Interreg
CENTRAL EUROPE
European Union
European Regional Development Fund

STORE4HUC

INTEGRATION AND SMART MANAGEMENT OF ENERGY STORAGES AT HISTORICAL URBAN SITES

TAKING **COOPERATION** FORWARD

The concept of the project

It is challenging to provide a low carbon energy supply in cities in a style of energy storages especially in historical urban centres due to strict architectural protection constraints, high implementation costs and conflicts with town planning policies.

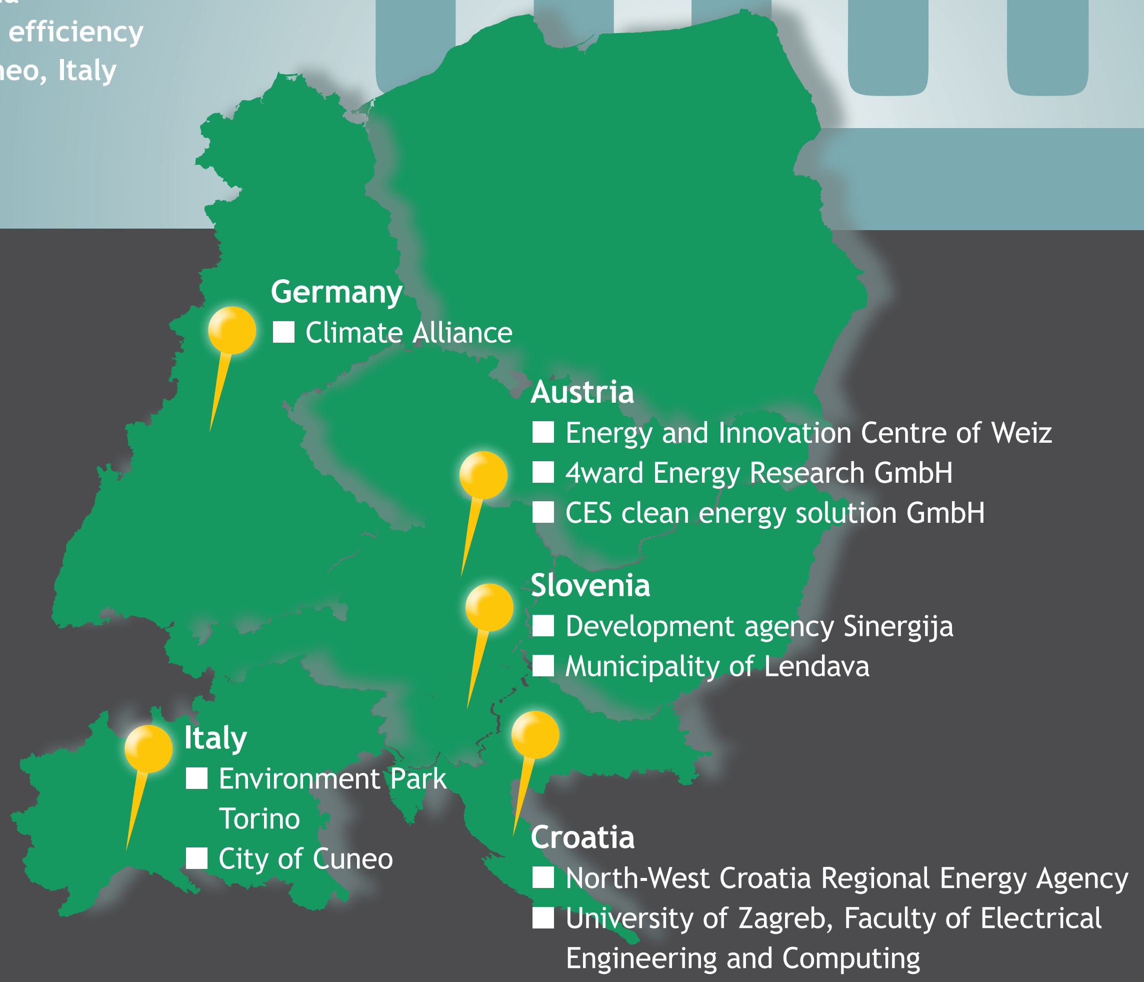
As a result came the idea of the STORE4HUC project, as the main objective was to improve and enrich energy and spatial planning strategies targeting historical city centres by focusing on integration of energy storage systems to enhance the public institutional and utility capabilities.

