TRANSNATIONAL STRATEGY FOR THE IMPLEMENTATION AND CAPITALISATION OF ENERGY STORAGES IN HUCs

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Content

1. Executive Summary

Starting with an analysis of the actual challenges and objectives of climate and energy related EU policies, the transnational strategy, jointly developed by the partners of the Store4HUC project, aims to provide a set of actions and recommendations for the future promotion of storages in Central Europe regions and capitalization of the main results of the project in the mid-term.

The strategy is part of the evolution of the current legislation at European level, which with the "fit for 55" package will see a reform of the main European directives on renewable energy, energy efficiency and greenhouse gas emissions.

The SWOT analysis of the factors that today influence positively or negatively the diffusion of energy storage systems has been integrated with the experience deriving from the pilot actions of the project, which allowed to test the application of different storage solutions in different contexts and regulatory frameworks. The document formulates a set of 21 actions for the transfer of Store4HUC results and 16 recommendations, divided into 4 categories, for future actions to promote the application of energy storages.

2. Introduction

Urban areas account for 80% of European energy consumption. In order to reach the objective of reducing CO_2 emissions associated with energy consumption through the use of renewable energy sources, storage systems integrated with the use of RES represent an important opportunity in such contexts.

Store4HUC project has the main objective of Improving energy planning strategies and policies to support climate change mitigation in urban centres, by promoting the use and integration of energy storage systems and improving the level of knowledge of relevant public administrations and utilities.

The specific objectives of the project are:

1. Improving energy planning strategies at municipal level, integrating the use of storage systems
2. Providing tools for effective planning and subsequent management of investments in storage systems within urban centres
3. Increasing efficiency in the use of energy from renewable sources through the use of storage systems for different applications (pilot actions)

Collaboration with relevant stakeholders and the application of innovative tools contribute to the implementation of 4 pilot actions, whose results are transferred, together with the lessons learnt, in final recommendations for the future implementation of energy storages at the EU level.

3. The aim of the document

This document describes the transnational strategy for the implementation and capitalisation of energy storages in HUCs, mainly based on the results of the Store4HUC project pilot actions.

The objectives of the strategy are:

- Give recommendations for the improvement in the implementation and use of energy storages to different type of actors and stakeholders
- Provide some recommendations for further implementation of energy storages in European regions
- Capitalize the results of Store4HUC and its pilot actions; transfer and upscale the project results through an action plan involving the project partners and the identified stakeholders

The document mainly addresses local and regional authorities, that are invited to integrate the recommendations in their respective strategies and plans with the double aim of increase the awareness level about energy storages in their communities and increase the efficient use of renewable energy on their territories to face the challenges of energy transition at EU level in the next years.

The strategy is structured in the following sections:

- Common challenges and objectives

  This section describes the actual common challenges at the EU level in relation to the energy transition and decarbonization targets, and how energy storages can contribute to reach these ambitious targets. It presents a SWOT analysis for the implementation of energy storages at the EU level and the policy and regulatory framework in countries participating in the Store4HUC project

- Description of pilot actions and results

  This section describes the main results and best practices implemented in the pilot actions, where different energy storage solutions were tested for different applications and contexts. It also illustrates the tools developed in the project and their application in the pilot actions

- Measures and methods for transferring and upscaling of the project results

  In this section the action plan set up by the project partners is presented. The plan is aimed to describe the measures identified by each partner to transfer the project results at different levels, with the collaboration of the stakeholders and actors involved during the project and the deployment desks.

- Recommendations for further action in energy storages

  This final section presents a list of recommendations based on the results of the Store4HUC project, listed for each of the targets identified: regional authorities, public authorities, local communities and energy technicians.

4. Common challenges and objectives

All EU countries are asked to contribute to the main common environmental target of the EU, which set the ambitious goal to become the first climate-neutral continent in the world by 2050. Climate action is at the heart of the European Green Deal.

Decarbonising the EU's energy system is critical to reach climate objectives. The European Commission will make proposals to increase the EU's climate ambition for 2030, based on some key principles:

- Prioritise energy efficiency and develop a power sector based largely on renewable sources
- Assure a secure and affordable EU energy supply
- Develop a fully integrated, interconnected and digitalised EU energy market

Figure: Pathway to clean energy – GHG reduction targets relative to 1990. EU Commission

In 2019 the EU completed a comprehensive update of its energy policy framework to facilitate the transition away from fossil fuels towards cleaner energy and to deliver on the EU's Paris Agreement commitments for reducing greenhouse gas emissions.

Based on Commission proposals published in November 2016, the Clean energy for all Europeans package consists of eight legislative acts:

- Energy Performance in Buildings Directive;
- Renewable Energy Directive;
- Energy Efficiency Directive;
- Governance;
- Electricity Directive;
- Electricity Regulation;
- Risk-Preparedness Regulation in the electricity sector;
- Rules for the regulator (ACER, Agency for the Cooperation of Energy Regulators)

In particular, the European Clean Energy Package proposed the revision of the European directives on renewables (RED II) and the electricity market. The revision would favour the aggregation of demand and distributed generation, and energy communities as a way to build a digital and intelligent energy management system that stabilises the grid locally and supports big energy utilities in keeping the transmission grid balanced through the provision of services.

Storage systems, by their very nature, are devices designed to provide these services.

In order to meet the target of reducing greenhouse gas emissions by 55% by 2030, the EU has issued the "Fit for 55" package, which contains 13 legislative proposals on energy and climate including amendments to the Renewable Energy Directive (RED III).

Under the proposed update, European countries will be required to define ad hoc measures in their building regulations and support schemes to increase the share of green electricity, heating and cooling in their building stock. This will also include measures to increase self-consumption, local energy storage and renewable energy communities.

4.1. SWOT analysis for the implementation of energy storages at the EU level

Energy storages are more and more one of the key components to enable the clean energy transition of the EU.

The European annual energy storage market reached in 2020 a cumulative installed base of 5,4 GWh, with an increasing trend (source: *https://ease-storage.eu/publication/emmes-5-0-march-2021/, fifth edition of the European Market Monitor on Energy Storage (EMMES)).*

Energy storages have in fact several applications and can provide many different existing and emerging services:

- Generation support services (bulk storage services)
- Transmission and distribution support services
- Ancillary services
- Services providing customer energy management

The present document mainly focuses on generation support services and customer energy management related services, which are at the core of the Store4HUC project.

Strengths	Weaknesses
• Energy storages represent an optimal solution to increase the efficiency in the exploitation of renewable energy sources • Storages increase the possibility to use, for application in Historical Urban Centers (HUCs), energy from renewables that can be massively produced where big plants are located • Storage systems combined with RES systems are able to provide a small, reliable, local grid infrastructure that is more flexible and ready to handle new electrical loads • Energy storages coupled with RES allow primary energy savings and reduction of GHG emissions • Battery storage technologies are increasing their efficiency	• The technology is not completely mature to answer the needs (capacity, dimension, cost) • Higher planning costs due to implementation in a HUC • Higher investment costs due to implementation in a HUC while introducing ecologically acceptable technical solutions • Implementation of storages in a HUC requires special technical solutions • Capacity degradation of battery storage systems over time
Opportunities	**Threats**
• European policies are promoting investments in energy storages • European policies for energy transition and decarbonization	• The reduction in the energy demand, as a consequence of the economic crisis, could reduce business opportunities related to innovation on energy storages

• R&I programs and initiatives to make the use of intermittent renewable sources more effective and efficient • Increasing trend in creation of citizen and renewable energy communities and models based on collective self-consumption. Energy storages can play an important role in the optimization of the balance between produced and consumed energy • “Prosumer” role is emerging, encouraged by digital technologies, smart metering and distributed energy generation approach • Existing best practices in terms of implementing innovative (ecologically acceptable) energy storage systems integrating RES in HUCs • Energy storage solutions represent an effective way to reduce electricity peak demand and lower electricity bills when the final prices of energy and fuels increase due to global dynamics (energy security)	• Regulatory and administrative barriers • Additional permits due to cultural heritage protection laws • Public procurement procedure

Starting from the picture described in the above SWOT analysis, this document aims to provide a summary of the Store4HUC action plan and recommendations based on the pilot activities and lessons learnt.

