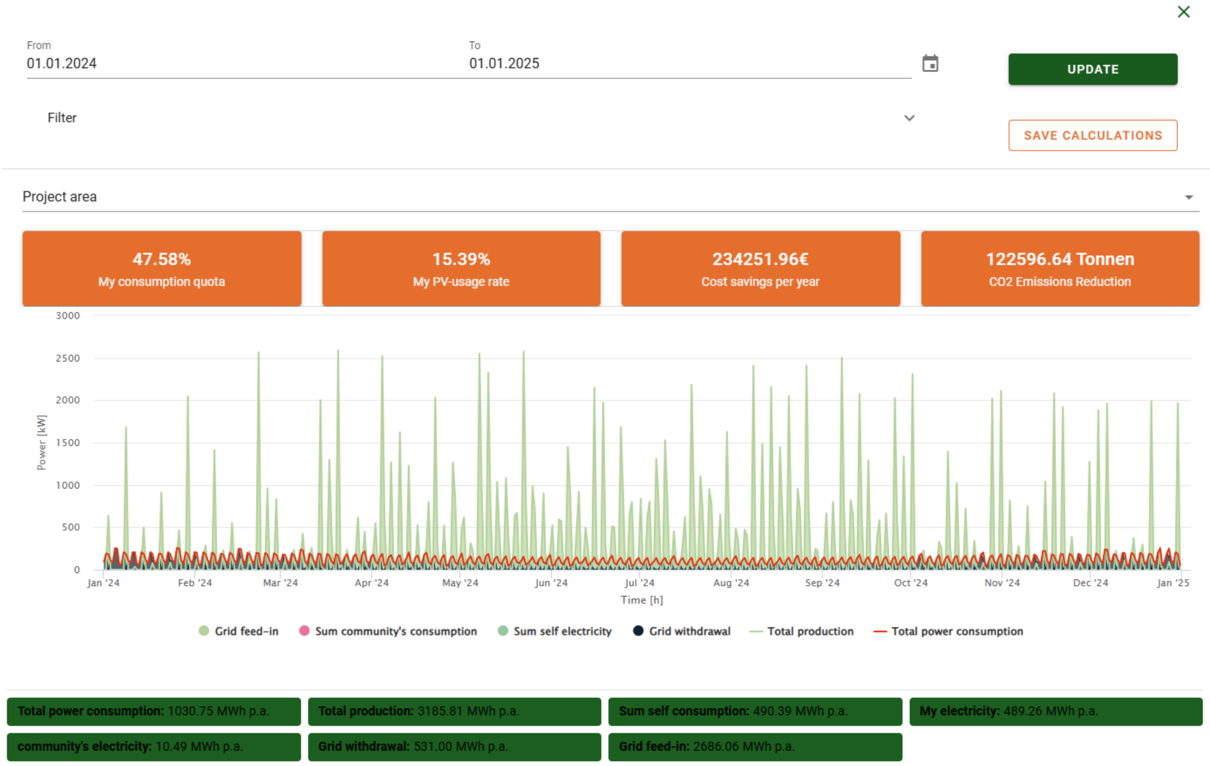

Figure 56: Yearly building power calculation in Bari.

Figure 56 shows yearly calculated power data in terms of electricity in the whole target area of Bari. As seen from the figure there are 47.58% consumption quotes, 15.39% PV usage rate, 234251.96-euro cost savings per year and 122596.64 Tons CO2 emissions reduction.