The pilot actions implemented in specific sites demonstrated the various energy storages that can be adapted and transferred to other local or regional environments. The storages provided good show cases to the local authorities which benefited in sense of improved energy efficiency and increased usage of renewable energy sources and lower costs for energy. The transnational strategy provided the recommendations for improving the energy and spatial planning. The energy management tools enabled monitoring all features that proof the effectiveness of the pilot installations. Additionally, the autarky rate tool indicated the economic and reasonable utilisation of storages.

By establishing the stakeholder deployment desk Store4HUC reached the relevant players to share the knowledge and also transfer it to other additional audience. It enabled the gaining of wider consensus of the pilot instalment and further tool usage, especially with the signed memorandums of the future tools utilisation.

The project approach also included peer review actions, mutual learning within project consortium and exchange of experiences and knowledge with target groups that can enhance the transnational added value. Innovative energy storage installation and storing of renewable energy sources determined the innovative aspect of Store4HUC.

CONTENT



Partners from five central European countries join their forces to improve environmental management in urban areas.

WHO ARE YOU?

Are you a house owner ready to lower your energy demand?

Our Autarky Tool might be the place to start exploring what Store4HUC offers.

https://store4huc-autarky.4wardenergy.at

Are you an energy expert or similar?

For electricity storage read about our Optimal Sizing Calculator first.

https://bit.ly/3BB0ByH

The Optimal Heat Source Scheduler

Thermal energy storages introduce flexibility into heating systems with numerous advantages on system performance and operational and maintenance costs. One of the most prominent advantage is the ability to use heat sources at their maximal efficiency, which reduces not only the cost of primary energy, but also exhaust emissions. To use the full potential of a thermal energy storage, an adequate control algorithm is required to control the heat sources connected to it.

The Optimal Heat Source Scheduler uses power demand predictions, along with parameters of the heating system, to output an optimal schedule of the heat source(s). Although the tool outputs schedule for a single heat source, it can be useful for systems having multiple heat sources, as they can be aggregated and represented with a single heat source. The schedule refers to a 24-hour power profile that constitutes of power references (in kW) for the heat source that should be applied.

The tool takes into account different aspects like:

- Heat source efficiencies at different referent powers.
- Heat source warm-up time.
- Size and insulation of the storage tank.

The results respect the required supply temperature of the heating system. The user is also shown the comparison of performance of such predictive operation with a standard automation system to decide whether it makes sense to opt for the computed schedule compared to a usual way of operation.

The Autarkey Rate Tool

The Autarky Rate Tool is a simple but very useful online tool which is available for everyone who is interested in the installation of electrical storage solutions in combination with renewable energy sources. By adding only a few numbers, the user will get an evaluation of the

- Technical
- Economical
- Ecological

effects of the chosen system configuration. The main output is of course the autarky rate, which is a figure for the independency of the public grid. If the autarky rate is high, this means, that the user is able to self-supply major parts of his energy demand.

As the economical perspective is always a substantial fact for every investment decision, the energy cost savings as well as a rough estimation of the amortisation period are shown too, to give the user an idea if this configuration is economically feasible or not. To evaluate the ecological impact, the CO_2 savings, based on the national electricity mix are calculated.

Another major part of the tool is the so-called checklist, which can be created as a pdf-file. On the one hand, the idea of the checklist is to give the user a possibility to save the calculation results and, on the other hand, it should serve as a further explanation how to make results understandable.