4.2. Actual policy and regulatory framework in the project countries

Italy

About 18,000 storage systems are installed in Italy (Source: ANIE, 2019), with a total power of 80 MW and a production capacity of 167 MWh. Most of these are distributed storage systems, combined with PV systems. But there is still a long way to go: the Integrated National Plan for Energy and Climate (PNIEC) envisages the installation of distributed storage systems for a total of 15,000 MWh by 2030.

The prevailing technology is lithium, which covers 93% of the number of installations; 99% of the installations are small-scale photovoltaic systems and about 72% of the number of installations have the storage connected on the production side (60% Direct Current); the remaining part is connected on the post-production side.

The measures that currently support the residential storage system are:

- regional calls for tenders;
- the tax deduction of 50% of the value of the investment, recoverable in 10 years;
- the benefit of self-consumption, which leads to savings on the electricity bill;
- the UVAM pilot project for the implementation of Mixed Enabled Virtual Units, through which Terna (National Regulator of Electric Energy Network) remunerates the plants that, by joining together, offer network services necessary for Terna to dispatch the energy of the Storage systems, to keep the operation of the network in safety conditions and assure the continuity of operation.

With regard to Citizen Energy Communities (CEC) and Renewable Energy Communities (REC), the Piedmont Region, with regional law no. 12/2018, promotes energy communities, as non-profit bodies, participated by public and/or private entities, set up to promote the process of decarbonisation of the economy and territories. Such law establishes that at least 70% of the energy produced must be intended for self-consumption by the members of an energy community. The regional law gives the energy communities an "area community" dimension, characterised by a guarantee role played by the promoting municipality, through the adoption of a memorandum of understanding. The energy community has to develop an energy balance and a strategic plan, and the following minimum requirements need to be respected:

- electrical contiguity -the members of the energy community must belong to contiguous electrical "domains"
- the amount of electrical consumption -the annual electrical consumption (of the founding energy community) must be at least 0,5 GWh
- A minimum of 35% of the energy produced for self-consumption must be generated by locally available FER
- A plurality of actors and consumers of electricity must be present

More recently, the Decree Law n. 199, 8 November 2021 (implementation of RED II Directive) has defined some principles for the incentivisation of energy storages:

- the coupling of renewable sources with storage systems shall be promoted, so as to allow greater programmability of sources, including in coordination with mechanisms for developing centralised storage capacity

- the incentive encourages self-consumption and the coupling of non-programmable renewable energy systems with storage systems, so as to allow greater programmability of the sources;
- criteria and modalities are defined for the granting of interest-free financing of up to 100 per cent of eligible costs for the development of energy communities in small municipalities through the construction of RES production plants, also combined with energy storage systems.
- criteria and modalities are defined to incentivise the implementation of off-shore renewable energy production systems, which combine technologies with high development potential together with innovative technologies in experimental configurations integrated with storage systems.
- criteria and procedures are defined for the granting of non-repayable benefits to encourage the construction of charging infrastructures for fast and ultrafast electric vehicles, including those equipped with integrated storage systems

Austria

Till 2030 it is energy political target of Austria to achieve an electricity supply of today about 75 % to 100 %. This energy political target is quite ambitious and needs among the implementation of photovoltaic, wind and hydropower plants storage facilities to effectively use prosumers as a resource for system management, able to increase the renewable fraction of decentralised generators towards a high degree of self-sufficiency and to interact also with energy and ancillary service market.[1] A summarising report of the responsible Austrian ministry is saying that "The switch to an energy supply with 100 % renewable energy sources poses major technical and organisational challenges to our energy system. To be able to guarantee the safe and efficient provision of electricity and heat in the future, new approaches in energy distribution and storage with greater flexibility in energy requirements are needed…" Based on the tradition of using a large number of hydropower plants in Austria "…hydraulic storage power plants with a gross maximum capacity of 8.8 GW and gross electricity generation of 14.7 TWh Electricity storage…" were installed in 2020. At the same time the "…4,385 photovoltaic battery storage systems with a cumulative usable storage capacity of approximately 57 MWh…" were running. Wind power in combination with electricity storage systems are still in the pilot phase. The same report provides the following figures about grid-connected heat energy storage systems: "Of the total of 875 local and district heating networks surveyed, heat accumulators have been installed as an element of flexibility in 572 heating networks over the last 20 years. Tank water storage systems were used almost exclusively in terms of heat storage technology." In 2019 data of 840 water storage tanks of around 569 district heating networks with a total volume of around 191,150 m^3 were collected and analysed. Taking into account an average usable temperature difference of 35 K, this stock has a total heat storage capacity of around 7.8 GWh.[2]

In order to support the development and extension of electric and heat energy storages the Climate and Energy Fund launched the so-called "Storage System Initiative" in 2015, to connect market actors in the storage sector with each other to exchange knowledge and to collate information about how to improve the political and legal framework for energy storages in Austria. The following standard is considered for today: Electric - part of IEC 62485 provides safety requirements for stationary secondary batteries and battery installations.

Apart from the pilot intervention at Weizberg one huge example of a multiple heat energy storage in Austria is HELIOS, a 26 m high large-scale renewable storage system with a diameter of 12 m and a usable

[1] https://www.klimafonds.gv.at/wp-content/uploads/sites/16/eia_05_21_fin_english.pdf

[2] Peter Biermayr, et al. "Energiespeicher in Österreich Marktentwicklung 2020", Berichte aus Energie- und Umweltforschung 35/2021

volume of 2,500 m^3. The district heating storage tank is fed by a 2,000 m^2 solar thermal system, a landfill gas combined heat and power plant and a power-to-heat plant. In the medium term, the aim is to expand the solar thermal collector area to 10,000 m^2. The multifunctional heat storage system is directly integrated into the district heating network. The heat output in regular operation is around 3.5 MW. If required, peak loads of up to 10 MW can be made available.[3] All applications require heat storage tanks with low losses and robust components that can be sensibly integrated into buildings and surroundings. Further developments in this regard are related to the reactor and system optimization as well as new methods of storage loading with high efficiency.

Croatia

New Act on Electricity Market was recently adopted and soon, a new Act on Renewable Energy Sources and High-efficiency Cogeneration should also be adopted. The revised INECP version introduces new, more ambitious targets, especially in the heating and cooling sector, given that this sector was not incentivised to the extent as the electricity sector. These revisions are mostly targeting the RES share in the gross consumption of energy for heating and cooling, which is now aimed at 39,4% instead of 36,6%. The more ambitious target will be made possible using the funds available through the National Recovery and Resilience Plan and Multi-annual Financial Framework. These targets are intended to raise competitiveness and increase market stability.

