H2020 Work Programme

D5.6 - REPLICATION STRATEGY OF SO WHAT IN EASTERN EUROPE

Lead Contractor: **MEDGreen**

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Executive Summary

The present deliverable is summarizing the results that have been obtained in the activities of the WP5 and particularly in the Task 5.4 – Replication studies

The replication activities have been organized within the demo sites that were selected by the project consortium members. The replication activities, outside the consortium, was possible through stakeholders group mobilized in WP7,. In this way it has been possible to identify additional case studies where private companies and/or public bodies external to the consortium have evaluated the possibility of making new investment for industrial waste heat/cold recovery.

New potential projects have been characterized in terms of demand, boundary conditions, end-users' requirements and other several aspects.

The objective of all these activities was to accompany through such studies the mobilization of new projects interested and supporting the implementation of waste heat/cold and/or RES installation.

The activities of replication in Slovakia, have been done in partnership between MEDGreen and an SME – INTRAVIS, located in Kosice, specialized in the development and operation of gasification plants. Their recently commissioned plant in Snina, was mainly focused on the production of electricity. With the support f soHWat partners and tools, it has been possible to evaluate the possibility to identify a customer for waste heat and to prepare the support information for initiating the contacts with target customers and start the negotiations for a possible future deal.

The activities in Bulgaria, have bee developed in partnership between MEDGreen and a public institution – Technical University of Varna – TUV. At present, TUV is developing a broad program of modernization with the support that has been obtained from the Government, as part of the assistance programs of the EU. In this way there were refurbished the campus buildings with modern solutions, and the buildings were insulated for improving the energy efficiency. As a result, the thermal plant of the University gained an extra capacity of 2.9 MW. In this context, with the support of the soWHat consortium partners and tools there were evaluated the best options to use such an extra capacity by selling the surplus heat to the neighbouring institutions.

With the replication cases in Slovakia and Bulgaria, it has been possible to extend the potential geography and the sectors addressed by the future commercial tools.

Abbreviations

°C: Celsius degrees

B2B: Business to Business

B2C: Business to Consumer

CAPEX: CAPital EXpenditure

CHP: Combined Heat and Power

COP: Coefficient of Performance

DH: District Heating

DHCN: District Heating and Cooling Networks

EII: Energy Intensive Industries

ESCO: Energy Service COmpany

EU: European Union

OPEX: OPerating EXpense

RES: Renewable Energy Sources

ROI: Return On Investment

SME: Small and Medium Enterprises

WH/C: Waste Heat/Cold

WHR: Waste Heat Recovery

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1 Introduction

The replication activities in South-East Europe have been developed based on the evolution of District Heating systems in the different countries and the evolutions in the industrial sectors and services. At the same time, there were taken into consideration similarities to the validation case in Romania.

As a consequence, there were selected two replication cases in Slovakia and in Bulgaria.

The replication case in Slovakia has been developed by the involvement of a company -INTRAVIS- specialized on the manufacturing, development and operation of gasification plants.

Figure 1. WTE gasification plant in Snina, Slovakia

The typical gasification plants that are manufactured by INTRAVIS are designed to operate with biomass, agricultural waste and municipal waste. In the gasification plant, the main product is the syngas that is obtained from the gasification reactor. At the same time, there are waste heat streams from the gasification reactor, syngas clean-up and conditioning and ancillary equipment. The usual type of applications consists on the integration of waste heat in different possible applications.

Their recently commissioned plant in Snina, was mainly focused on the production of electricity. With the support f soHWat partners and tools, it has been possible to evaluate the possibility to identify a customer for waste heat and to prepare the support information for initiating the contacts with target customers and start the negotiations for a possible future deal.

In Bulgaria the replication case has been developed in partnership with the Technical University of Varna. The reason was that the university inherited a thermal power plant for the heating purpose of the university campus.

In the last decade, based on the rehabilitation of the campus buildings, the demand for thermal energy has been significantly reduced, but the capacity of the thermal plant was optimized for higher flows of thermal energy. By the operation of the plant at lower capacity, the efficiency is reduced. As a consequence, it has been identified the possibility to sell extra capacity of thermal energy to other possible customers located in the neighbourhood.

Figure 2. Campus of the Varna Technical University

Within the activities carried-out in the Task 5.4, with the support of the soWHat consortium partners and tools there were evaluated the best options to use such an extra capacity by selling the surplus heat to the neighbouring institutions of the TUV.

2 Replication studies in Slovakia

2.1 INTRAVIS Ltd

2.1.1 Description of the Site

INTRAVIS is a Slovak SME located in Kosice. Last year, the company developed a new project in the city of Snina, located in the NE part of Slovakia to produce electricity and heat from waste materials and biomass that are available in large extent on site. Feedstock material was considered with main component being the waste derived fuels - TDP (certified type of waste based fuel) and variety of biomass waste materials.

Total land area is 3690 m^2 including buildings for technology and employee facilities and the main components include the following: Feedstock intake and indoor storage - 122 m^2; Closed industrial hall for Gasification line - 430 m^2; Closed industrial hall for CGUs placement - 203 m^2.

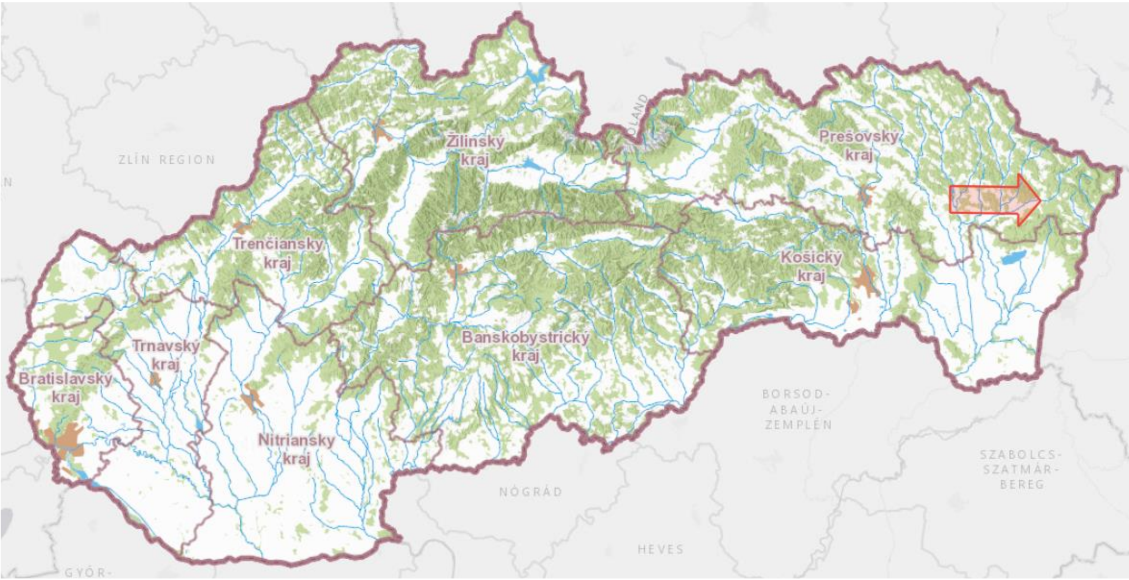

Figure 3. Location of the WTE gasification plant in Snina

The location of the plant has been modelled using Sketch-up Pro and imported in the iSCAN platform, as it can be seen in the figure below.

In figure 4 there are presented the details of the physical model of the site. As it might be seen in the model, the site in an old industrial site located in the East part of Slovakia.

In the area there were, some old buildings belonging to some old companies that meanwhile have been taken over by some new companies. There are some support programs for encouraging the local industrial companies and related activities in order to facilitate economic development of the region and creation and securing of jobs.

For INTRAVIS the opportunity was created by such support programs and abundance of wood waste materials in the region that are creating a pressure on the environment.

So, the WTE plant of INTRAVIS in Snina is specialized in neutralization of waste and production of electricity. At present, the produced heat was not considered in the income balance of the company as an income.

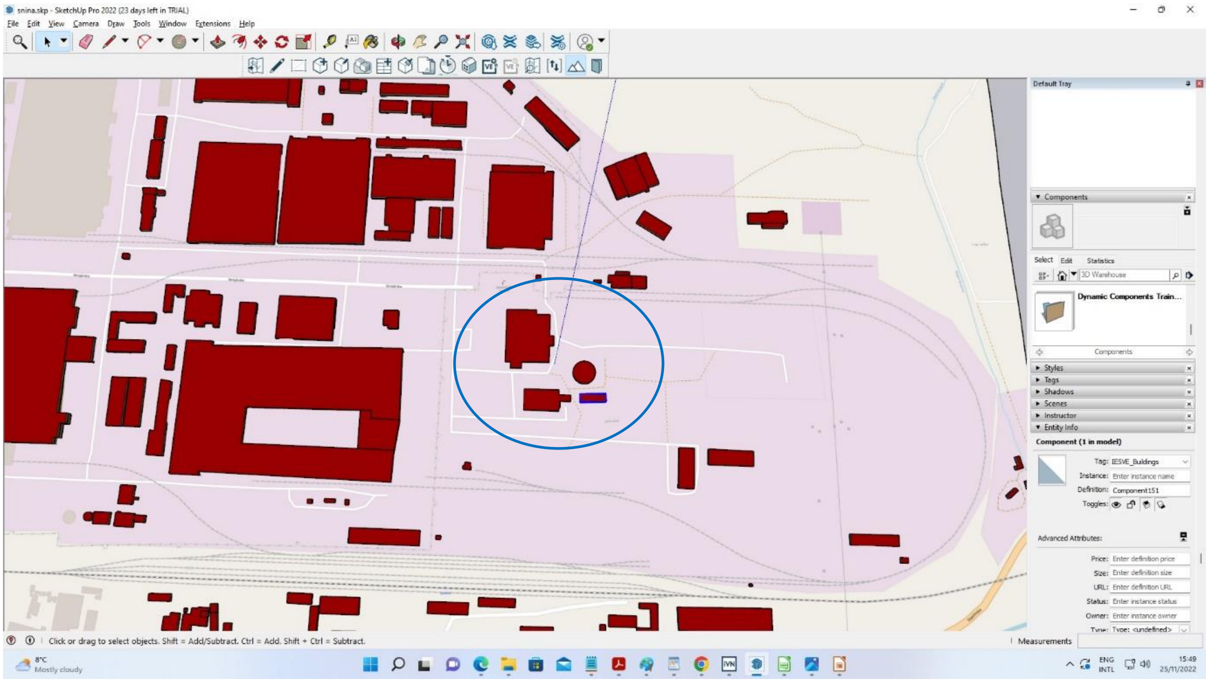

Figure 4 Sketch-up model of the site

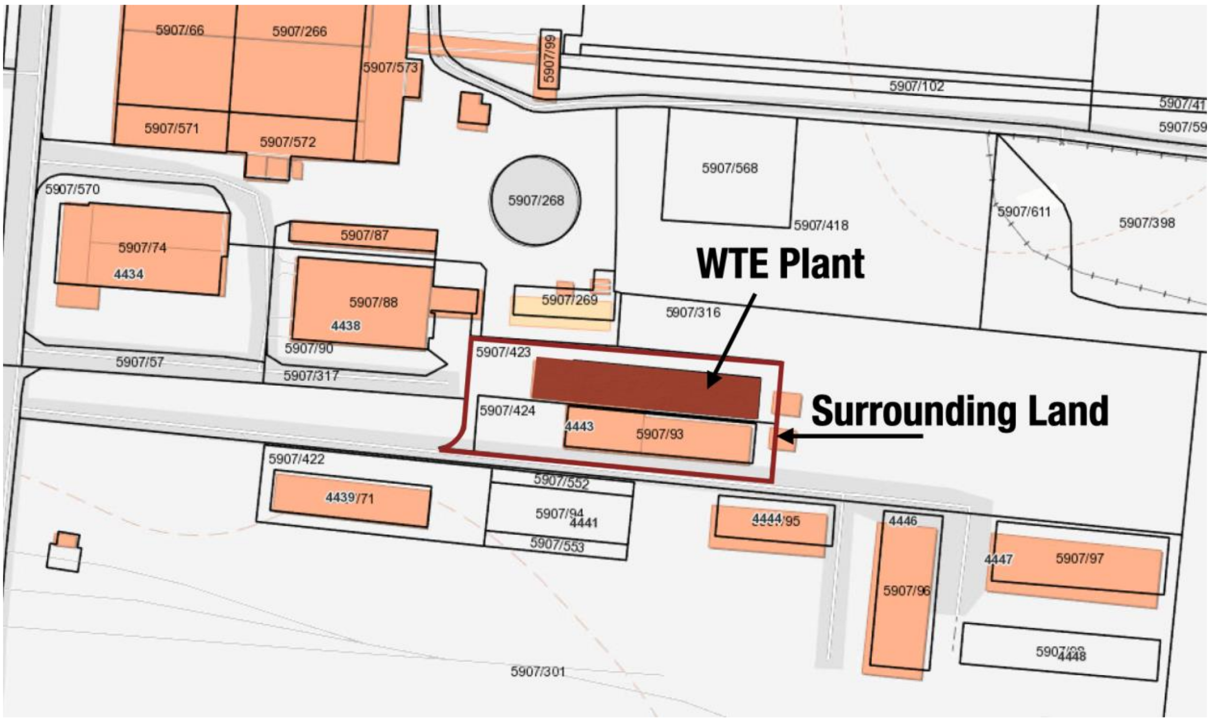

Figure 5. Detailed model of the site

The plant is located in an industrial area of the city of Snina and there are some other industrial companies that are located in the neighbourhood.