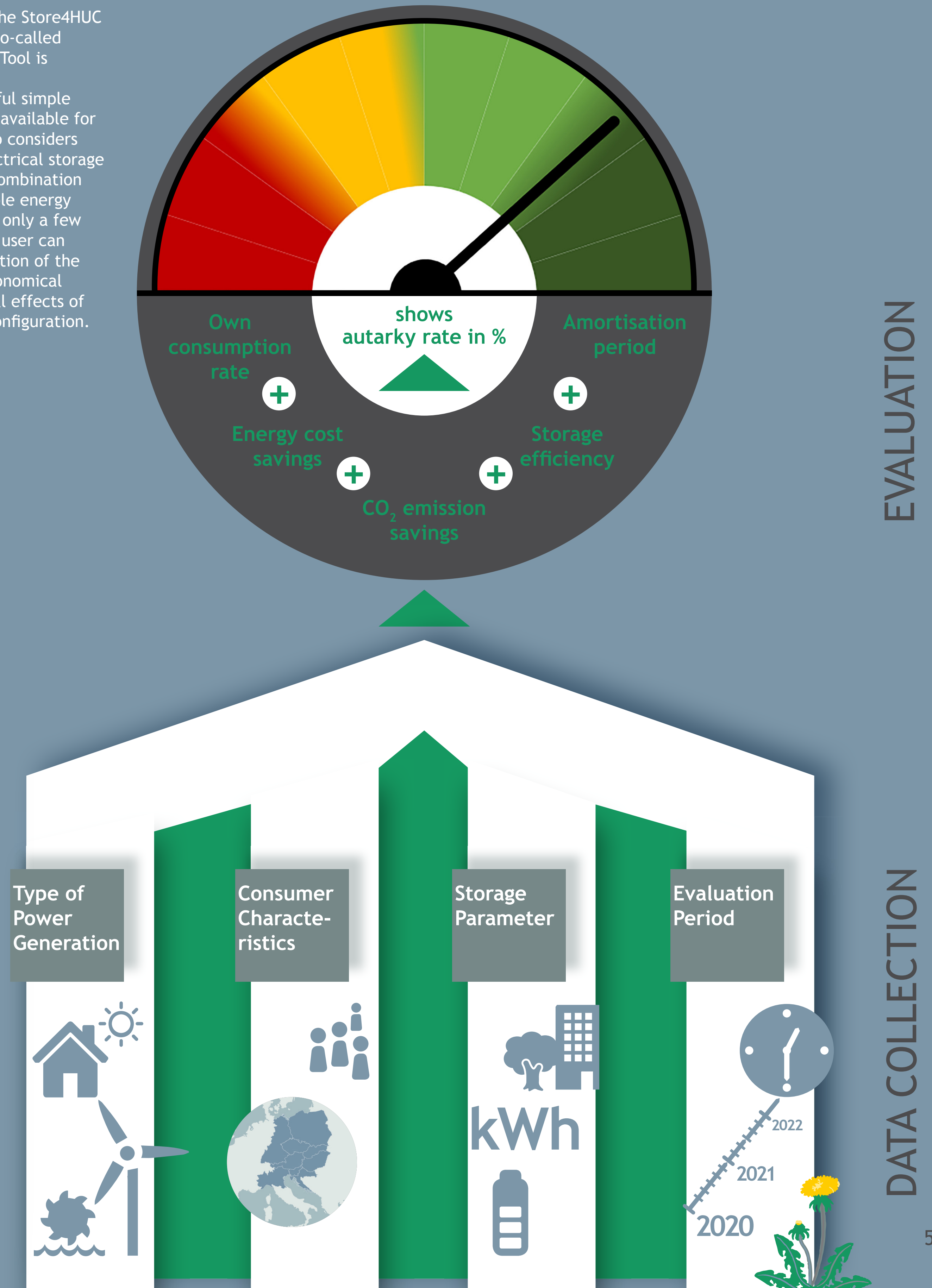
The tool results are valid in general and not only for historical urban buildings. For the users who are planning the integration of a stor-age in a historical urban centres (HUC), a further page is added, which provides them with addition-al information and advices from the Store4HUC project.

The tool does not replace an individual technical configuration assessment, but it gives a good overview of what positive influence the installation of a storage solution in combination with renewable energy sources might have and will possibly motivate more people to consider such installations on their own. The tool is available in Eng-lish, German, Italian, Slovenian and Croatian.