The functional electricity market model is perceived as a key element that enables the increase in the use of renewable energy and this was one of the reasons for adopting the new Act on Electricity Market. The new Act on Electricity Market for the first time introduces subjects such as active customer and energy community citizens, as well as new energy activities such as aggregation, energy storage, organizing the energy community of citizens and the closed operator of the distribution system. These novelties will enable all end customers to directly participate in the generation, consumption or sharing of electricity. Additionally, the new Act empowers greater access to the information on energy prices of different suppliers and will allow participation in all electricity markets for all end consumers, thus putting the emphasis on distributed generation and equal treatment of citizens producing electricity on a small scale and large power companies. End consumers will also have access to smart metering systems that will provide accurate feedback on energy consumption or production in almost real-time. Another novelty includes the introduction and the emphasis on the role of electromobility, which is considered an important element of the energy transition.

The new legislation specifically brings new opportunities for market participation, introduces active customers and energy communities, as well as new energy activities such as aggregation, energy storage, organizing the energy community of citizens and the closed operator of the distribution system. The new regulatory framework in Croatia should encourage greater competition and enable further development and application of future technologies. It will also bring significant changes in the energy market landscape and some of them may pose a challenge for financial institutions that will have to design appropriate financial models to follow energy communities in their efforts to take part in the energy transition process.

The democratization of the energy sector through greater citizens involvement, a segment that is also strongly underlined in the new Act on the Electricity Market, is expected to empower citizens and increase the number of prosumers in Croatia. With rapid changes in the technology sector and with the cost of PV systems plummeting, the technology cannot be considered a bottleneck of the energy transition anymore and a barrier to wider implementation of PV systems.

[3] https://www.solare-grossanlagen.at/files/pdf/2014_EnergieGrazGmbHundCoKG.pdf

Citizens in Croatia are now interested in setting up energy communities and investing in RES projects, especially after the regulatory changes that acknowledge the energy community as an equal subject on the energy market.

The legislative changes and the emphasis on sustainable investments and projects is an opportunity to establish solar consumer cooperatives, that would aggregate investments to achieve better financial conditions and in turn, increase the number of sunny roofs and storages across Croatia by 2030.

Citizen energy communities are included as equal electricity market players in the EU directives and the new Croatian Electricity Market Act introduces this term together with the rights and obligations of energy communities. While the new Electricity Market Act has recently been adopted, the secondary legislation is still missing so it is not clear how energy communities will be governed by Croatian policy framework.

The number of citizen energy communities in Croatia has seen a steady rise in recent years with Croatian islands leading the way. Although the legislative changes are expected to further boost the number of energy communities, the questions of funding citizen-led investments and speeding up the administrative procedures remain open.

The experience of the Green Energy Cooperative (ZEZ)

In Croatia Green Energy Cooperative (ZEZ) is focused on finding different models to involve citizens and the public sector in planning, development, and investment in RES by creating an ecosystem that will support the growth of such initiatives. According to the survey conducted by ZEZ, citizens are interested and willing to participate in RES investments, especially in their local communities. However, the results of the survey do not paint an accurate picture as the RES investments in Croatia are mostly financed by large companies, regardless of the location.

ZEZ has developed a crowd investing model aimed at financing solar energy projects and linking them with public buildings. Together with the city of Križevci, ZEZ has launched a project Sunny Roofs, where about 100 investors were given the opportunity to invest in two solar power plants on public buildings. The model is based on the model of microloans, in which ZEZ acts as an intermediary between citizens and the owner of the public building. Both, citizens and the owner of the public building have a contractual relationship with ZEZ. Citizens invest in solar power plants via ZEZ and in return realise a certain annual interest on borrowed funds, whereas ZEZ provides solar equipment to the public building owner. The citizens' interest in investing in the project was beyond any expectations, leading to the finished crowdfunding campaign within 48 hours. Riding on the solar wave and generated interest, the city of Križevci have the vision to install 1000 integrated solar power plants on roofs by 2030, which could result in an investment of up to 30 million euros. The Sunny Roofs initiative in Križevci has contributed to the recognition of Križevci, a small city in central Croatia, as a solar roof leader in Croatia and wider.

Despite the large interest from citizens to replicate the Sunny Roofs project on more public buildings in Croatia, there was a lack of interest from public building owners. Additionally, not all public buildings are adequate for installing solar power plants, as many do not use electricity during the summer months, however, with rising prices this will not be a decisive factor in the future. One of the replication bottlenecks is the public procurement procedure, which does not recognise the social factor of public investment, i.e. there is no additional valorisation of the social element such as the involvement of citizens in the investment. However, with the legislative changes, ZEZ is optimistic that there will be a large number of sunny roofs across Croatia by 2030.

Croatian Law on the Protection and Preservation of Cultural Property prohibits any action that could directly or indirectly change the properties, like the shape, the meaning, and the appearance of cultural property and it is obligatory to protect and preserve cultural goods in their pristine and original condition, and to pass on cultural goods to future generations. Therefore, the installation of a photovoltaic system on the roof of a building is impossible and for that reason, it was necessary to look for other solutions to accommodate a photovoltaic system. Given the technologies available today, the legal framework needs to be adapted to simplify the procedures for installing energy storages and photovoltaic systems on historical urban sites. In Croatia, this would enable further integral renovation of buildings that are under cultural heritage protection, which would be adapted to modern requirements and needs. Historical urban sites would thus be modernised and would stop lagging in time. In this way, historical urban sites would become more comfortable to live in, and their market value would increase.

Slovenia

Energy storage is not specifically considered within the Slovenian legislative framework. Given the lack of special status of energy storage and the lack of subsidies, there are pending regulatory burdens and potential disadvantages for investors interested in this particular field. The Ministry of Infrastructure, Directorate for Energy, is the Government body responsible for Slovenian energy policy.

In 2014 the Republic of Slovenia has adopted a new Energy Act EZ-1[4] (Official Gazette of the Republic of Slovenia, No. 17/01 of 7 March 2014), that came into effect in March 2014. This Act lays down the principles of energy policy, energy market operation rules, the ways and forms of providing public services in the energy sector, principles and measures for achieving secure energy supply, for increasing energy efficiency and energy saving and for increasing the use of energy generated from renewable energy sources, lays down the conditions for the operation of energy installations, and regulates the responsibilities, organisation and tasks of the Energy Agency and the competences of other authorities operating under this Act.

On the other hand, historical urban centres (HUCs) are in Slovenia subject of the building and spatial planning laws of the local community and the Slovenian Preservation of Cultural Heritage Act.

Today the Institute for the Protection of Cultural Heritage of Slovenia (Zavod za varstvo kulturne dediščine Republike Slovenije) brings together art historians, archaeologists, architects, ethnologists, historians, landscape architects, sculptors, painters and many other experts, who work in the Institute's Cultural Heritage Service with the seven regional offices located across Slovenia and in its Conservation Centre with its Restoration and the Preventive Archaeology Centres. In 1999 the new Law on Cultural Heritage Protection clearly defined the administrative and professional functions of protection, especially in binding the rights and obligations of heritage owners to a legal document. In 2008 the Preservation of Cultural Heritage Act was adopted, which includes movable as well as non-movable and intangible cultural heritage, defining the tasks to be performed by public services concerning the preservation of cultural heritage and its executants.

Modern heritage protection encompasses more than simply the protection of buildings and objects. By considering the spatial totalities and values of the cultural environment, it brings together the expertise of the fundamental disciplines of archaeology, architecture, ethnology, landscape architecture, history, technical history, art history and urban history, and the specialist knowledge and theoretical approaches of conservation, restoration and preventive archaeology.

In 2016, The Ministry of Culture in cooperation with the Ministry of Infrastructure published a Guidelines for energy renovation of cultural heritage buildings[5].

In addition, all the RES and RUE actions have to be also in accordance with the current valid local strategies like: Local Energy Concept of the Municipality and the current valid Sustainable Energy Action Plan of the Municipality - SEAP.