2.1.2 Analysis of Energy Consumption of the Site

Production efficiency

For the WTE Plant of INTRAVIS in Snina, by the properly matched systems components and the sophisticated and proven technology, a high efficiency of the system is achieved. The individual processes have been optimized through experience and reach a thermodynamic efficiency of up to 93%.

Most of other competitive solutions remain with an efficiency of 85% and in most cases significantly behind. Overall efficiency of the process with low potential heat is 65% with an electric efficiency of 22% (ratio of generated electrical energy to energy content in the fuel) and thermal efficiency of 43% (ratio of extracted thermal energy to energy content in the fuel).

Gas utilisation

In a designated room, gensets from German company R Schmidt Enertec with capacity of 250kWe are installed for electricity generation. Produced energy is used to cover own consumption of the plant and the rest is supplied to the grid. R Schmitt Enertec's engines are characterized by high quality and high efficiency - both electric and thermal.

The main characteristics of the plant are as followings:

Item	
Installed capacity	500 kWe
Running time (annual)	7 500 hours
Feedstock consumption (annual)	4 550 tons
Electrical output (annual)	3 700 MWh
Thermal output (annual)	5 600 MWh

As it may be seen from the figures above, it is a small plant that is assuring by the gasification of waste biomass and RDF the sygas to feed 2 cogeneration units with internal combustion engines.

The residential area is in the city and region is surrounded by forests and wood exploitations. Therefore, the main feedstock for heating in the region is wood and there are available other types of fuels as natural gas and liquid fuels.

For these reasons, it has not been taken into consideration the possibility of selling the heat from the WTE plant and the sustainability of the investment has been conceived based on the existing local factors as cheap biomass, relative low cost of labour in the region and the subsidies for investment.

In this way the lonely income was considered as the income from the electricity. Based on the support offered by MEDGreen and other partners from the soWHat consortium it has been initiated an evaluation of the site and using IESVE it has been taken into consideration the possible need for heating in the neighbouring building.

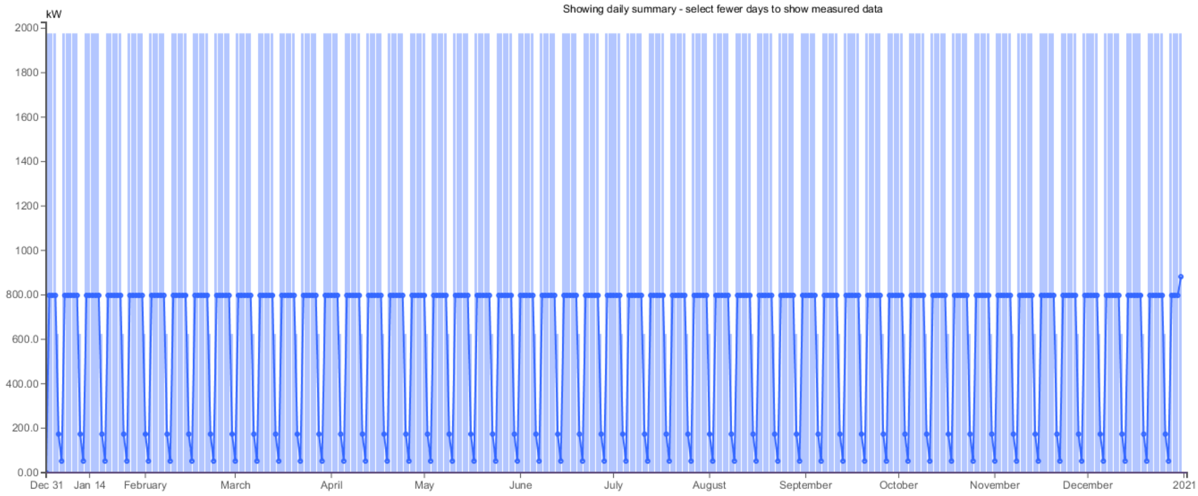

Figure 6 – Hot water demand load

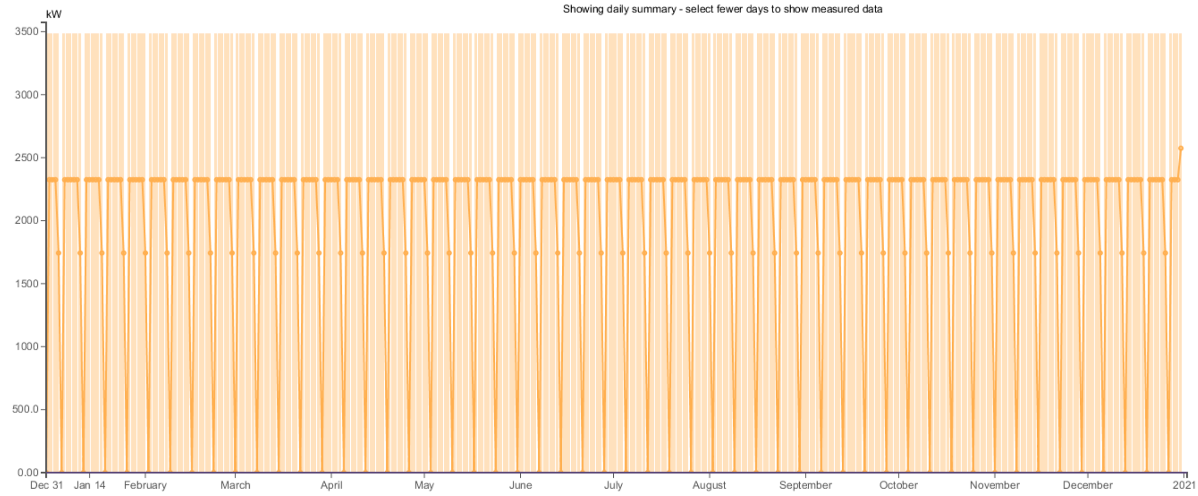

Figure 7 – Simulated auxiliary energy

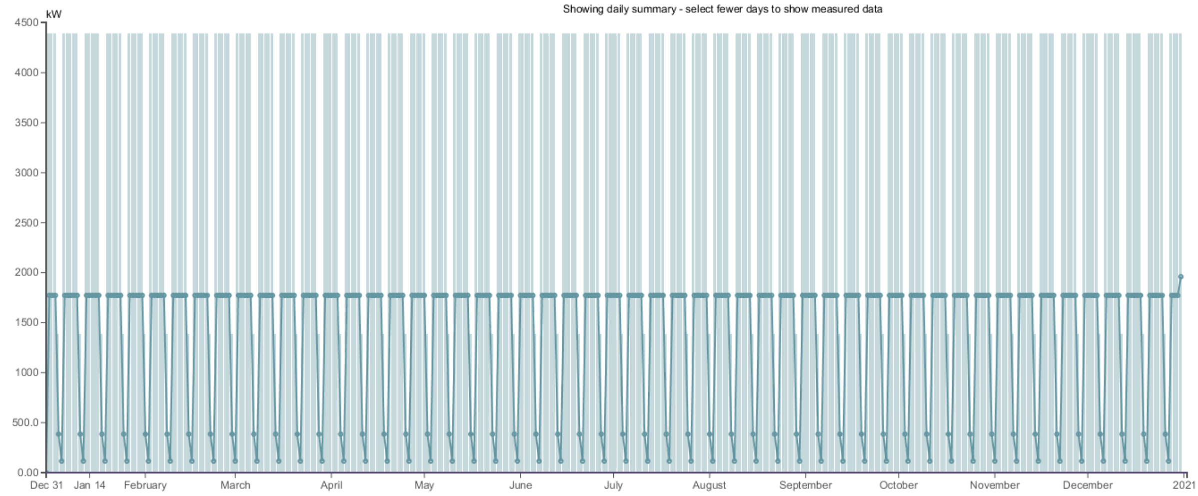

Figure 8 - Simulated heating energy demand

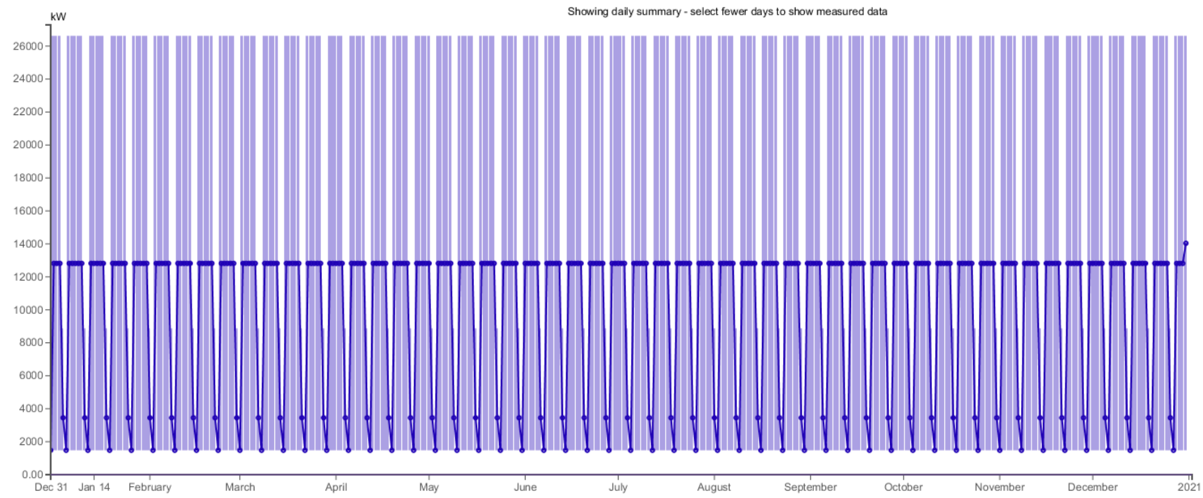

Figure 9 - Simulated demand of energy for different equipment

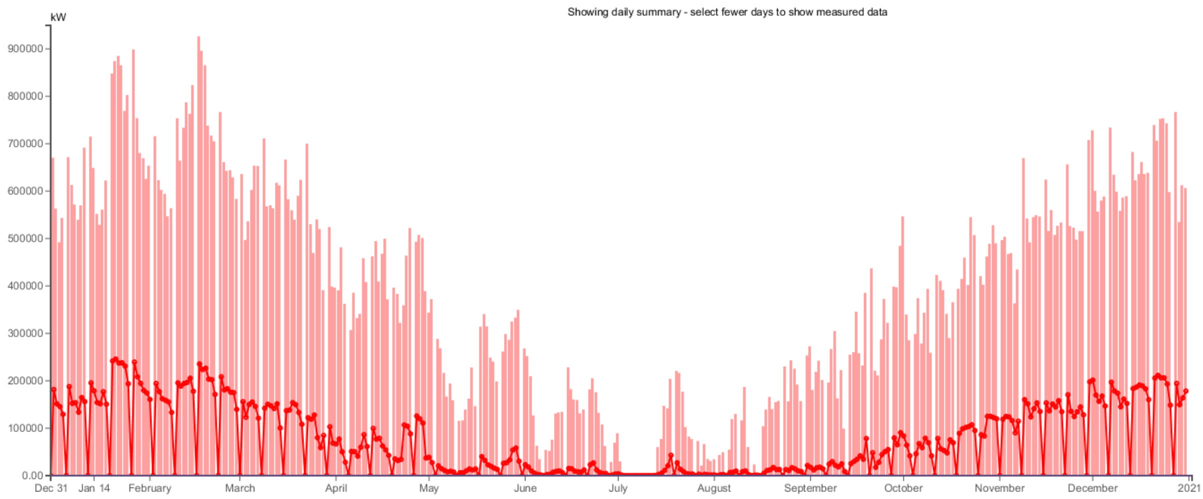

Figure 10 – Simulated heating energy for building

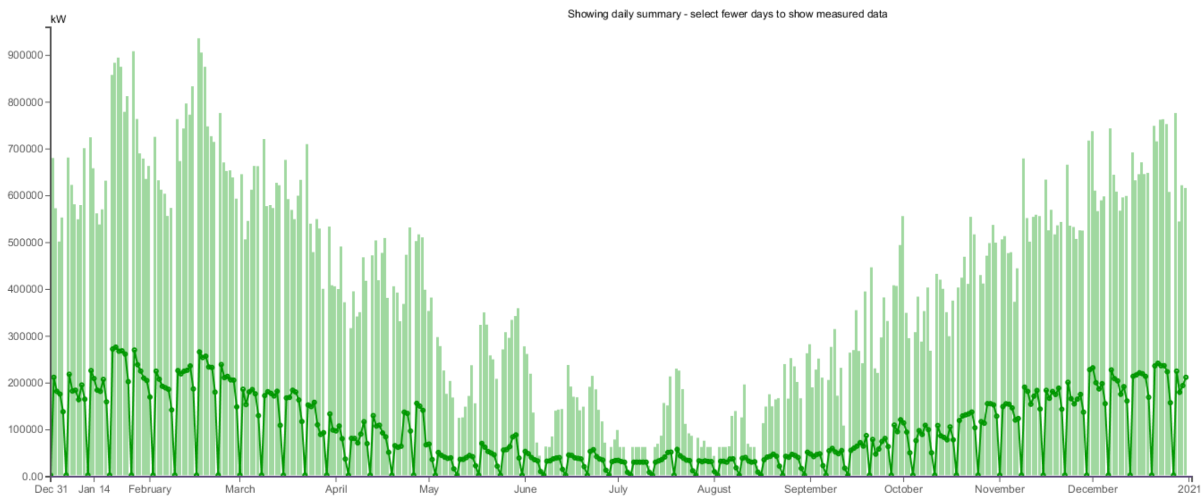

Figure 11 - Simulated total energy

As it can be seen from the figures 6 – 12, there is the opportunity to provide constantly heat for the specific processes of a company specialized on plastic waste processing during the entire period of the year.