AUTARKY RATE TOOL

https://store4huc-autarky.4wardenergy.at

In course of the Store4HUC project, the so-called Autarky Rate Tool is developed. This very useful simple online tool is available for everyone who considers installing electrical storage solutions in combination with renewable energy sources. With only a few numbers, the user can get an evaluation of the technical, economical and ecological effects of the chosen configuration.



The Optimal Sizing Calculator Tool

Photovoltaic (PV) systems are widespread renewable energy sources that can be installed at a variety of locations. Because of their sun dependence, their energy production is intermittent. Having a battery energy storage system (BESS) can ensure that the excess of energy is stored and used later to avoid selling the energy at low price and then buying it at higher price. It also contributes to environmental protection in terms of reduced CO_2 emissions through increased usage of renewable energy sources.

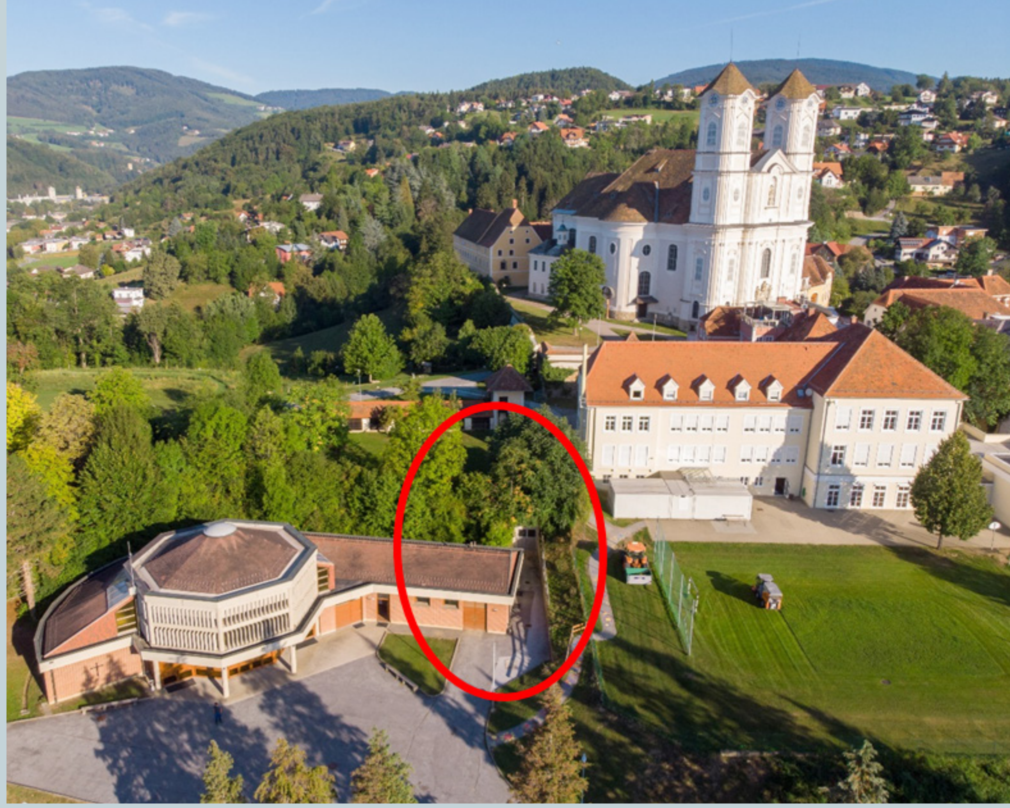
With Optimal Sizing Calculator a person could maximise the benefits of such systems, while minimising the cost of installation and maintenance. The tool calculates optimal sizes of the investment in a PV system (its peak power) and a BESS (battery capacity and power converter nominal power) for a particular consumer. It uses a variety of pre-recorded electricity consumption and PV energy production profiles, but it can be supplied with a custom profile as well. It takes into account peak power pricing, feed-in energy pricing, energy efficiencies of the power converter, degradation of the batteries and maintenance costs, which in turn gives credible results. The results are obtained for a specific investment payoff period specified by the user.