[4] Source: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6665

[5] Source: https://www.culture.si/en/Heritage_Preservation_and_Restoration_in_Slovenia

5. Description of pilot actions and results

The four pilot actions implemented in the Store4HUC project represent four different approaches to the application of energy storage technologies for a more rational use of the energy produced and the increase in use of renewable energy sources (for electric or thermal energy production) in different contexts.

The 4 pilots globally reached the following outcomes:

- Total mobilized investments: 543.354 Euro
- Expected electric energy savings: 36.408 kWh
- Expected thermal energy savings: 1.730.824 kWh
- CO_2 savings: 30 t/year

The next paragraphs briefly describe the four pilots and their main outcomes.

5.1. PV and storage at the sloping elevator in the city of Cuneo (IT)

Main objectives of the pilot action

The storage was installed next to the sloping elevator, located in the city of Cuneo. The elevator, entirely located within the territory of the Municipality of Cuneo and the urban perimeter area, was built by the Municipal Administration as a permanent public transport system. It links the free car parking area serving the sport facilities near the Gesso stream with the city centre, with the purpose of relocating the parking area for regular users outside the historic 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 is produced by the elevator during some operating phases.

Main technical specifications of the energy storage solution

A specific storage unit consisting of a battery pack, with electronic controls and commands, has been supplied and installed in order to enable the storage of the electrical power produced by the inclined lift and the backing photovoltaic field, and to make it available to the elevator system drive when necessary. Since it must be able to supply alternating current power to the user, the storage unit is equipped with an inverter for DC to AC conversion. This type of device for energy storage is a “hybrid inverter”.

The battery uses long-life Lithium-Iron-Phosphate batteries, not affected by the critical stability and safety issues that other types of lithium-ion batteries have, and featuring a lower risk of fire that allows easier installation in rooms with no need for special protections.

The storage unit is composed of 7 modules with rated capacity of 2.76 kWh/53 Ah for a total capacity of 19.32 kWh.

Results of the pilot action and KPIs

KPI	Initial situation	After the pilot action
External energy needs (kWh/year)	18.226 [kWh]	7.431 [kWh]
External energy cost (€/year)	3.584 [€]	1.486 [€]
CO_2 emissions (t/year)	8,8 [tCO_2]	3,6 [tCO_2]
Autarky rate (%)	0 [%]	53 [%]
Use of energy from RES (kWh/year)	0 [kWh]	8.544 [kWh]
Hours without service interruptions/discomforts	99 [%]	n/a
Average power peak (kW)	5 [kW]	n/a

Barriers and obstacles encountered

The main obstacle encountered since the very beginning of the intervention implementation referred to the innovative character of the project. The integration of a storage connected to a RES within an already existing system proved to be a quite challenging task. Since the intervention design phase, a detailed monitoring of the elevator energy consumption was needed in order to calculate the right dimension of the electric component of the pilot action intervention. Once it was defined, the second challenge was the understanding of how to integrate it with a multidirectional energy flow system, since the energy needed and used by the elevator after the intervention would have been provided by three different sources: the public grid, the PV plant newly installed and the self-production during unbalanced rides.

Beside those technical challenges, the whole implementation faced some difficulties first of all because of the Covid-19 situation, that slowed down the intervention soon during the design phase. Another reason of slowness was due to the hybrid nature of the intervention, made of both electric and structural works, that represented the reason for the first public procurement procedure failure. No offers were presented because the share of electric and structural works was not balanced and a new procedure had to be set up, slowing down the implementation of about 2 months.

Once works have been awarded to the company, a new challenge arose, consisting in the difficulty of providing the materials, above all the electric components of the intervention, highly required throughout the EU and thus less available: this situation ended well, with a slight delay compared to other interventions. The delay was also due to the little amount of materials required for the intervention: the construction company had to wait for a bigger order of the same material needed to get it. Once the components and materials have been delivered, works moved forward quickly, but bureaucratic procedures for the connection of the PV plant to the system took many months, finally delaying a bit more the whole implementation.

All this, summed-up, led to a total delay of the pilot action and of the testing phase that was run for onemonth only. Currently the monitoring is continuing, therefore it will be possible to gather important data on the investment outcomes by the end of the Store4HUC project and after one year from the intervention completion.

One final obstacle, or better a challenge, was due to the little experience of the City of Cuneo staff appointed for the Store4HUC project, in the topic of energy efficiency measures.

5.2. Integration of PV and batteries for energy management of Bracack manor (HR)

Main objectives of the pilot action

The aim of the Bračak pilot project is 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 is 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 and wastewater treatment as well as electric vehicle charging station. The already existing systems will be combined with the new ones through an advanced energy management ICT system that will be built on top of the already existing central monitoring system as decision support for the system operators instructing how to run the micro-CHP and wood pellets boiler on one-day ahead scale, in the presence of the newly introduced photovoltaic and battery system.

Main technical specifications of the energy storage solution

The storage (battery system) is placed in the premises of the Bračak Manor, in the basement next to the stairs. Three-phase battery system has a capacity of 8,0 kWh, together with inverters / chargers and battery management equipment. Some of the technical details are: Max. active power battery 88,5%; Max. active power charging/discharging: 96%; Discharge depth: 100%; Communication: Web interface via Ethernet, external communication via Modbus TCP; Maximum output current: 11.0 A; Nominal output current 9.1 A.

CARBOCAP BATTERY MODULE FOR GREENROCK SYSTEM 6.0 – 10.0

Battery module	GR CC 6.0	GR CC 8.0	GR CC 10.0
Number of modules	3	4	5
Usable capacity	6 kWh	8 kWh	10 kWh
Nom. charge current *1	45 A	60 A	75 A
Nom. discharge current *1	45 A	60 A	75 A
Max. charge current < 1 sec. *1	60 A	80 A	100 A
Max. discharge current < sec.*1	60 A	80 A	100 A
Nominal Voltage	50.6 V		
Voltage Range	44 – 56.2 V		
Dimensions W x H x T	900 x 900 x 450 mm		
Weight	132 kg	169 kg	205 kg

Tested at25°C
*1 Depending on GREENROCK inverter power

Figure: Technical characteristics of the battery
Source: REGEA

Figure : The storage (battery system) is placed in the premises of the Bracak Manor, in the basement next to the stairs (Source: REGEA 2021)

The canopy has a rectangular roof surface measuring 9,44 x 6,39 meters and a total of 36 photovoltaic monocrystalline modules with a capacity of 300 Wp each is installed on it. It is installed 4 rows with 9 modules, which ensure that the entire roof surface is covered with photovoltaic modules. This means that the peak power of the photovoltaic system is 36 X 300Wp = 10,8 kWp.

Figure: Installed photovoltaic modules
Source: REGEA

Photovoltaic system and the battery system are connected to the billing metering point of the Bračak manor where all produced energy is primarily used for own consumption and the surplus is stored in the battery system. If the production of electricity exceed the needs of Bračak Manor and the capacity of the battery system, then the surplus is delivered to the grid. The distribution system operator, as one of the stakeholders, was informed from the beginning about the implementation of the pilot project and its task was to issue the prior electricity approval required for the connection to the distribution network.

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%. These electricity savings will also generate savings on electricity bills for HRK 23,739.21 per year.