The energy required for heating and domestic hot water by the possible customers in the area, is following the usual seasonal variations, connected with the existing local meteorological data, which was imported into the simulation.

2.1.3 Identification of Potential WHR/WCR or RES Opportunities

The INTRAVIS gasification technology is designed to permanently maintain the quality and characteristics of produced syngas even in spite of fluctuations in the input material.

Gasification technology supplied by INTRAVIS has the advantage of low operation and maintenance requirements and costs, low requirements on input fuel and high efficiencies of conversion (solid to gas).

The power plant has achieved an approval for utilization of Waste-derived fuel by fulfilling the process of the Environmental Impact Assessment process (EIA), as the first gasification plant in our region.

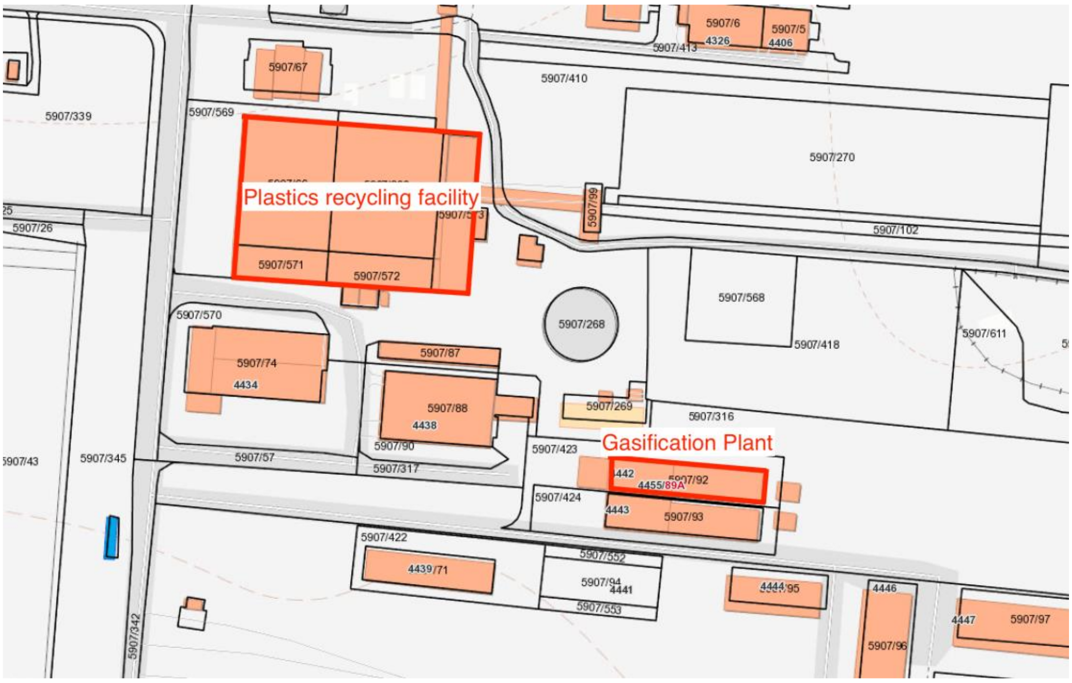

Figure 12 Customer identification and connectivity for waste heat supply

Potential customer for produced heat is a nearby plastic recycling facility. The facility processes plastics from MSW and manufactures secondary products out of it. The process is energetically demanding, moreover, the heat is required for heating of the facility.

- General info:
- Distance from CGU - 155 m

- Electricity demand - 300 kWe / 2 250 MWh annually
- Heat demand - 150 kWt (85/75°C) / 1 125 MWh annually

2.1.4 Evaluation of Energy Savings and Avoided GHG Emissions

The technology for energy production based on the gasification of waste is environmentally friendly and the residual materials such as created charcoal are utilized in a separate way. All filter fillings are further used within the process even after the end of their operating life and technological water is circulated and cleaned within the closed circuit.

The existing data was fed into the IES application in order to analyse the energy demand, especially for heating, domestic hot water and process heating. The results for the plastic recycling facility can be visualized below:

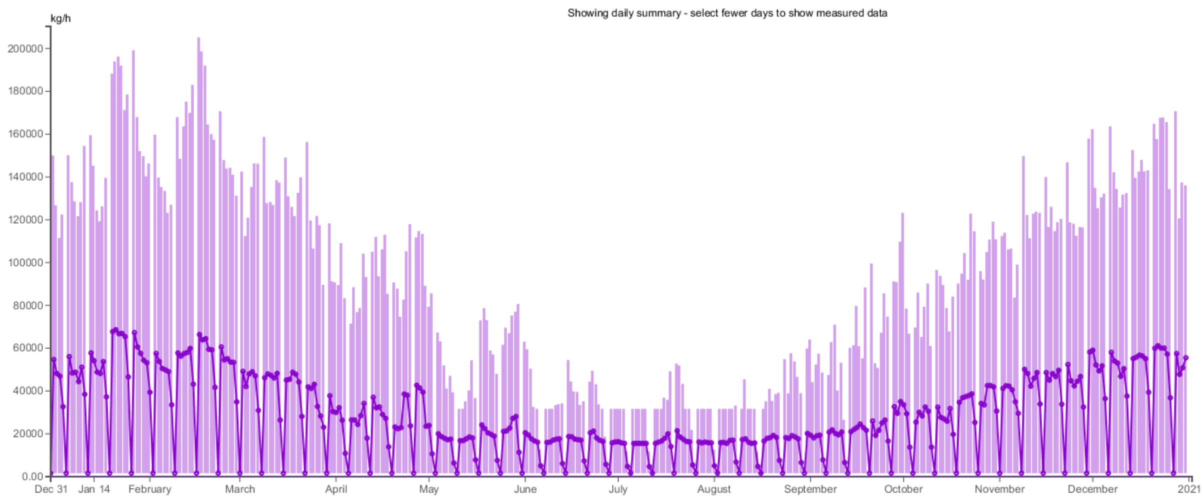

Figure 13 - Simulated total carbon savings from waste heat use for heating the buildings

As it may be seen in figure 13, the tool is providing an evaluation of the CO2 mitigation potential of the waste heat use for heating the buildings.

In the case of the application in Snina, the interest of the company INTRAVIS is to identify a customer for using constantly a fixed quantity of heat over the entire year for proper operation of the gasification plant and of the cogeneration unit.

The following step was to import the model into the iVN platform for the detailed analysis of heat production, heat requirements, virtual and physical network analysis. The results are shown below:

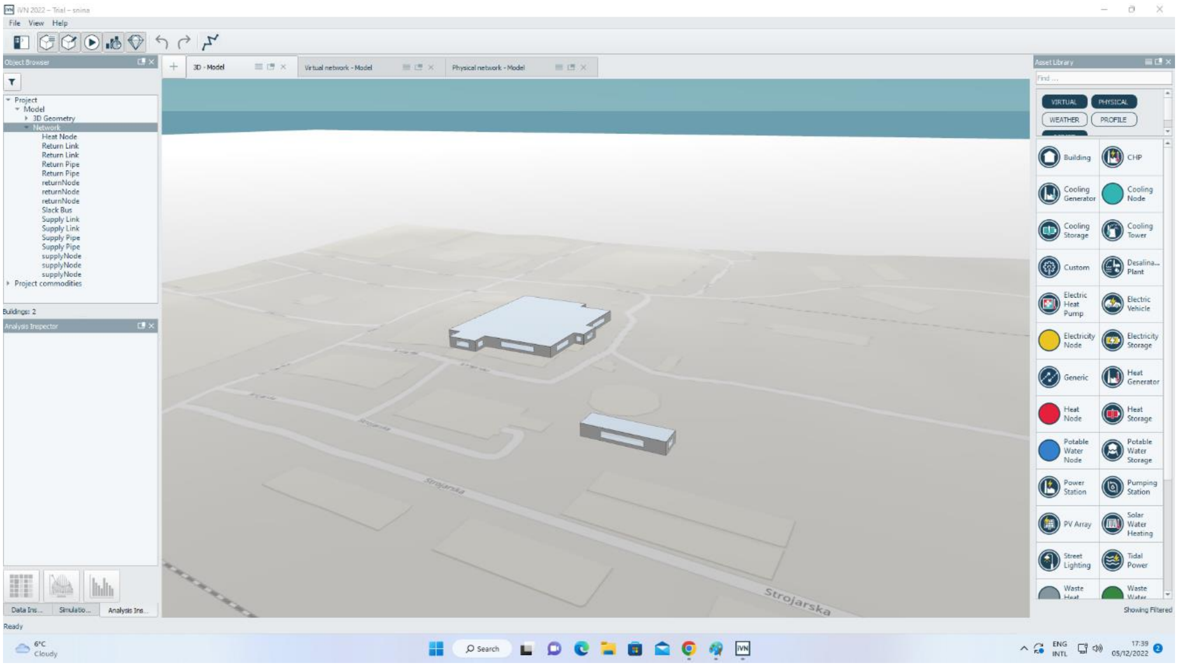

Figure 14 – Snina 3D model

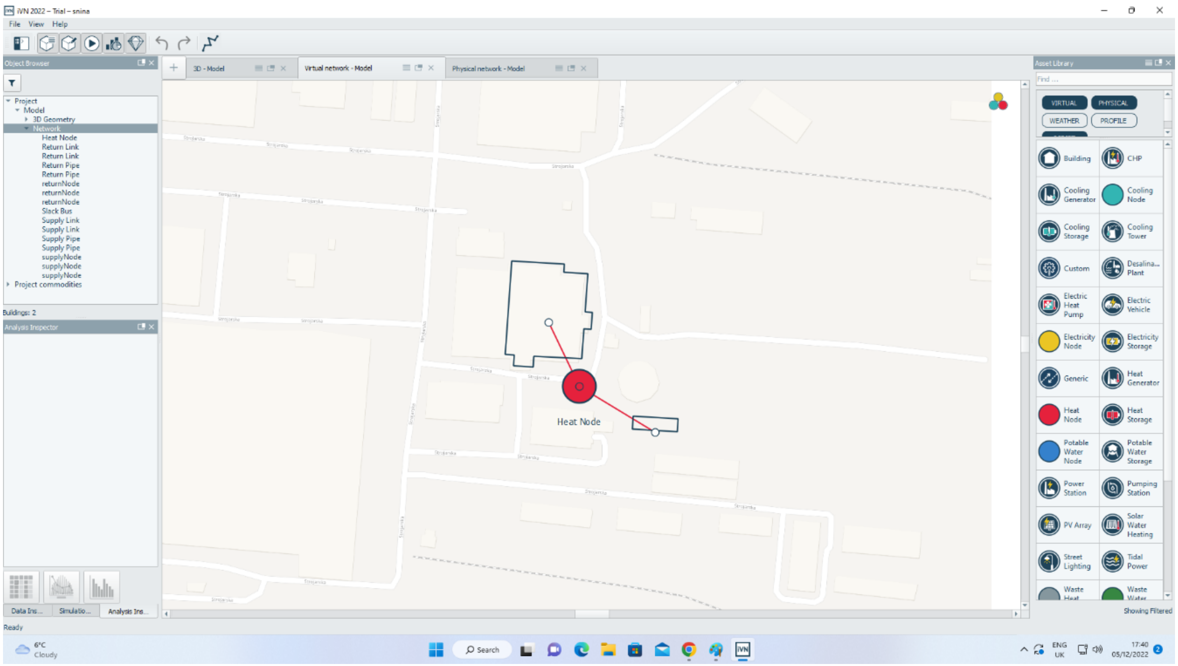

Figure 15 – Snina virtual network

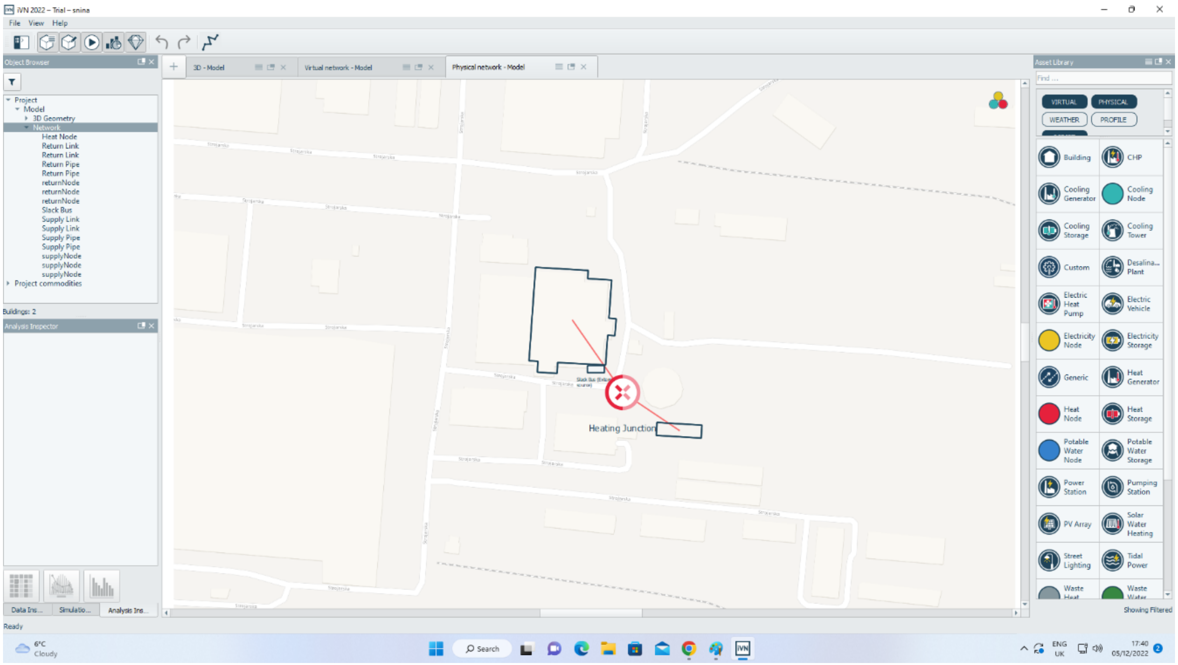

Figure 16 – Physical network

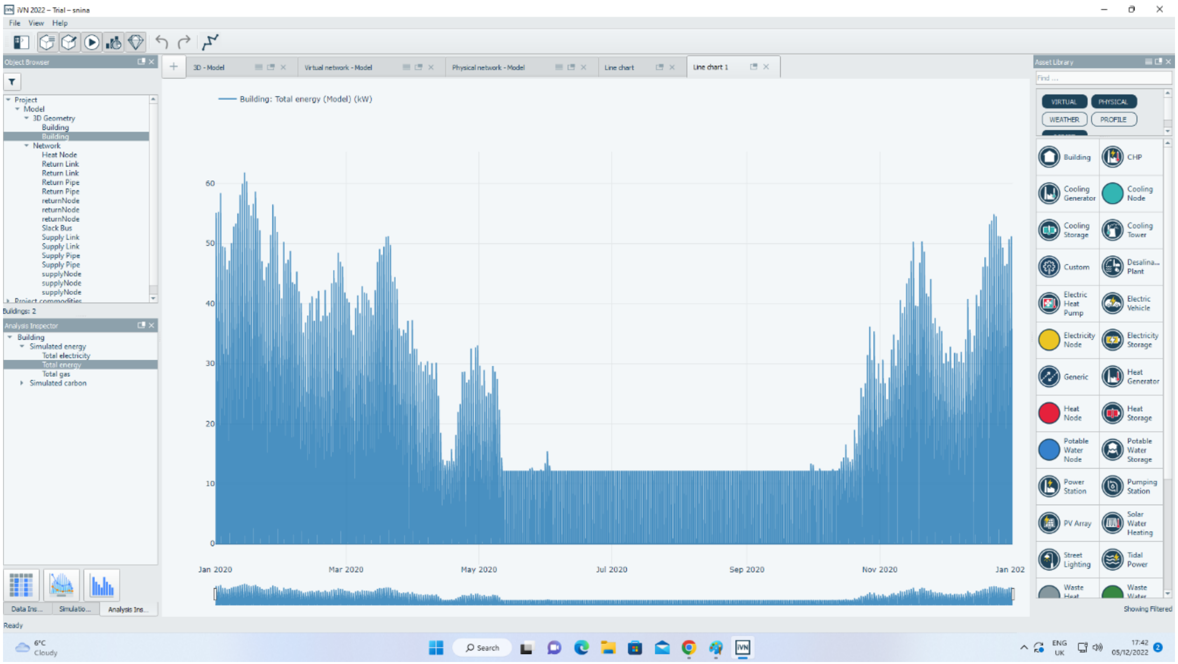

Figure 17 – Gasification plant total energy

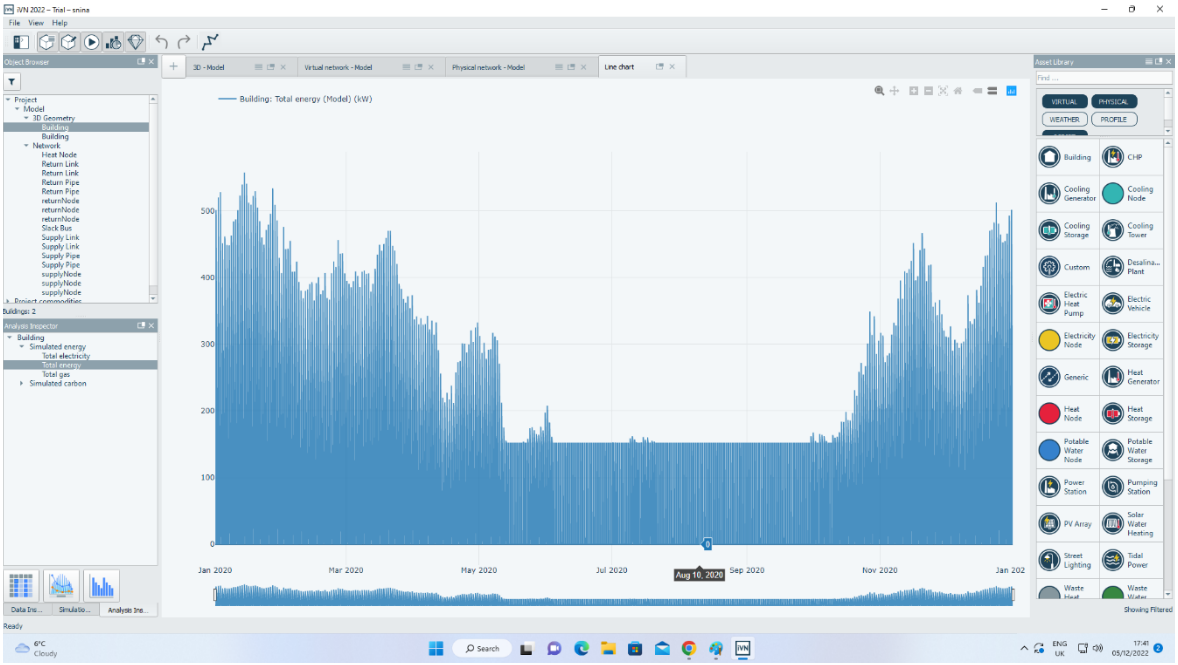

Figure 18 – Plastic waste processing plant total energy

2.1.5 Cost-Benefit Analysis

The Cost-Benefit analysis has been conducted for the above mentione conditions and the scenario of selling a fixed amount of heat over the entire period of operation of the plant as 7500 hours per year.

The base line was considered the posibility for the potential customer to produce heat internally with a boiler of similar capacity of 150 kW. The investment was estimated at 45 000 Euros for high efficiency boiler with all ancillaries and using natural gas as fuel.

The waste heat integration scenario requires an investment of 18 000 Euros for piping, pumps, heat exchangers and associated fittings, metering and ancilliaries.

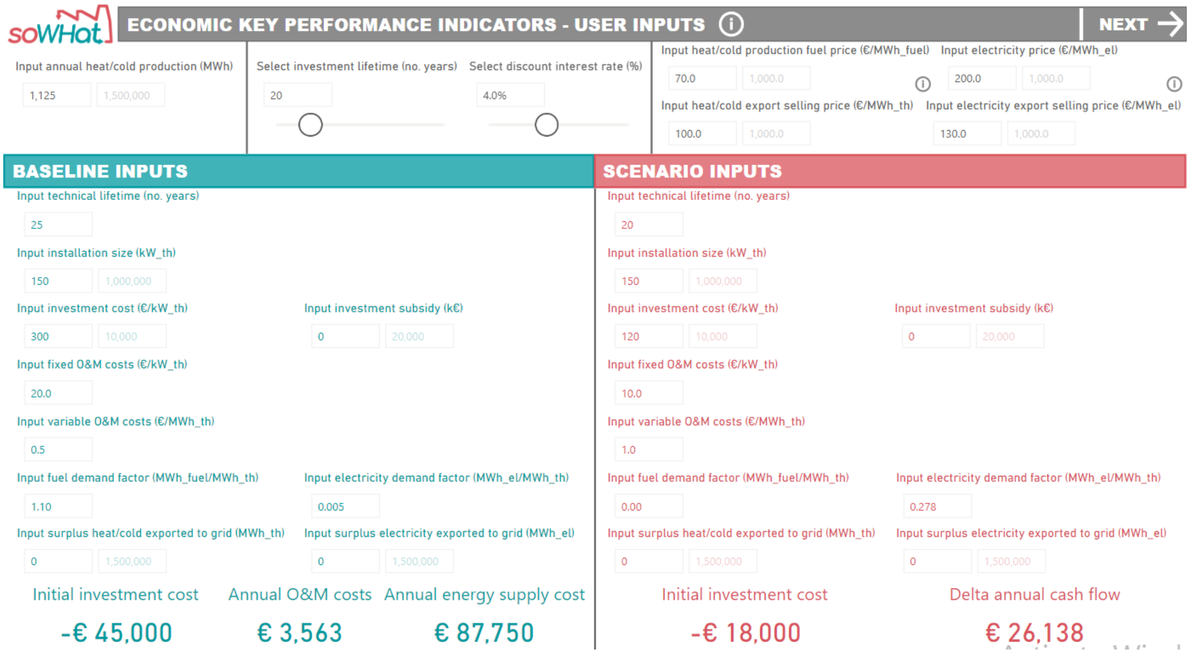

Figure 14. Screenshot with simulation data

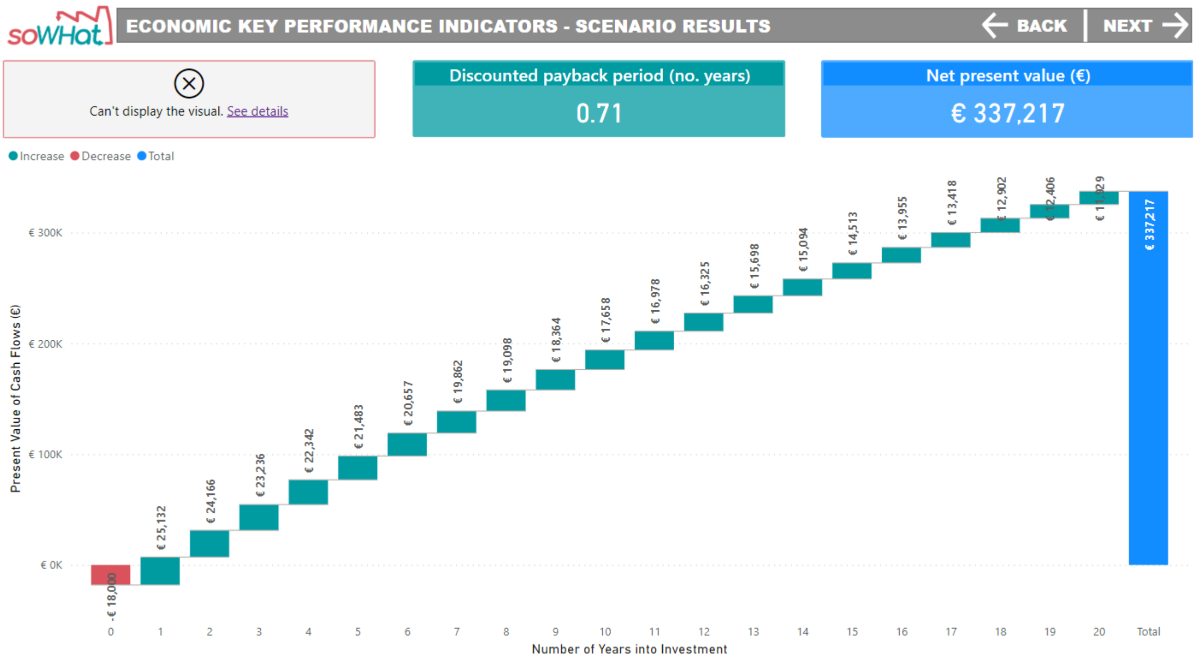

Figure 15. Scenario results with payback time and NPP

The results obtained presented in figures 14 and 15 have been obtained with some estimated costs because, the period is very complicated in the energy sector.

There are many aspects that are temporary due to the current situation in Europe determined by the war in Ukraine and the raise of the prices of energy.

For the purpose of the present study there were taken into consideration some estimated prices that are used in the Feasibility Studies by the banking sector.

The results that have been obtained are very reasonable and have been appreciated by the INTRAVIS team. The company initiated the main contacts with the tentative customer that was identified during the present study.

3 Replication studies in Bulgaria

3.1 Technical University of Varna

3.1.1 Description of the Site

The campus of Technical University of Varna is located in the NW part of Varna City, in a residential area.

The location of the plant has been modelled using Sketch-up Pro and imported in the iSCAN platform, as it can be seen in the figure below.