OPTIMAL SIZING CALCULATOR TOOL

Optimal parameterization of a photovaltaic (PV) and a battery energy storage system (BESS) add-on for a consumer. To maximize the contributions while minimizing the price of the installations, the calculator finds the optimal sizes of a PV and a BESS for a site. Those sizes are peak power of the PV system, energy capacity of the BESS, and power converter rated power of the BESS.

Download:
https://bit.ly/3BB0ByH

Central heat storage in Weizberg, Austria



Top left: The Town of Weiz.
Top right: The location of the implemented heat storage.
On the left: Installation of the new heat storage tank to the heating plant.

In 1999 a local heating network and heating plant were built in Weizberg. This plant supplied 12 costumers, the largest of which are a hotel and the parish of Weizberg. The heat supply was ensured by two biomass boilers that were running on regional wood chips with a total nominal output of 840 kW. The previous operation of the boiler system of the heating plant had to be operated mostly in the partial or low load range, with increased fuel consumption and pollutant emissions. Also, due to the lack of central storage, the heating network was also used as a thermal buffer, combined with correspondingly high heat losses of the grid.

Therefore, despite being under monumental protection, a central heat storage tank with a capacity of 38,000 litres was integrated into the existing heating plant as part of the Interreg Central Europe project Store4HUC.

Another innovative approach was implementing a new regulation with a fully integrated, intelligent load management. Through the mutual communication of all system components (boiler system, central storage, grid) including access to the control of decentralized storage systems at the customers, a holistically optimized operation of the heating plant and the local heating network was implemented.

Despite the location in a district protected by the site, the integration of a central heat storage system into the existing heating plant in Weizberg was a significant contribution to optimized operation.

The aim of the pilot project in Weiz is the integration of a central heat storage tank into the existing heating plant of the local heating network in the historic monument and landscape protection zone of Weizberg as well as the implementation of a new control with a fully integrated, intelligent load management with mutual communication of all plant components

The innovation of this project takes place on the storage tank as well as on the system level. On the one hand on the system level by the implementation of a new control with a coherent load management of all system components boiler plant, central storage, network and decentralised storage at the consumers by mutual communication of these and by access to the control of the decentralised storage at the consumers, and on the other hand on the storage level with the integration of a central heat storage in in the historic monument and landscape protection zone.

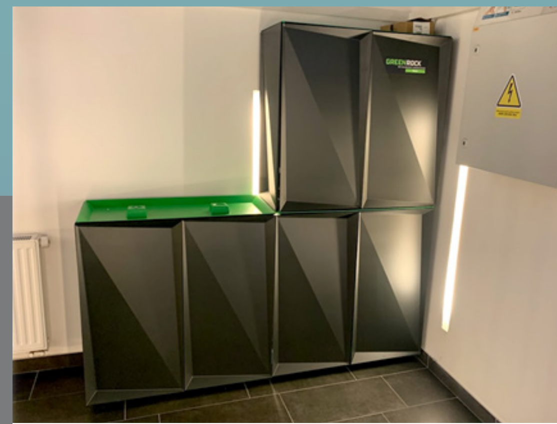
This project can and should therefore serve as an innovative best-practice facility and as a model for simplified technical and above all economic implementation at other protected sites and lead to a significant increase in the proportion of renewable energy sources in historic city centres.

Integration of photovoltaic and battery systems in Bračak Manor, Croatia

The aim of the Bračak pilot project was the implementation of a central battery (bank) system, installation of a photovoltaic system, and integration of it to an advanced Energy management system (EMS).

Bračak Manor was already equipped with:

- Wood pellets boiler for heating.
- Micro CHP for hot water and power production.
- Air-water heat pump system for cooling and heating in transitional periods.
- Wall insulation on the inside and energy efficient windows and doors.
- Efficient lighting system.
- HVAC system.
- Central EMS for monitoring of heating, cooling and energy consumption.
- Rainwater harvesting for irrigation of green areas.
- Wastewater treatment.
- Electric vehicle charging station.