Results of the pilot action and KPIs

KPI	Initial situation	After the pilot action
External energy needs (kWh/year)	138.219,76	126.879,76
External energy cost (€/year)	10.882,87	9.295,27
CO_2 emissions (t/year)	17,25	14,59
Autarky rate (%)	0	8,2
Use of energy from RES (kWh/year)	0	11,340
Hours without service interruptions/discomforts	8759,32	8759,32
Average power peak (kW)	22	8,5

With the installation of a battery system and the installation of a photovoltaic power plant is expected to reduce the annual cost of electricity. It is also expected that the consumption of pellets decreases due to the improved central monitoring system and a more frequent usage of micro-CHP when it is economically beneficial, as the application of Module 2 of the energy management tool has shown. It is estimated that in the future the average annual cost for energy will amount to HRK 52,859.76 (EUR 7095.27 according to the middle exchange rate of EUR 1 = HRK 7.45)

The calculation of savings was made based on a comparison of electricity bills in the year before and after the installation of a photovoltaic power plant (compared, for example, 10/2020 with 10/2021, etc.). Now, the productivity of photovoltaics is very low and will be so until April 2022, when the time with better insolation starts again. Actual savings will be visible only after a year of using the system because we are currently in the wrong (winter) part of the year in which the production is small. Without the input of energy from the photovoltaic system, the battery system itself also has no effect on consumption (there is no point in putting energy from the mains into the battery). The point of the storage management system (battery) is that in the summer months in the day mode the part of the energy that is produced and is not currently consumed (in the morning) is stored and consumed in the night mode. In this way, the transfer of surplus energy to HEP's network is avoided because it does not make financial sense (HEP pays much less for purchased energy than it charges for energy from the network - the ratio is approximately 26 lipa-0,035EUR to 1 HRK – 0,13 EUR per kWh).

Barriers and obstacles encountered

Due to the need of obtaining a building permit for the installation of the photovoltaic system, whose proceedings lasted more than two months, the start of execution of works was slightly delayed. Also, due to the COVID 19 pandemic, the manufacturer of the designed battery system could not deliver the equipment in due time, so the deadline for the execution of works was extended.

Construction officially started on 28.10.2020, while the commissioning was done on November 2, 2020. Construction works were completed on 30.06.2021. Due to the need of obtaining a building permit for the installation of the photovoltaic system, whose proceedings lasted more than two months, the start of execution of works was slightly delayed. The works on the construction of the solar power plant have been completed, the solar power plant is in operation. The works were not performed within the deadline as defined in Annex II of the contract because no technical inspection was held, that is the conditions of the Contract were for the issued permit to be considered a successful completion of the works. On that occasion, the contractor received an extension until 30.09.2021. After eliminating all deficiencies, the Administrative Department for Physical Planning, Construction and Environmental Protection, Zabok issued on 23.11.2011. decision (Use permit, CLASS: UP / I-361-05 / 21-01 / 000097, REGISTRATION NUMBER: 2140 / 01-08-5-21-0011 dated 26.10.2021) which became final.

The biggest obstacle to the improvement and greater use of renewable energy sources and energy storages in buildings under cultural heritage is the insufficiently adapted legal framework to new technologies. Croatian Law on the Protection and Preservation of Cultural Property prohibits any action that could directly or indirectly change the properties, like the shape, the meaning, and the appearance of cultural property and it is obligatory to protect and preserve cultural goods in their pristine and original condition, and to pass on cultural goods to future generations. Therefore, the installation of a photovoltaic system on the roof of a building is impossible and for that reason, it was necessary to look for other solutions to accommodate a photovoltaic system. Given the technologies available today, the legal framework needs to be adapted to simplify the procedures for installing energy storages and photovoltaic systems on historical urban sites. In Croatia, this would enable further integral renovation of buildings that are under cultural heritage, which would be adapted to modern requirements and needs. Historical urban sites would thus be modernised and would stop lagging in time. In this way, historical urban sites would become more comfortable to live in, and their market value would increase.

5.3. Themal energy storage in Weiz (AT)

Main objectives of the pilot action

A central thermal energy storage was integrated into the existing heating plant of the local district heating network in the historic monument and landscape protection zone of Weizberg. The storage was combined with a new control system providing a fully integrated and intelligent load management.

Before the storage was installed, the heating plant was often operated in a disadvantageous part-load range. This operation led to increased fuel consumption and pollutant emissions (CO, NOx, dust and volatile unburned CnHm emissions). In addition, the heating network was used as a thermal buffer to absorb the heat supplied by the boilers, particularly in the burnout phase, in order to be able to supply the decentralised hot water storage tanks at the customers' premises. In this way, the heating network was constantly maintained at correspondingly high flow temperatures and unnecessary heat losses of the network (distribution losses) occurred.

The implementation of the fully integrated, intelligent load management of all system components in interaction with the central thermal energy storage and the decentralised storages at the customers' premises made it possible to minimise the disadvantageous operating mode of the boiler plant and prevent the local heating network from being used as a thermal buffer. In that way these measures increased the flexibility and energy efficiency of the entire biomass heating plant.

Main technical specifications of the energy storage solution

The local heating network with a grid length of 773 m was built in 1999 and is currently supplying 12 consumers. Two biomass boilers with a maximum capacity of 300 kW and 540 kW are used for the heat production. The sold heat amounted to 1,476 MWh in the heating season 20/21.

As storage a water buffer tank with a capacity of approximately 38 m³ was installed. To meet the requirements of the protected area of Weizberg, the storage was installed mostly underground below the ground level, so that only a part of the storage is visible from the outside. A specially adapted design (colour, geometry) for the visible parts and a minimally invasive integration, in order not to influence existing natural conditions such as trees and bushes, was used.

In combination with the storage a new control system with a coherent load management through mutual communication of all system components (boiler system, storage tank, network and decentralised storage tanks at the consumers) was integrated. The controller MR-12 from the company Schneid is used for that.[6]

Results of the pilot action and KPIs

The following positive effects have been achieved:

- Use of the heating network as a thermal buffer is avoided → lower heat losses (distribution losses), optimised fuel utilisation
- Operation of the heating network during the summer months only at certain times when hot water is required and after communication with the decentralised storage → Lower heat losses (distribution losses) and savings on pump energy
- Saving of primary energy (fuel savings) by increasing efficiency → CO2 savings through lower energy expenditure for the provision of the wood chips (production, transport, etc.)
- Lower emissions of pollutants (carbon monoxide (CO), dust, NOx and volatile organic carbon compounds (CnHm))
- Increase of the service life of the plant components
- Considerable saving of ecological resources for the production of a new boiler plant, which would result from avoiding the early complete replacement of the boiler plant

KPI	Initial situation	After the pilot action
External energy needs (kWh/year)	1,833,500	1,812,965
External energy cost (€/year)	51,338	49,625
CO_2 emissions (t/year)	29.34	29.01
Autarky rate (%)	0	0
Use of energy from RES (kWh/year)	0	0
Hours without service interruptions/discomforts	99.23 %	99.65 %
Average power peak (kW)	476	409

[6] Schneid Gesellschaft m.b.H. (2020): MR12 Basismodulregler mit AKP; https://schneid.at/product/mr12-basismodulregler-mit-akp/; last access 10.03.2020

It should be noted that the monitoring phase was affected by COVID-19 related measures. Due to lockdowns and other restrictions in Austria, the largest heat consumer of the grid, a hotel including a restaurant, was closed for a longer period. The resulting lower heat demand had an influence on the calculated KPIs after the pilot action.

Barriers and obstacles encountered

No major barriers or obstacles have been occurred during the planning and construction phase of the Weizberg pilot. Even due smaller COVID-19 related delays, the commissioning of the system could be carried out as planned and the pilot was completed before the heating season 20/21 started.

5.4. Energy storage in the public library of Lendava (SLO)

Main objectives of the pilot action

The main objective of the pilot project was the replacement of the existing Oil-Fired Boiler in Lendava Library (public building) with a renewable energy source. The building has been connected to the existing geothermal district heating network to increase the share of T_{hwe} public sector.