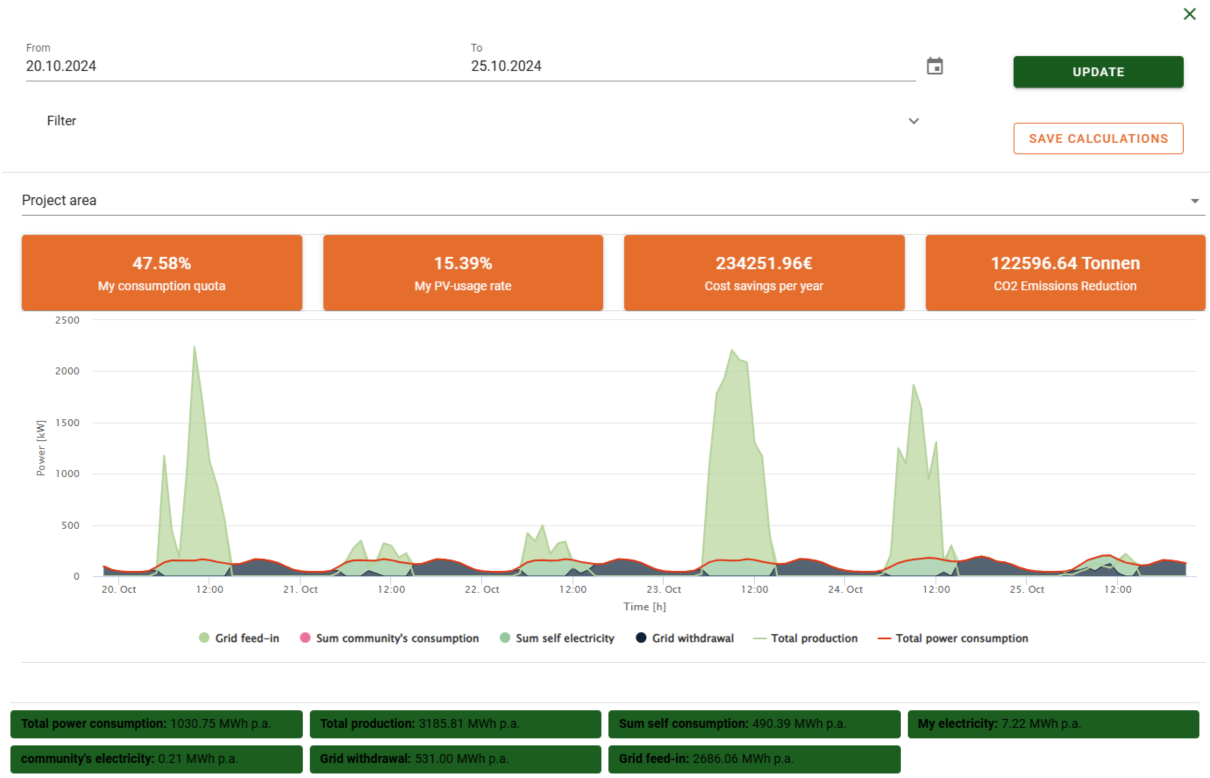

Figure 57: Weekly building power calculation in Bari.

Figure 57 shows weekly calculated power data in terms of electricity in the whole target area There is a total power consumption of 1030.75 MWh p.a, Total production of 3185.81 MWh p.a, sum self-consumption of 490.39 MWh p.a , self-electricity of 7.22 MWh p.a, community's electricity of 0.21 MWh p.a , grid withdrawal of 531 MWh p.a and grid feed-in of 2686.06 MWh p.a.