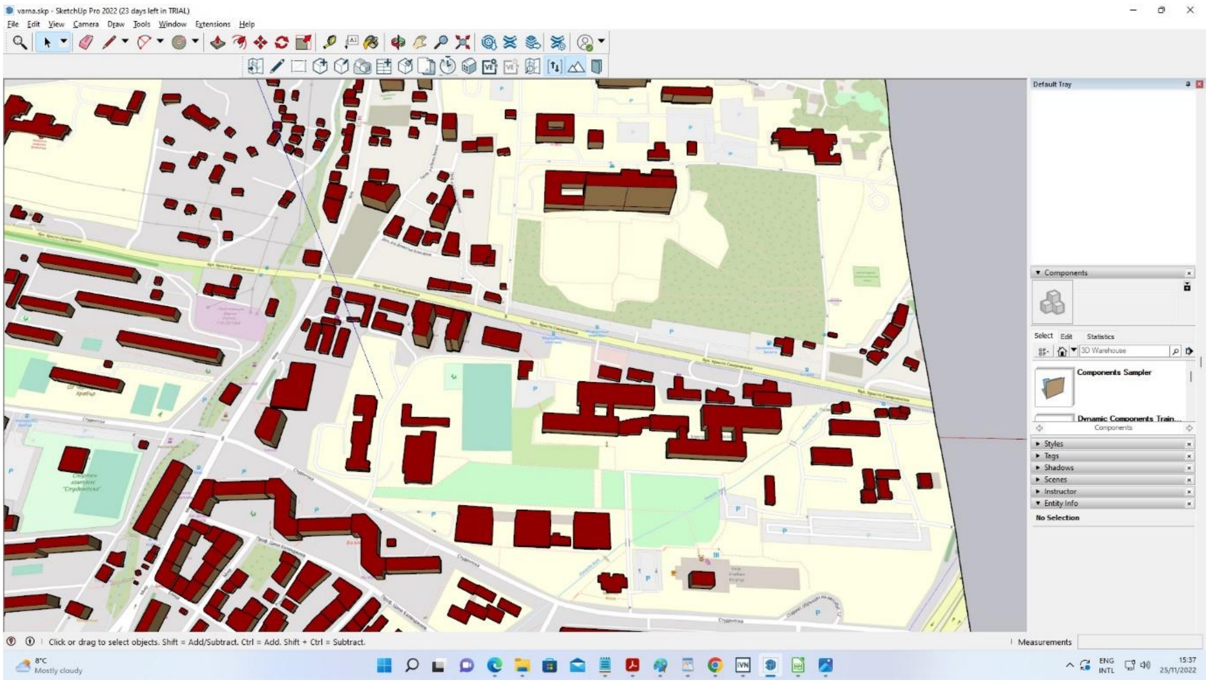

Figure 16. Sketch up model of the target region

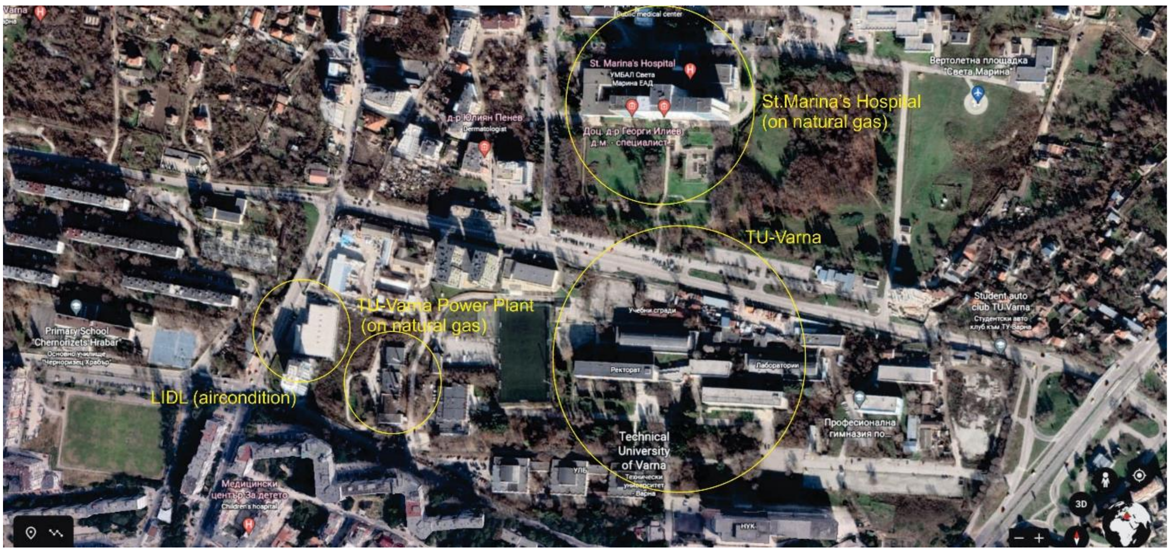

Figure 17. Detailed plan of the region with target locations

The model offered the possibility to evaluate the possible partners and the required investments for several alternative customers.

3.1.2 Analysis of Energy Consumption of the Site

As it has been mentioned in the previous chapters, the Thermal Plant of the TUV was developed to assure the required thermal energy for heating the campus building and the domestic hot water. It has been equipped with 3 natural gas fired boilers as followings:

1 boiler of 3.48 MW

2 boilers of 2.32 MW

The total installed capacity was of 8.12 MW and the nominal peak consumption was of 7 MW. After the refurbishment of the campus buildings, the demand for the campus needs dropped and an extra capacity was estimated at 2.9 MW.

As a consequence, there were considered the possibilities of selling of an amount of 21750 MWht per year for potential customers .

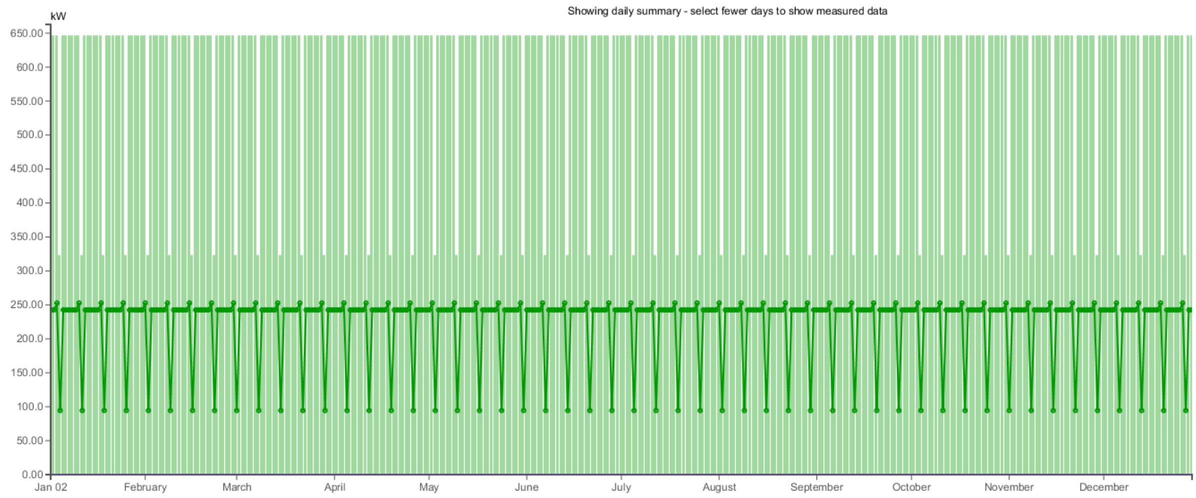

Figure 18 – Hot water demand load for LIDL supermarket building

Thre were identified 2 possible customers as LIDL supermarket and the St. Marina Hospital located in the immediate neighbourhood.

Using the Sketch-up tool there were evaluated the distances and there were collected required information from the field for completing the model and for importing them it in the IESVE tool.

The LIDL supermaket building is very close to the thermal plant of the campus. There are no other building in between and the connectivity could be assured very easy.

The hospital site is also close but, there is a separation road between the two sites that shall require additional permits and higher costs.

In order to prepare the economic analysis there were prepared activities of evaluation of the required energy for the identified buildings.

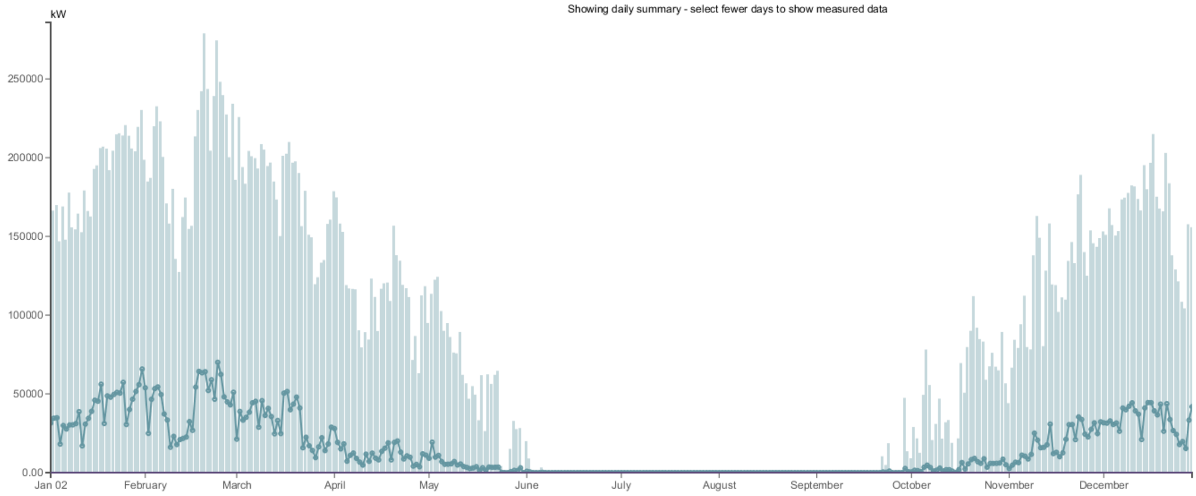

Figure 19 - Simulated heating energy demand for LIDL supermarket building

The buildings in SketchUp are developed in a simple manner, having a ground area and a defined height. It does not allow for a shape to have multiple heights and if two volumes are united, the height from one building is transferred to the other. For that reason, the building of the St. Marina Hospital from Varna is composed of two volumes, each with a different height. In order to make it easier to transfer data during sync between applications, the name of the two buildings are HC11 as building 1 and HC12 as building 2. The results of simulations are displayed in the followings.