Lendava Library is now the last connection in the geothermal district heating network and the supply is not stable - the supply medium temperature will/cannot be constant. This was the main reason, why the owner did not change the fossil fuel in this building yet - the storage selection in the pilot is crucial, to change into RES. The properly selected storage has in this case ensure the stable supply for end users.

An innovative solution of energy storing system has been installed in the basement of Lendava Library to increase the level of energy efficiency in public buildings (related to the higher efficiency of the heating system). Paraffin cells are modern and innovative buffer storages that have been developed to efficiently store heat and cold generated from small irregular energy sources such as solar energy, heat pumps etc. Thermal energy storage technologies and geothermal district heating systems have the potential to play a significant role in the transition towards 100% renewable energy systems through increasing system flexibility and overall efficiency and thus reduce CO_2 emissions and increase domestic energy security and additionally reduce the costs of heating. The advantage of paraffin used storages compared to regular water storages: requires less space, which is very important in case of Lendava Library.

Main technical specifications of the energy storage solution

Before the investment the average annual heat consumption of the Lendava Library was 84.351 kWh on a heated area of 596 m^2. Together with the electric consumption (32.653 kWh), it has an annual energy consumption of 196 kWh per square meter.

In the existing boiler room where the old oil-fired boiler is located, an indirect heat station has been installed for the purpose of heating. To reduce the peak heat load, a PCM (phase change material - change of liquid/solid phase) storage tank has been installed, which enables the storage of thermal energy at a selected temperature potential of around 50°C. The existing hot water distribution from the neighboring Kranjčeva street, which already supplies multi-residential buildings with numbers 2, 4, 6, has been used for connection to the existing geothermal district heating. The power of the planned heating substation is 70 kW. The length of the new connection to the heating pipeline is 65 m.

In case of Lendava library, we were also limited by the operating temperature of the district heating, which is low, and with the required indirect connection to the heating system, the flow temperature is further reduced by 5°C, if we take into account the losses of pipelines. In energy terms, the PCM storage tank used is already a proven technology in some countries in EU. This solution of course cannot be regarded as the most cost-effective solution compared with other storage technologies (for example: water buffer tanks), but due to the additional problems with lack of space in the Lendava Library (e.g. the problem of low basement height) and due to the several positive effects of paraffin based latent storages, this is the appropriate solution.

Latent paraffin storage tanks consist of a classic heating water storage tank filled with balls that have a paraffin filler (PCM). At a temperature withdrawal of 45/30°C, energy can be absorbed during the day, distributed overnight and in the morning.

Thermal energy storage technologies and geothermal district heating systems have the potential to play a significant role in the transition towards 100% renewable energy systems through increasing system flexibility and overall efficiency and thus reduce CO_2 emissions, increase domestic energy security and additionally reduce the costs of heating.

Results of the pilot action and KPIs

As a result of the connection to RES and newly implemented storage in accordance with the newly implemented control and EMS system, the following positive general effects have been achieved:

- Increased energy efficiency of the system by changing the heating system from energy inefficient (old Oil-Fired boiler) to efficient (DHS) → min. primary energy savings → CO_2 saving through lower final energy consumption
- Reduced pollutant emissions by changing from fossil to renewable energy source (carbon dioxide - CO_2, carbon monoxide - CO, dust and other greenhouse gas emissions as NOx and CxHy)
- Exploitation of local renewable energy – geothermal energy
- Extension of maintenance intervals → lower maintenance costs (no maintenance on heating system and low maintenance cost on storage).

KPI	Initial situation	After the pilot action
External energy needs (kWh/year)	84.350,9	69.930,0
External energy cost (€/year)	8.460,45	2.102,42
CO_2 emissions (t/year)	23,53	0,00
Autarky rate (%)	0	0
Use of energy from RES (kWh/year)	0	0
Hours without service interruptions/discomforts	8.672,4 (99 %)	8.760 (100 %)
Average power peak (kW)	22,25	21,60

Barriers and obstacles encountered

Due to the Covid-19 pandemic the construction work and all planned stakeholder engagement meetings had to stop for some weeks in the last quarter of 2020. This situation resulted in the building phase starting in January 2020. Before the construction work the most important obstacle was also to find a suitable expert for geothermal district heating in connection with PCM storages and in parallel to find a suitable product on the market which would lead to the expected results.

Due to the Corona-19 virus also almost all planned stakeholder engagement meetings were adapted. However, energy experts (for example the Consortium of Slovenian Local Energy Agencies) to the project of Lendava pilot connected, got valuable and transferable experience in the field of this “new” technology in connection with low temperature geothermal energy. Local authorities have been involved in the procurement and communication processes as harbingers providing the necessary permits of the site and for future other projects. Pilot-related socio-economic aspects are investigated during and after the construction work. We even suggest to include more stakeholders (experts from different sections) immediately at the start of the project/measure to avoid delays related to bureaucracy and also to market research in case of an innovative solution (to find a suitable product on the market).

As with all construction measures at sites listed as monumental and landscape protected, the greatest challenge for the pilot in Lendava was to harmonise the additional regulations and requirements of monument and landscape protection with the objectives of the implementation.

5.5. Store4HUC tools for energy management

5.5.1. Autarky Rate Tool

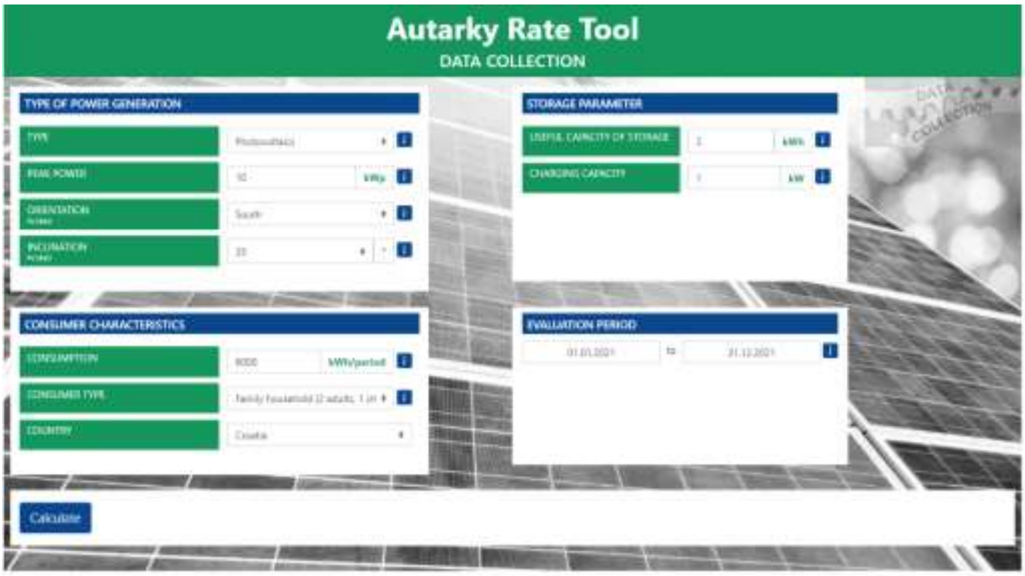
The Autarky Rate Tool is a simple but very useful online tool which is available for everyone who is interested in the installation of electrical storage solutions in combination with renewable energy sources. By adding only a few numbers, the user will get an evaluation of the