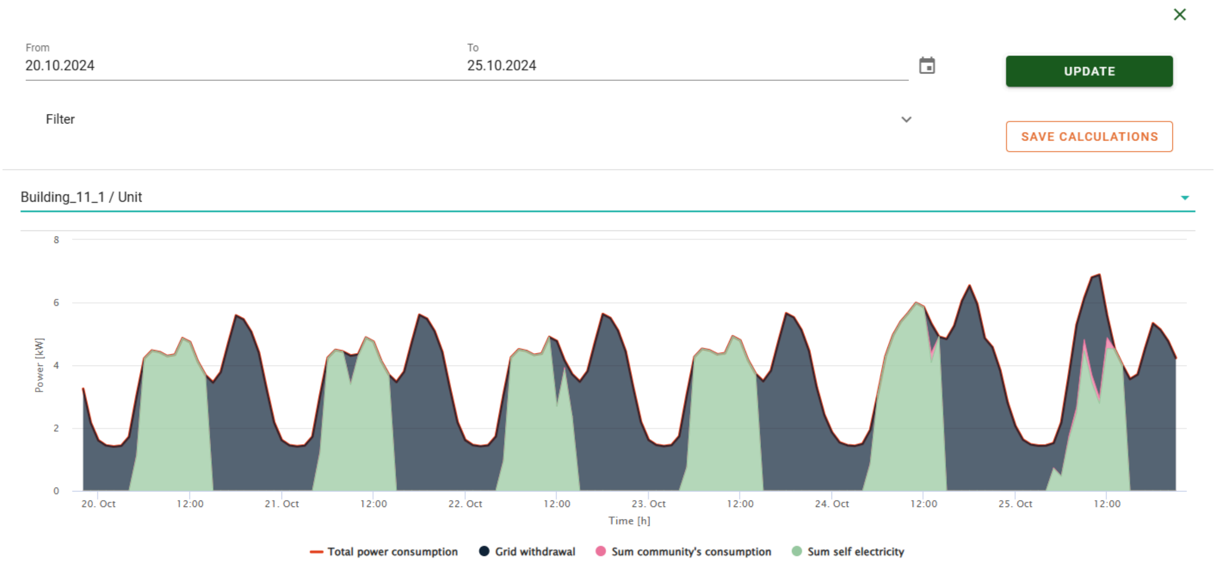

Figure 58: Power building profile of Building 11_1

Figure 58 shows power profiles of Building 11_1. The green lines represents sum of self-electricity and the black line represents grid withdrawal.

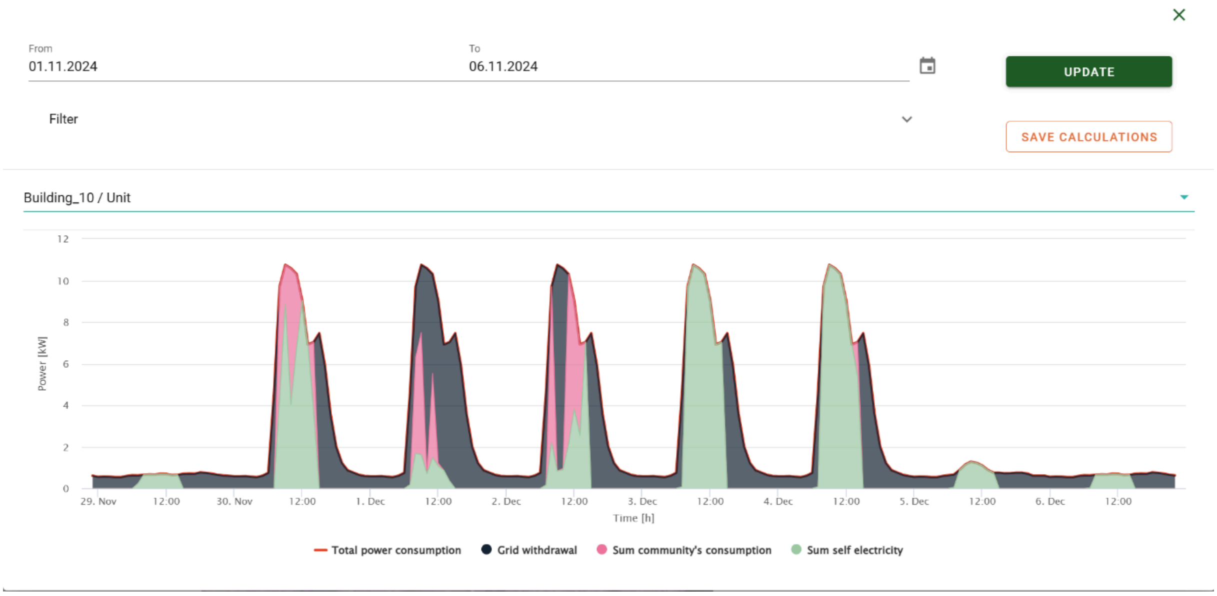

Figure 59: Church power calculation in Bari.