Top: The Pilot Site Bračak Manor.
Top right corner: The implementation of the solar panels right next to the building.
Right: The battery storage units.

Energy management of the Bračak Manor with photovoltaic power plant and batteries integrated with existing energy systems.

Energy management system serves for optimal coordination of the energy systems with the possibility of prediction and cost management via developed tools for historical sites.

Energy management of the versatile energy systems in the Bračak Manor including heating, cooling, energy production, and storage will allow to investigate what are the economically and ecologically most favorable technology mixes on historical sites.

The system was combined with the existing ones, to act as decision support such that the operators can decide ahead how to engage micro-CHP and the wood pellet boiler in the presence of newly installed photovoltaic and battery system. With the EMS integration the photovoltaic and battery system now have the ability to display all important operating parameters, such as the current production of PV, total energy produced trough time [kWh], battery voltage, time remaining to fully charged, time remaining to discharge, storage efficiency, number of charge/discharge cycles, temperature of battery, etc.

With these data it is possible to:

- Adjust energy flows.
- Perform load management and/or peak shaving.
- Coordinate the energy systems.
- Predict and manage costs.

Energy management also allows to investigate what are the economically and ecologically most favourable technology mixes on historical sites. The long-term goal is to show innovative materials and technologies in reconstruction as a demonstrative example to other similar historical urban sites and to show that despite of the strict conservation requirements the project of this type can be realised.

Paraffin based latent storage in Lendava, Slovenia

Top left: The Lendava library pilot site.
Middle top: Construction done on the library to put the new heating system in place.
Middle bottom: The special paraffin based phase change material.
Top right: The new paraffin based heat storage tanks.

The Lendava pilot project consists of a new paraffin based latent heat storage in combination with the geothermal district heating system in Lendava.

The main aim of the pilot project is the replacement of the existing Oil-Fired Boiler in Lendava Library with a renewable energy source – the building will be connected to the existing geothermal district heating network to increase the share of renewables in the public sector.

An energy management tool developed in connection with an effective monitoring report will serve for the presentation of the results of the investment, amongst others: CO_2 savings, kWh savings, cost savings, etc.

Slovenian pilot is a paraffin based latent storage in connection with geothermal district heating system in the city of Lendava located in north-eastern part of the country.

The aim has been the installation of innovative paraffin based latent heat storage and connect it to an existing grid in Lendava on the geothermal heating system. The storage is installed in the old neo-baroque villa built in 1906. This building is one of the last public buildings which used to be heated on fossil fuel.

It has had a very poor energy performance as it was using an old heating boiler. The library is the last connection in the geothermal grid (the temperatures here are around 50°C) and is historically protected. The aim of this project was to reduce the fossil fuel to zero, CO_2 reduction was between 25 and 28 tons per year.

The construction work has been carried out in two phases:

1. Connection of the building to the existing geothermal district network with the purchase of a 2 x 65 m of pre-insulated pipes, suitable for temperatures of up to 95°C, and the connection of the public.

2. Installation of the PCM storage tank and all electrical and mechanical components for energy transmission and measurement, namely two 1000 litres steel storage tanks filled with paraffin based-phase change material.

During the project preparation several energy results for the pilot were set up:

- Reduction of use/share of fossil fuels in the final energy consumption in public sector: 60 MWh.
- Reduction of CO_2 Emissions Pollution: 16,8 tons of CO_2 (geothermal energy has an CO_2-emission factor of “0”).
- Exploitation of renewable energy: 57 MWh; savings related to energy storing included.
- Increasing of energy efficiency: 5,5 % or 3 MWh.
- Implementation and presentation of an innovative way of energy storing.
- Integration of political decision makers/public sector in the development and implementation process of the pilot project – as a basis for further promotion of the project to other sectors and integration of measures into the policies.

For the presentation of the pilot operation and to displaying the energy results of the system, a central control system was installed, which involved accessing energy efficiency data and clearly displaying it. To fulfill this task, it was essential to receive valid data from the operations and use it for reports, evaluations and constant improvement.