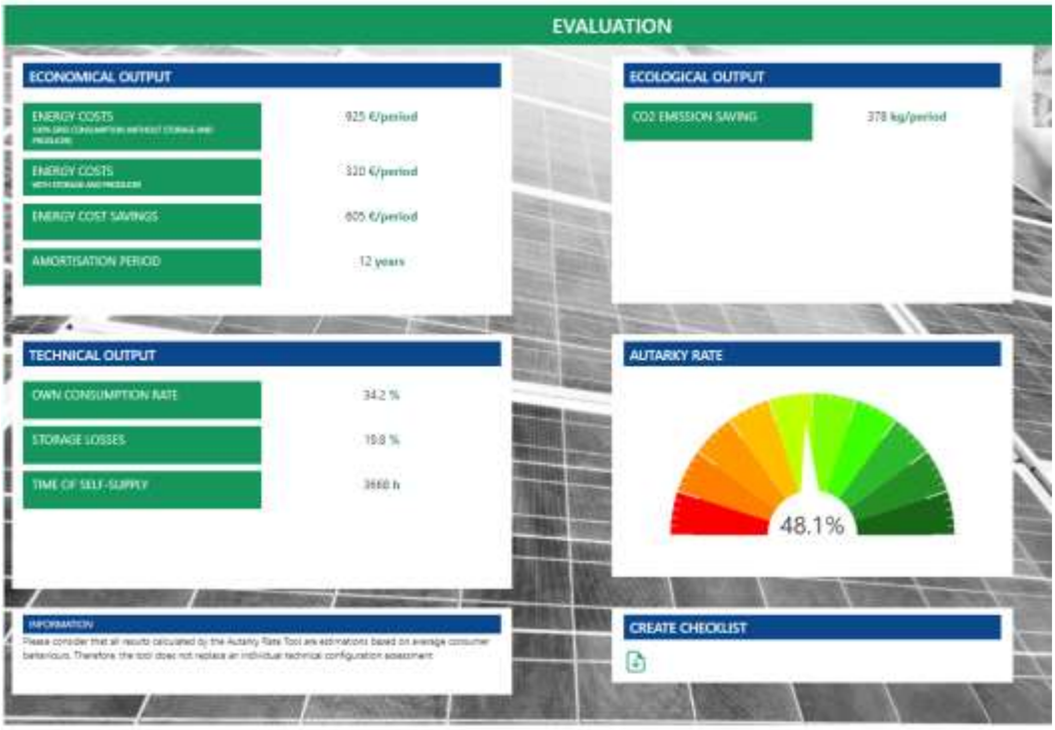
- technical,
- economical and
- ecological

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 storage in a historical urban centre (HUC), a further page is added, which provides them with additional information and advices from the Store4HUC project.

The tool does of course not replace an individual technical configuration assessment, but it gives a good overview 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 English, German, Italian, Slovenian and Croatian on: https://store4huc-autarky.4wardenergy.at.


Autarky Rate Tool
DATA COLLECTION
TYPE OF POWER GENERATION
STORAGE PARAMETER
CONSUMER CHARACTERISTICS
EVALUATION PERIOD
Calculate


EVALUATION
ECONOMICAL OUTPUT
ENERGY COSTS
925 €/period
ENERGY COSTS
320 €/period
ENERGY COST SAVINGS
605 €/period
AMORTISATION PERIOD
12 years
ECOLOGICAL OUTPUT
CO2 EMISSION SAVING
378 kg/period
TECHNICAL OUTPUT
OWN CONSUMPTION RATE
34.2 %
STORAGE LOSSES
TIME OF SELF-SUPPLY
AUTARKY RATE
48.1%
CREATE CHECKLIST

5.5.2 Optimal sizing calculator

To maximize the contributions while minimizing the price of the installations, the Optimal Sizing Calculator computes the optimal sizes of a Photovoltaic (PV) and a battery energy storage system (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. The calculator uses typical yearly consumption profiles of a variety of consumers, but if you have your own consumption profile recorded you can use it to calculate your optimal parameters more accurately.

Input information for the tool:

- Country: Austria, Croatia, Slovenia, Germany, or Italy
- Type of user: domestic, industrial, or tertiary use profiles
- Annual electricity consumption
- Maximum payback time
- Maximum economic investment
- Maximum installable PV power

The tool allows you to optimise the investment based on the following criteria (objective functions):

- Amount of energy drawn from the grid
- Annual cost of energy taken from the grid
- Total annual expenditure (sum of cost of energy taken from the grid, initial investment cost and annual maintenance cost)

Finally, it returns the optimal value of the following parameters based on the chosen objective function:

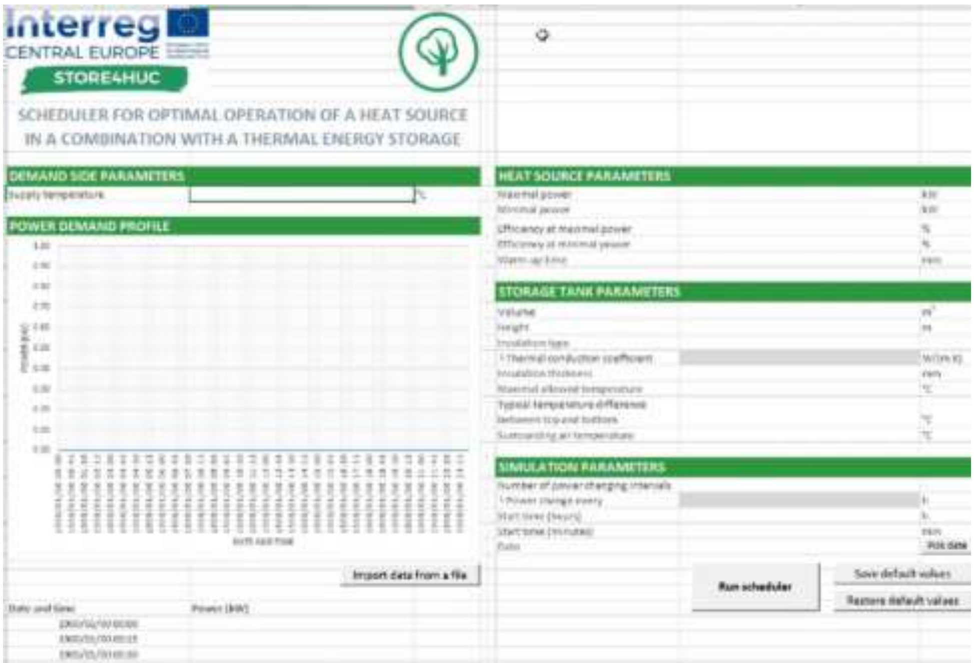
- Optimal capacity of electrical storage [kWh]
- Optimal converter power [kW]
- Optimum output of the photovoltaic system [kW]

The tool is available at: https://www.interreg-central.eu/Content.Node/Store4HUC.html

5.5.3 Optimal heat source scheduler

Installing a thermal storage to a heating system introduces flexibility which provides the possibility to control heat source(s) more efficiently. To ensure the maximal efficiency, the Optimal Heat Source Scheduler provides the user with an optimal schedule for the selected heat source(s) for a 24 hours period.

The tool includes powers of the respective heat source and provides the heat source on-off times. Furthermore, it uses the estimated heating power demand to create an optimal schedule, keeping the heating medium at the respective required temperatures.