Figure 59 shows power calculations of a church located in the target area of Bari. Based on the input data of the project partners this building can not have PV installed on the rooftop. Therefor we can see in the graph the pink line which represents the community power generation which is high especially during the peak of the day 12 o'clock.

10. Conclusion and recommendation

In conclusion, the D3.4 deliverable presents a comprehensive and detailed exploration of energy strategies aimed at achieving Positive Energy District (PED) goals within the unique contexts of four living labs: Kahlenbergdorf, Usquare, La Roue, and Bari. These living labs each face distinct urban, environmental, and social challenges, requiring tailored approaches to maximize energy efficiency and sustainability. The report's analysis of district heating networks, individual heat pumps integrated with photovoltaic (PV) systems, and energy demand reduction scenarios provides valuable insights into how these technologies and strategies can be optimized to significantly lower carbon emissions, enhance energy self-sufficiency, and reduce reliance on non-renewable energy sources.

The report highlights the effectiveness of district heating networks, which enable more efficient and equitable distribution of heat across multiple buildings, and individual heat pumps combined with PV systems, which promote decentralized renewable energy generation. Furthermore, behavioral strategies such as lowering comfort temperatures in apartments demonstrate the potential impact of occupant behavior in achieving energy conservation. Varying participation rates in district heating networks, as well as scenarios replacing gas-based systems with heat pumps and PV, offer a broad spectrum of energy-saving options for different urban settings.

The implementation of these strategies through the Arteria Technologies software platform adds another layer of depth to the findings. Arteria Technologies, a sophisticated tool for planning and optimizing district heating networks, has integrated these PED scenarios, providing practical and actionable insights. The simulations conducted using this platform demonstrated the viability and benefits of these strategies in real-world conditions. By comparing different strategies in diverse living labs, the platform showcased how district heating and renewable energy technologies could be efficiently scaled and customized to local needs. This combination of cutting-edge technologies and well-planned strategies highlights the importance of leveraging digital tools to drive sustainability forward in urban environments.

The overall goals of the PED strategies are clear: to reduce total energy consumption, significantly decrease carbon emissions, and foster energy independence in urban districts. Achieving these goals not only addresses pressing climate change concerns but also contributes to the creation of resilient and self-sufficient urban communities. Moreover, these strategies emphasize long-term benefits for residents, including lower energy costs, enhanced comfort, and a reduction in environmental impact.

The findings from the simulations underscore the need for adaptable, locally-tailored solutions to maximize the potential of PEDs. By integrating renewable energy sources and reducing energy demand, the living labs show that PED strategies can be both effective and scalable. The success of the scenarios explored in Kahlenbergdorf, Usquare, La Roue, and Bari further reinforces the importance of cross-city collaboration in advancing sustainable energy solutions.

Ultimately, the D3.4 report not only provides a roadmap for achieving PED goals in these specific living labs but also offers a blueprint for other urban areas striving to transition towards sustainable energy systems. The combination of advanced energy technologies, strategic planning, and innovative software solutions like Arteria Technologies demonstrates the transformative potential of PEDs in tackling global energy challenges. Through continued refinement and implementation of these strategies, cities around the world can adopt PED models that promote cleaner, greener, and more energy-efficient urban environments.

11. References

Byrne, J.,Taminiau J., Kurdgelashvili L. and Kim N. K. A review of the solar city concept and methods to assess rooftop solar electric potential, with an illustrative application to the city of Seoul. Renewable and Sustainable Energy Reviews, 2015. https://doi.org/10.1016/j.rser.2014.08.023

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This project has received funding from the European Union's Joint Programme Initiative Urban Europe programme.