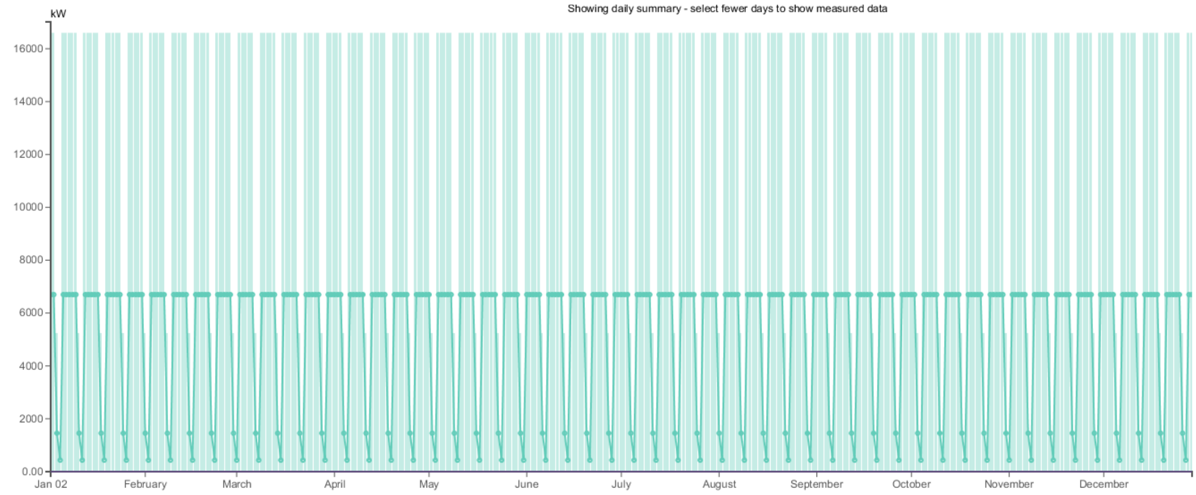

Figure 20 – Hot water demand load for Hospital building 1

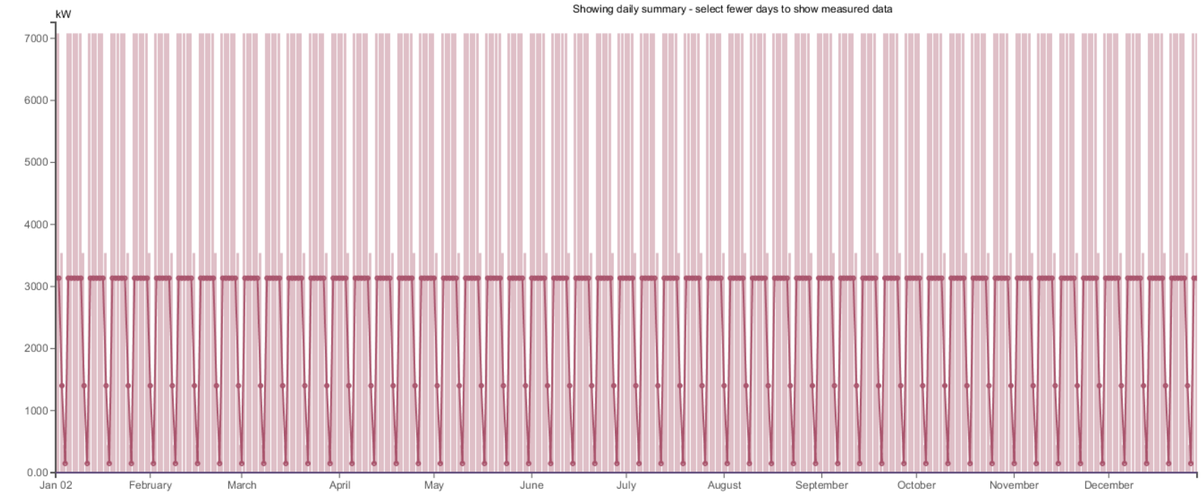

Figure 21 – Hot water demand load for hospital building 2

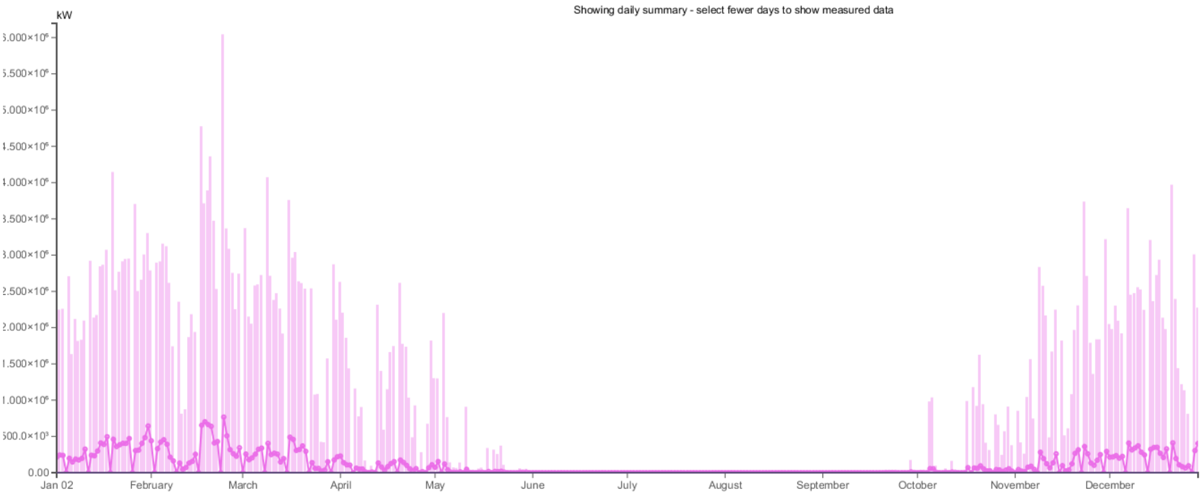

Figure 22 - Simulated heating energy demand forhospital building 1

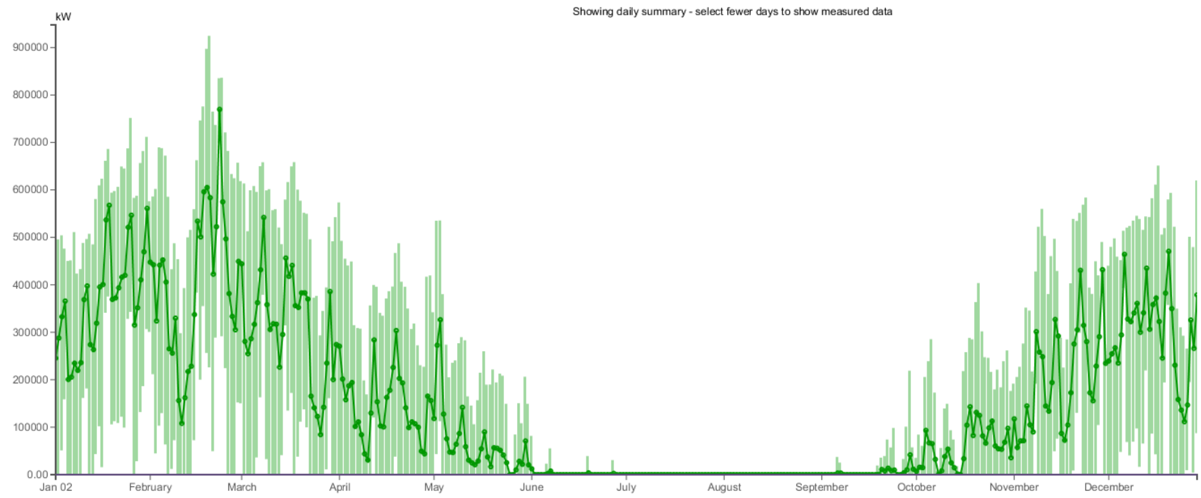

Figure 23 - Simulated heating energy demand for hospital building 2

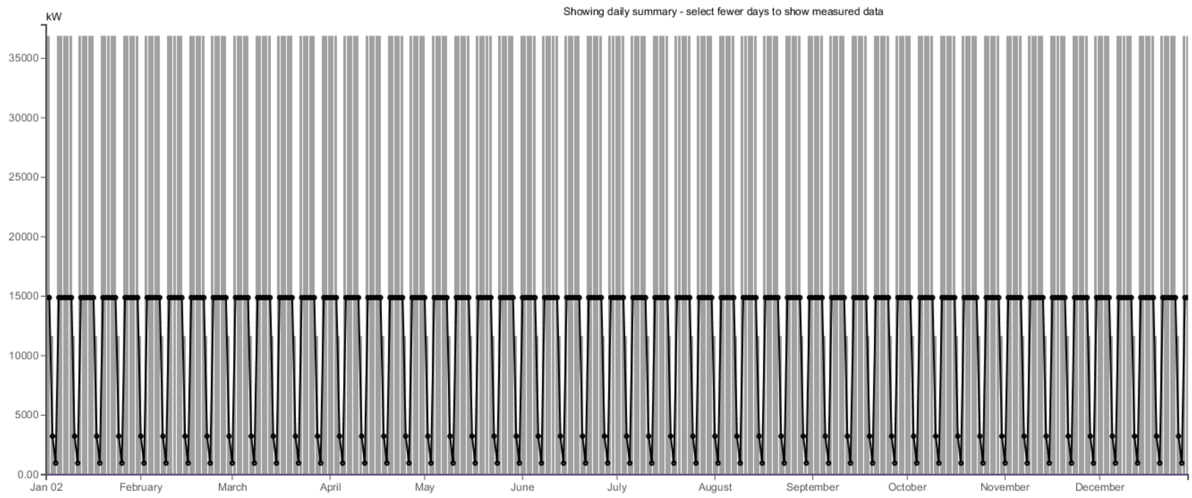

Figure 24 - Simulated waste energy integration for hospital building 1

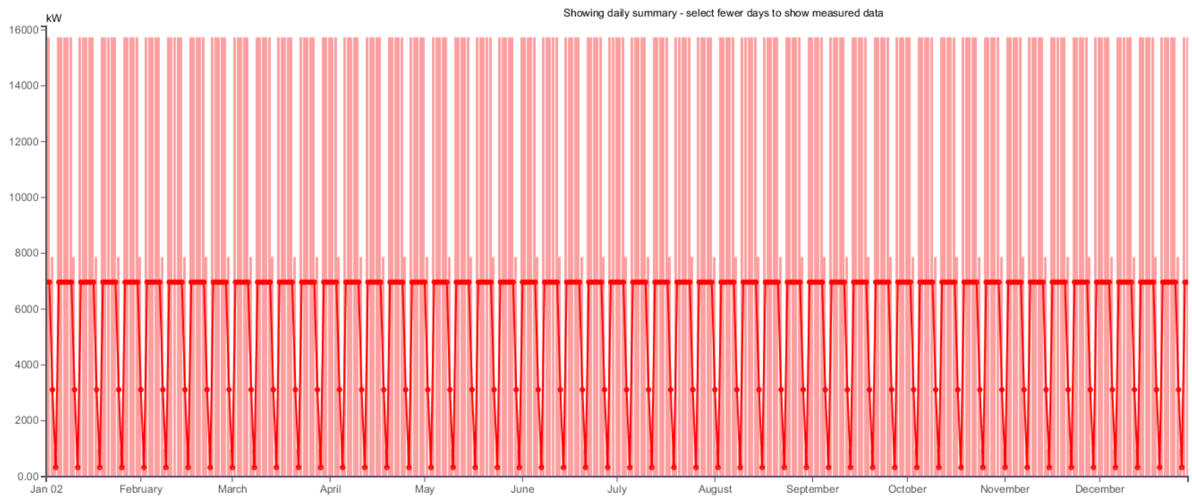

Figure 25 - Simulated waste energy integration for hospital building 2

The results presented in the figures 18 to 25 provide very useful inputs for preparing the decision regarding the possible scenarios for selling the extra heat by TUV.

3.1.3 Identification of Potential WHR/WCR or RES Opportunities

Based on the analyses presented in the previous paragraphs, it has been defined a strategy to consider a single scenario by considering the selling opportunity of the entire quantity of heat and to consider the cumulative value of the investment.

3.1.4 Evaluation of Energy Savings and Avoided GHG Emissions

The savings of energy consist mainly on the use of extra capacity of the TUV plant and are presented in the following figures.

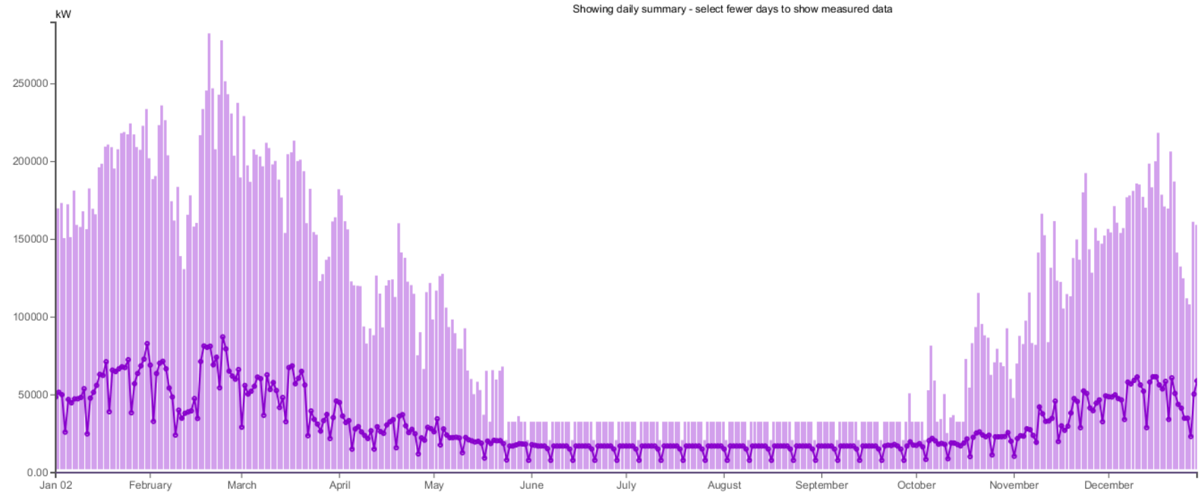

Figure 26 - Simulated total energy demand for LIDL supermarket building

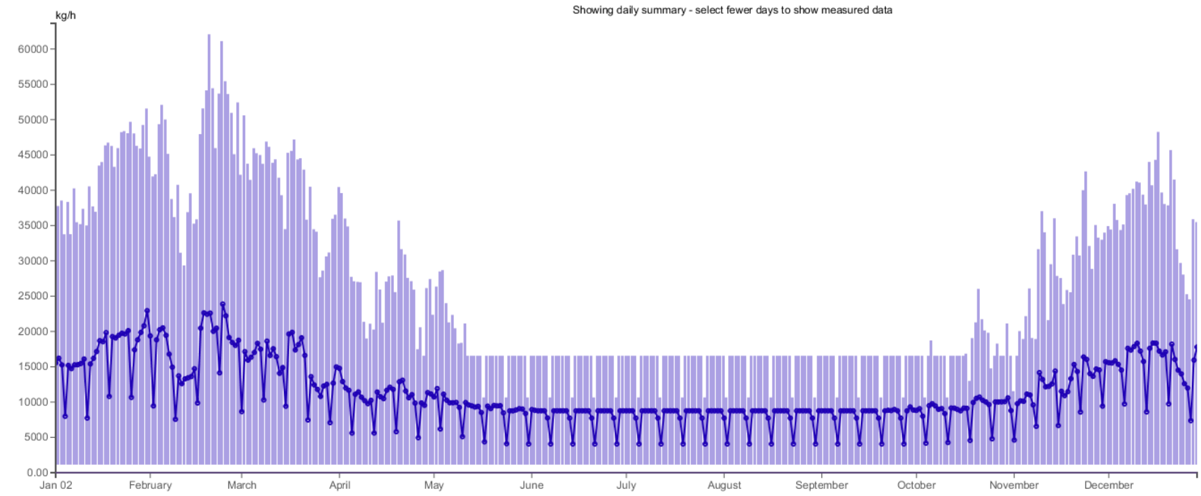

Figure 27 – Simulated total carbon mitigation waste heat use in LIDL supermarket building