Inclined lift energy efficiency pilot project in Cuneo, Italy

Top: The City of Cuneo.
Top right: The Sloping Elevator under improvement works.
Right: The full sloping elevator going from the commercial area to the historical city centre.

The inclined lift in Cuneo is a form of local transport widely used by the population of the city, as it connects the large parking area of Piazzale Cavallera with the historic and commercial centre of the city. The project included the realization of a new system for the production and storage of electrical power, integrated with the drive of the inclined elevator, as well as the construction of a small photovoltaic field along the system runway to supplement the amount of electrical energy that was produced by the elevator during some operating phases. This was actually a single integrated system, made up of several distinct elements, which also require some construction works for support. The project was aimed at optimising the energy resources necessary for the operation of the lift by means of the storage system, in which electricity is stored and from which it will be used when needed. The storage was utilised to recover the energy dissipated during the braking phases and produced during the elevator rides with maximum load unbalance, as well as the energy that is supplied by the small solar field that was installed.

This model, which can be defined as a “stand alone” system due to its complete independence of operation from the power supply network, allows for greater operational flexibility and is in line with the most recent guidelines for optimising energy resources. It also has a positive impact on the operating conditions of the public transport system, with an increase in the level of safety in the event of power failure from the network.

Therefore, the related energy efficiency project is configured as a measure totally in line with the strategy aimed at strengthening sustainable mobility that is currently supported and promoted by the Municipality of Cuneo.

The Cuneo pilot project consists of a new system for the production and storage of electrical power, integrated within the city inclined lift, made of a small photovoltaic field and a storage system.

The project is aimed at optimising the energy resources necessary for the operation of the lift by means of the storage system that will be used to recover the energy self-produced by the elevator rides, and to store the energy that will be supplied by the photovoltaic field.

This model allows for higher energy efficiency and carbon emissions reduction and will have a positive impact on the operating conditions of the public transport system, with an increase in the level of safety in the event of power failure from the network.

Pilot Results

Slovenia

The testing phase was carried out from April until November 2021 and for the rest of the yearly period we made a projection based on the consumption profile given by the numbers from past years. The monitoring data showed that the expected energy results during the project preparation phase were exceeded. The heating energy consumption is reduced by 17 % based on the higher efficiency of the new heating system in connection with storage and the CO_2 emissions are reduced by 23,5 tons/year.

Austria

The installation of the water buffer tank was necessary because the emission load was too high, there was no emergency boiler and, in general, the system life, energy efficiency and use of renewable energy sources could be increased. The energy savings amount to 9 % of biomass fuel, 2 % of grid losses and 12 % electricity savings. There is great potential for applying the implemented storage system in other HUCs.

Croatia

Projected annual production of the power plant is 11.340,00 kWh. In combination with the battery system, all the energy produced is used for the needs of the Bračak castle. In previous years, the building consumed an average of 24,312.67 kWh of electricity, and now this consumption will be reduced by 11,340.00 kWh or 46.4 % to 12,972.67.

Italy

The testing phase of the Cuneo pilot action on the sloping elevator lasted from October to November 2021, a period characterized by many cloudy days. However the monitoring showed interesting results: during sunny days, the energy produced by the renewable system reached 74 % of the total energy need of the elevator. On average, in the testing month, 21 % of the energy required by the system was produced by the PV/storage system while the remaining 79 % was bought from the public grid. The expected savings in economic terms are equal to about 2.000 € / year while the CO_2 emissions will be reduced of 5,5 tons/year.

Project Partner

- Development agency Sinergija, Slovenia
- Municipality of Lendava, Slovenia
- Energy and Innovation Centre of Weiz, Austria
- 4ward Energy Research GmbH, Austria
- CES clean energy solution GmbH, Austria
- Environment Park Torino, Italy
- City of Cuneo, Italy
- North-West Croatia Regional Energy Agency
- University of Zagreb Faculty of Electrical Engineering and Computing, Croatia
- Climate Alliance, European Secretariat

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