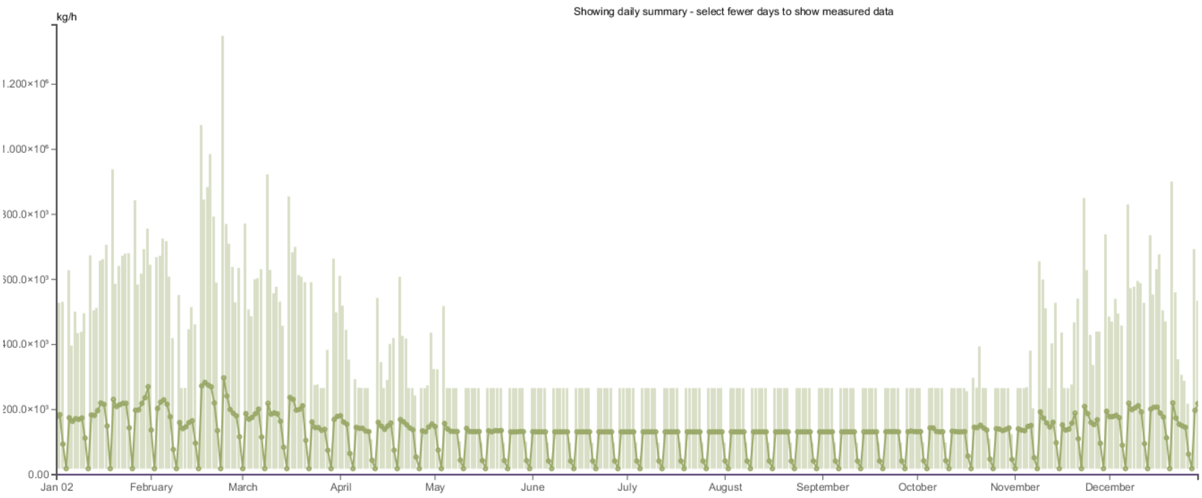

Figure 28 - Simulated total carbon savings from waste heat use in hospital building 1

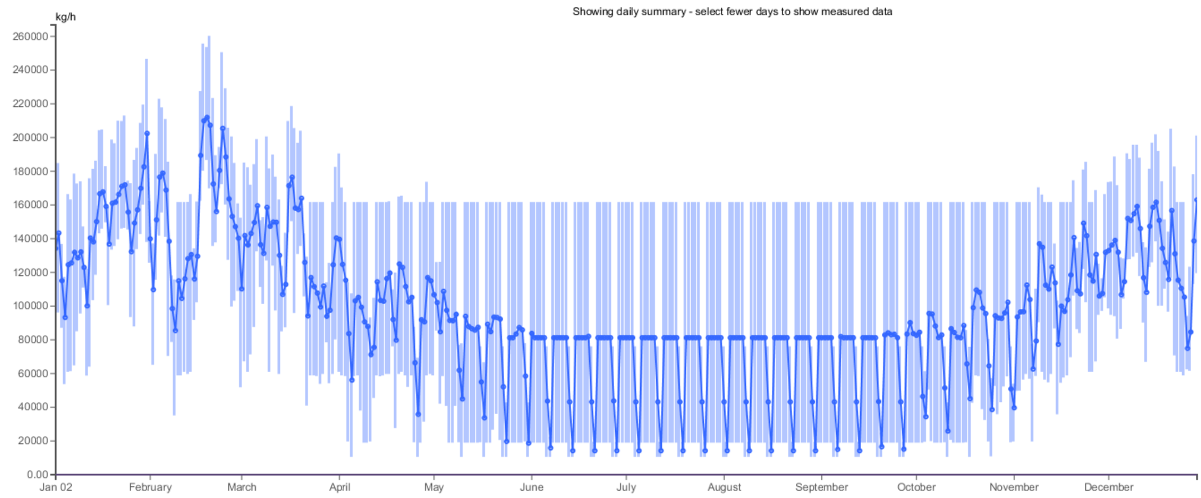

Figure 29 - Simulated total carbon savings from waste heat use in hospital building 2

The results, may also be considered for possible further development of projects aiming the integration of RES.

The following step was to import the model into the iVN platform for the detailed analysis of heat production, heat requirements, virtual and physical network analysis. The results are shown below:

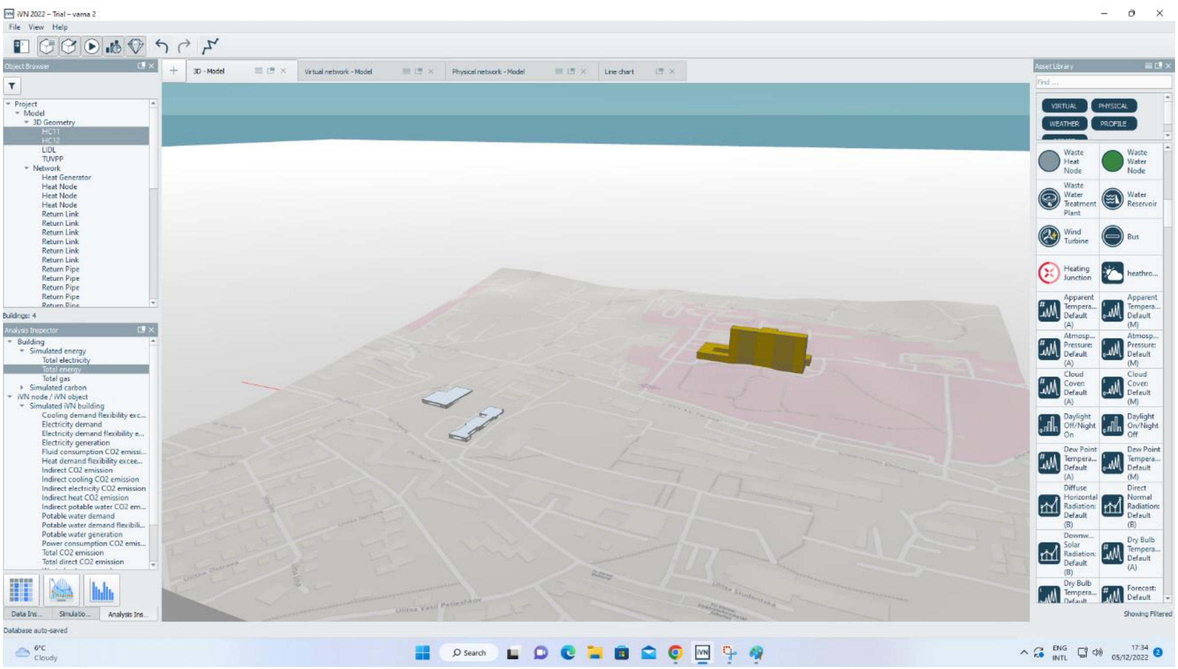

Figure 30 – Varna 3D model

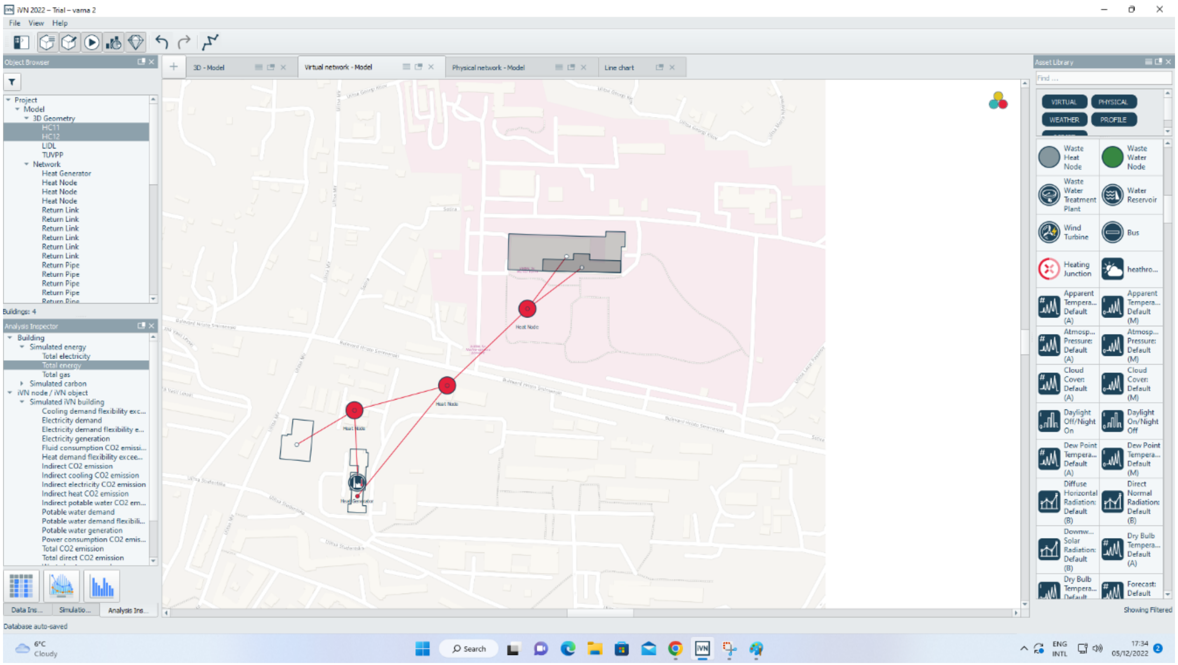

Figure 31 – Varna virtual network

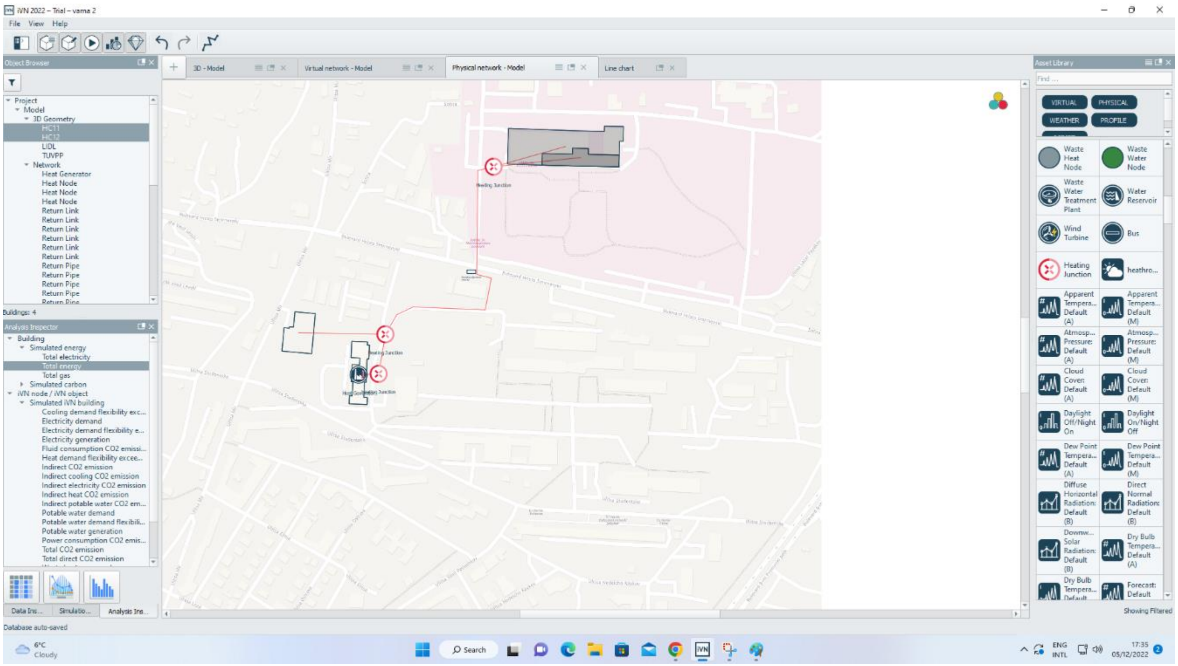

Figure 32 - Varna physical network

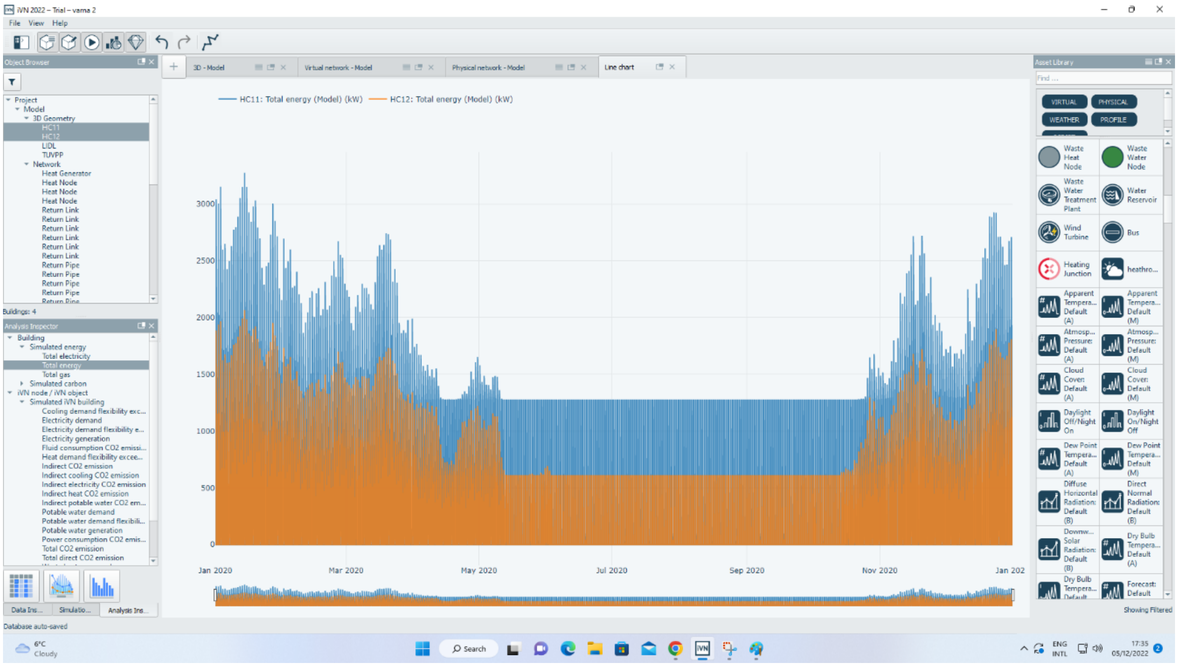

Figure 33 – Hospital total energy requirements

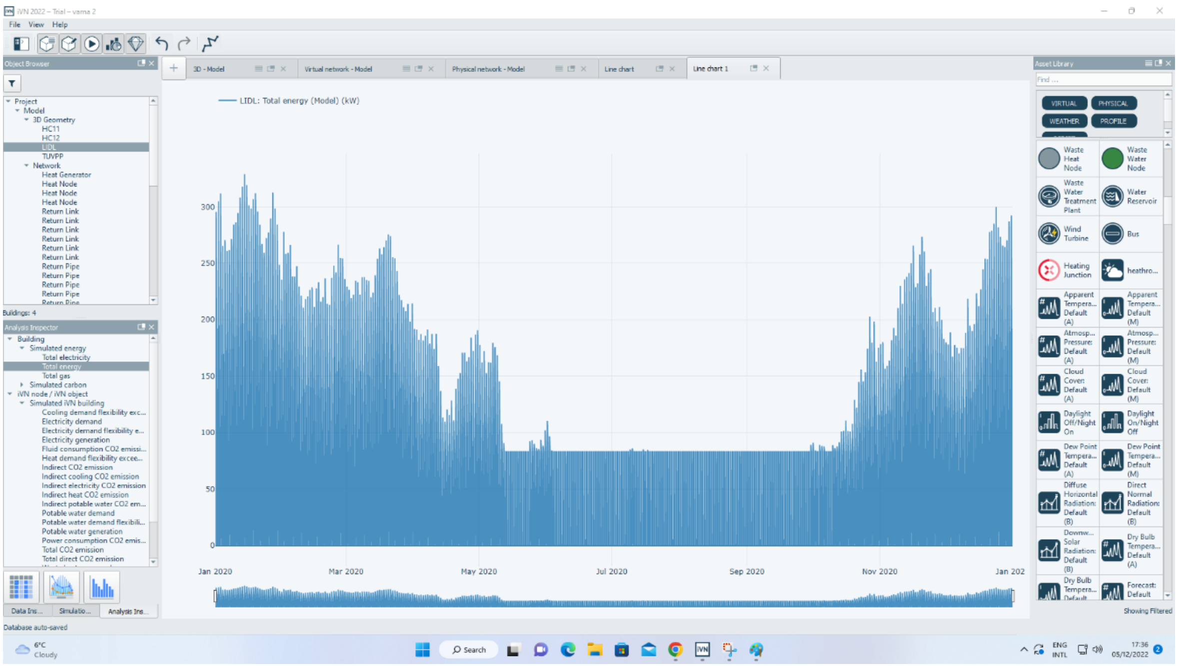

Figure 34 – LIDL total energy requirements

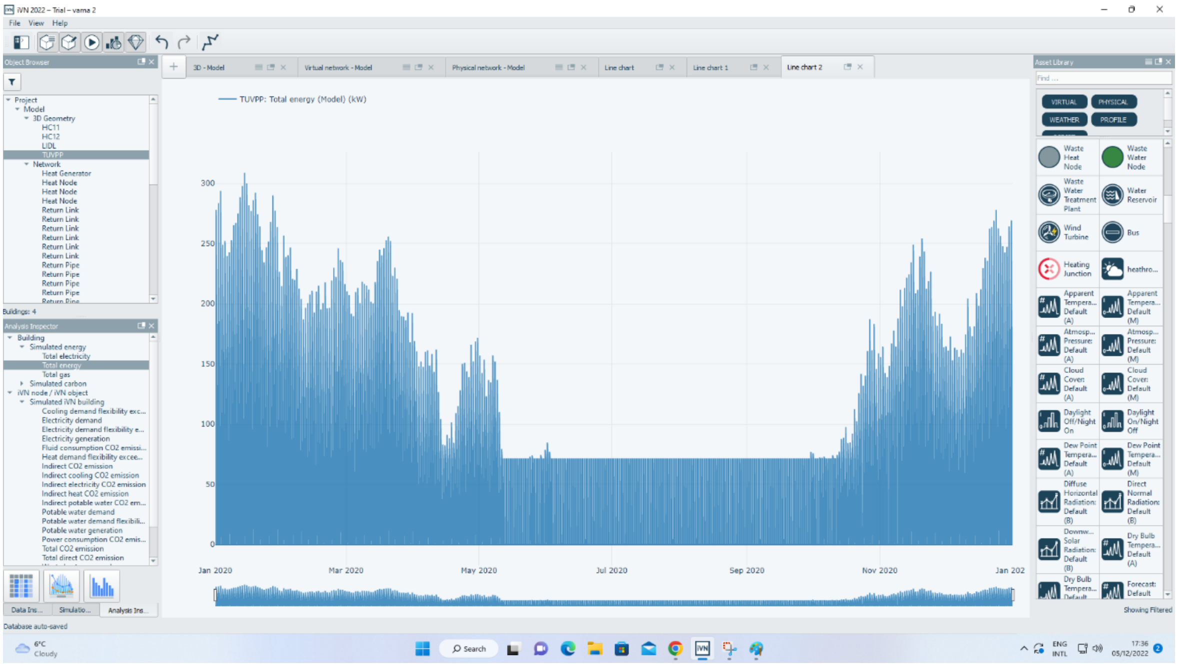

Figure 35 – TUV Power Plant total energy

3.1.5 Cost-Benefit Analysis

The Cost-Benefit analysis has been conducted for the scenario of selling a fixed amount of heat over the entire period of operation of the plant as 7500 hours per year.

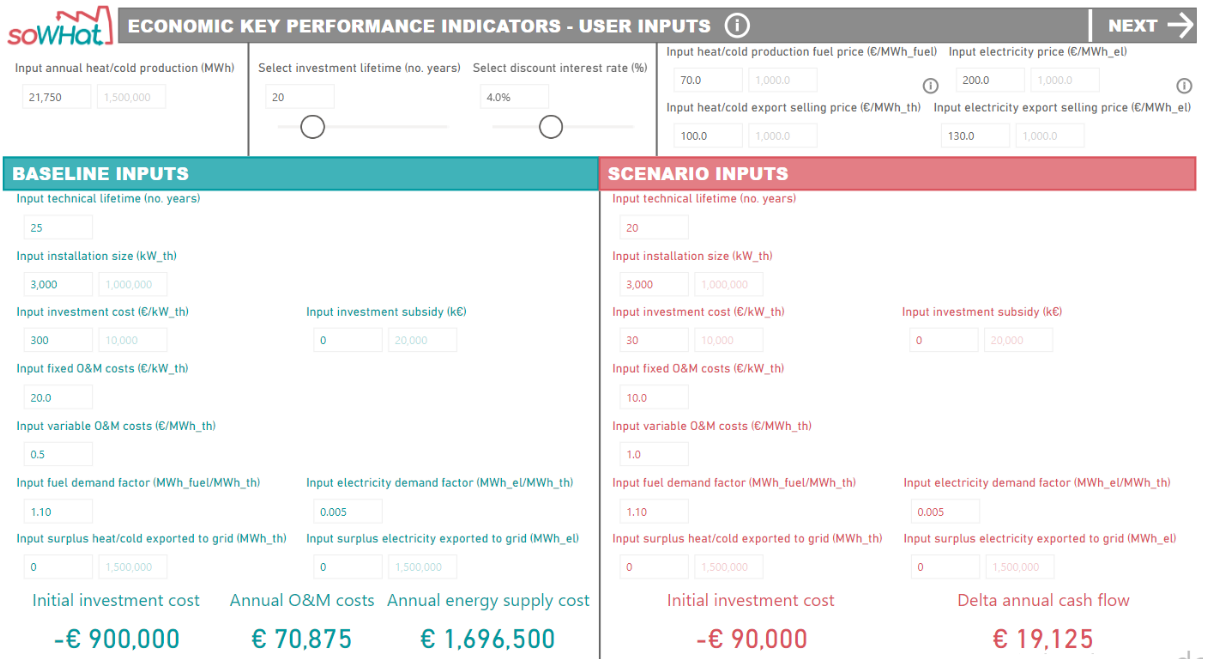

Figure 36 Screenshot with Cost-Benefit input data for TUV case

The base line was considered the posibility for the potential customers to produce heat internally with boilers of similar capacity of 2.9 MW. The investment was estimated at 900 000 Euros for high efficiency boilers with all ancillaries and using natural gas as fuel.

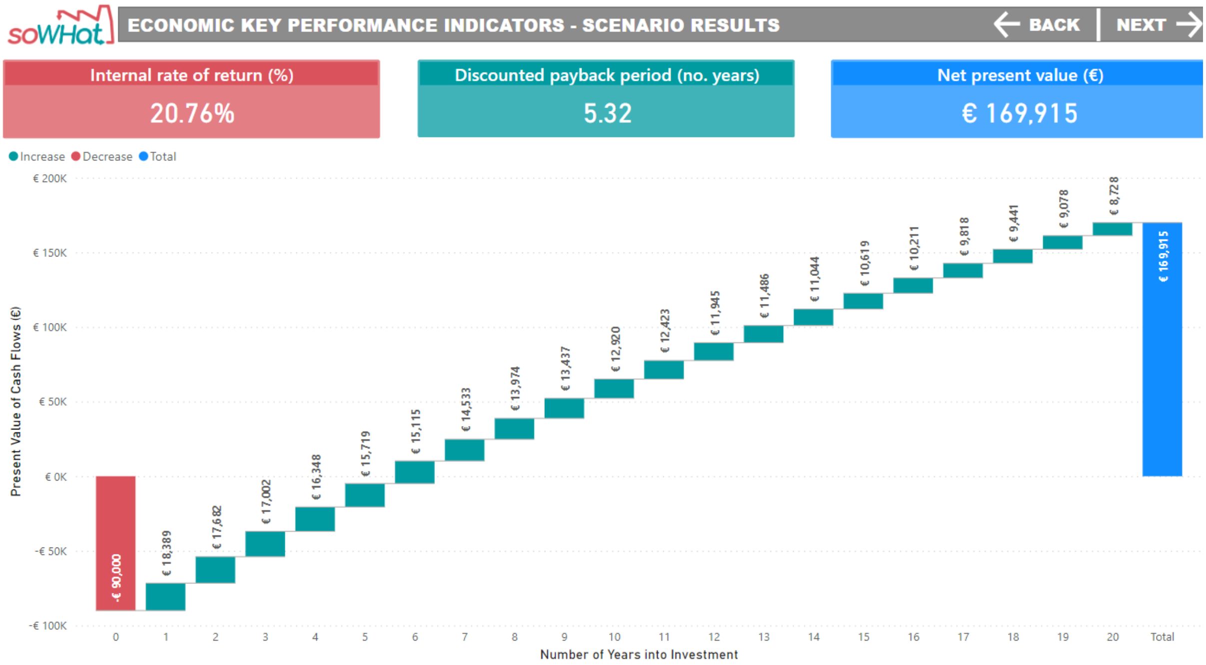

Figure 37 – Payback time, IRR and NPV for the TUV replication case

The waste heat integration scenario requires an investment of 90 000 Euros for piping, pumps, heat exchangers and associated fittings, metering and ancilliaries.

The results obtained presented in figures 30 and 31 have been obtained with some estimated costs because, the period is very complicated in the energy sector.

There are many aspects that are temporary due to the current situation in Europe determined by the war in Ukraine and the raise of the prices of energy.

For the purpose of the present study there were taken into consideration some estimated prices that are used in the Feasibility Studies by the banking sector.

The results that have been obtained are very reasonable and have been appreciated by the TUV team. The administration of the University intends to initiate the main contacts with the tentative customers that were identified during the present study.

4 Conclusions

The replication activities, outside the consortium, was possible by the involvement of two partner organizations of MEDGreen Cluster. In this way it has been possible to identify additional case studies to evaluate the possibility of making new investment for industrial waste heat/cold recovery.

The two potential projects have been characterized in terms of demand, boundary conditions, end-users' requirements and other several aspects.

The objective of all these activities was to accompany through such studies the mobilization of new projects interested and supporting the implementation of waste heat/cold and/or RES installation.

The activities of replication in Slovakia, have been done in partnership between MEDGreen and an SME – INTRAVIS, located in Kosice, specialized in the development and operation of gasification plants. Their recently commissioned plant in Snina, was mainly focused on the production of electricity. With the support f soHWat partners and tools, it has been possible to evaluate the possibility to identify a customer for waste heat and to prepare the support information for initiating the contacts with target customers and start the negotiations for a possible future deal.

The activities in Bulgaria, have bee developed in partnership between MEDGreen and a public institution – Technical University of Varna – TUV. At present, TUV is developing a broad program of modernization with the support that has been obtained from the Government, as part of the assistance programs of the EU. In this way there were refurbished the campus buildings with modern solutions, and the buildings were insulated for improving the energy efficiency. As a result, the thermal plant of the University gained an extra capacity of 2.9 MW. In this context, with the support of the soWHat consortium partners and tools there were evaluated the best options to use such an extra capacity by selling the surplus heat to the neighbouring institutions.

With the replication cases in Slovakia and Bulgaria, it has been possible to extend the potential geography and the sectors addressed by the future commercial tools.

References

[1] SO WHAT D1.6 Report On H/C Recovery / Storage Technologies And Renewable Technologies: https://sowhatproject.eu/wp-content/uploads/2018/05/SO-WHAT_D1.6_Report-on-HC-recoverystorage-technologies-and-renewable-technologies_FINAL_updateMARCH2021.pdf

[2] soWHat website https://sowhatproject.eu/