The tool is available at: https://www.interreg-central.eu/Content.Node/Store4HUC.html

6. Measures and actions for transferring and upscaling of the project results

Category of measure	Action	Time	Involved organizations
Policy level	Dialogue with Piedmont Region (energy sector) to include promotion of storages in future energy plans	31.12.2022	Environment Park
	Dialogue with Local Energy Agency Pomurje (energy sector - "Regional Development Network of the Pomurje Region") to include promotion of storages in future regional energy plans	31.12.2022	RA Sinergija
	Dialogue with Thannhausen (energy sector) to include promotion of storages in future energy plans SECAP	31.07.2022	WEIZ
	Communication with Ministry of Culture to propose changes and adapt legal framework of historical sites to new RES technologies in Croatia.	31.12.2022	REGEA
	Dialogue with Piedmont Region (innovation sector) to include the development of storages in the funding initiatives for R&I in energy sector	31.12.2022	Environment Park
	Promotion of storages in future energy plans on local level (Local energy concepts, SEAP´s, etc.)	31.12.2022	RA Sinergija
	Meetings with local Stakeholders for further improvements of the Biomass district heating Weizberg	31.5.2022	Weiz
	Adaptation of the legal framework to simplify the procedures for installing energy storages and photovoltaic systems on historical urban sites. In Croatia, this would enable further integral renovation of buildings that are under cultural heritage, which would be adapted to modern requirements and needs. Historical urban sites would thus be modernised and would stop lagging in time. In this way, historical urban sites would become more comfortable to live in, and their market value would increase.	31.12.2022	REGEA

Category of measure	Action	Time	Involved organizations
	Include in the agenda of the regional innovation cluster on energy technologies (CLEVER) a specific topic on energy storages	30.6.2022	Environment Park
	Dialogue, through the National Consortium of the Energy Agencies of Slovenia, with the energy competent Ministry to include promotion of energy storages in future national energy plans	31.12.2022	Local Energy Agency Pomurje
	Integration of storages for biomass district heatings in the municipality of Thannhausen	28.8.2022	Weiz
Training and capacity building	Support of the ITS on energy efficiency (tertiary school) in the development of a training module on energy storages, to be integrated in the curriculum of students of energy plant and building manager	30.9.2022	Environment Park
	Transfer the developed tools through the National Consortium of the Energy Agencies of Slovenia to stakeholders in other SI regions	31.12.2022	Local Energy Agency Pomurje
	Support and promote the developed Autarky Rate Tool	30.4.2025	4ward Energy
	Support of stakeholders from Krapina-Zagorje County in the implementation of renewable energy sources in historical sites. They will gain additional experience and knowledge that will allow all processes to be shorter in the future when implementing similar projects.	31.12.2022	REGEA
Networking and knowledge exchange at EU level	Transfer of the project results through a next Interreg project aimed to contribute to EU common challenges. Partners agree to capitalize the experience and the Store4HUC approach in a project focused on different applications and services of storages, in particular on the contribution to the balance of the energy network, peak loads control and reduction of the energy feed in.	31.12.2022	Environment Park, 4ward energy, WEIZ, REGEA, RA Sinergija, Local Energy Agency Pomurje
	Participation as a stakeholder in the extended network of the	31.12.2022	Environment Park

Category of measure	Action	Time	Involved organizations
	StoRIES (Storage Research Infrastructure EcoSystem) initiative		
Research & Innovation	Demonstrate the use of storages based on hydrogen technologies for the pilot applications identified in Store4HUC, involving the consortium in joint R&I projects	31.12.2022	Environment Park
	Continuous research work and implementation of innovative projects on thermal energy storage technologies and geothermal district heating systems, that have the potential to play a significant role in the transition towards 100% renewable energy systems	31.12.2022	Local Energy Agency Pomurje
	Presentation of Store4HUC results on the 4th edition of SSPCR 2022 in Bolzano (18th to 22nd of July 2022) and ISEC Graz (International Sustainable Energy Conference) on 5th till 7th of April 2022	31.7.2022	4ward Energy
	Energy management of the versatile energy systems in the Bračak Manor including heating, cooling, energy production and storage, to investigate which are the economically and ecologically most favourable technology mixes on historical sites. Target groups will thus benefit from future renovations of historical urban sites because they will have the best example of which technology is most cost-effective.	31.12.2022	REGEA

7. Recommendations for further action in energy storages

The following table presents some recommendations, based on the experience of Store4HUC project. Each recommendation addresses different targets and specific aspects (technical, economic/financial, political, legislative).

Type	Target	Recommendation
Legislative	Regulation authorities	Implement technical and political working groups with stakeholders from R&I and energy policy experts, on how to strengthen the national legal frameworks in the field of energy storages and provide common guidelines for storage installation
Economic/financial	Regulation authorities	Support of storages implementation through dedicated calls for funding of research and innovation actions in the sector
Technical	Public authorities and local communities	Include the potential of energy storage among actions of local sustainable energy plans (SECAP) to maximise the use of renewables in reducing GHG emissions
Political	Public authorities and local communities	Promote storage as a technology for creating smart energy networks in the territory, integrated with public utility services (e.g. charging stations with bidirectional inverters, vehicle to grid) Promotion of storage systems in public and private building rehabilitation (minimum standards and awarding criteria in building and construction regulations)
Political	Public authorities and local communities	Include the wide implementation of the energy storages in future energy plans on regional/local level (Local energy concepts, SECAP´s, etc.)
Technical	Public authorities and local communities	Transfer capacity building to energy experts in the selection of the best technologies, in collaboration with R&D organizations and energy clusters
Technical	Public authorities and local communities	Transfer capacity building to energy experts in the field of innovative thermal energy storage technologies in connections with RES in the transition towards 100% renewable energy systems

Political	Regulation authorities	Storage related measures to be included in the strategic plans (national, regional and local) that set the energy and GHG reduction targets at 2030, 2040 and 2050
Economical/Financial	Public authorities and local communities	Publication of public open tenders for the provision of subsidies promoting investments in energy storages for residential/commercial buildings, industrial processes and public buildings
Economical/Financial	Regulation authorities	Definition of incentive schemes for the implementation of RES systems integrated with energy storage systems, as foreseen by the RED II Directive
Economical/Financial	Regulation authorities	Institutionalisation of schemes for remuneration of grid services offered by storage systems, capitalising on pilot experiences in the different countries
Technical	Public authorities and local communities	Dissemination of best practices and capacity building in the implementation of Renewable Energy Communities and Citizen Energy Communities foreseen by the RED II Directive and the 2019/944 Directive (Electrical directive)
Political	Regulation authorities	Ensuring non-discrimination of small storage systems in the market for services providing flexibility, balancing and storage capacity for energy networks
Legislative	Regulation authorities	Expand the scope of articles 21 and 22 of RED II Directive on renewable self-consumers and RES communities, in the next RED III, to incentivise smart charging and vehicle to grid applications, which can maximise the uptake of RES in transport sector
Economical/Financial	Regulation authorities	Support the transition of traditional manufacturing sectors and value chains (chemicals, automotive, electric and electronic equipment) to the production and process integration of storage solutions (battery factories, electric vehicles, ...)

Political	Regulation authorities	Definition of common guidelines and standards for the localisation and optimal installation and integration of energy storages and vehicle charging infrastructure in urban centres, both for stationary applications and vehicle-to-grid solutions in the transport sector

8. Conclusion

The actual EU targets for a fast energy transition and neutralization of GHG emissions represent a very favorable framework for the implementation of energy storages.

In fact, energy storages provide very different services to answer many of the actual energy and climate related challenges: increase and optimization in the use of energy from RES, effective and efficient management of energy networks, valorization of the active role of citizen and operators in the contribution for a clean energy future.

It is challenging to provide a low carbon energy supply in cities in a style of energy storages. Especially in historical urban centres it is very difficult to achieve these results, because interventions in this specific area meet strict architectural protection constraints, involve higher implementation costs and often come in conflict with town planning policies. Therefore, one of the main objectives of the Store4HUC project was also 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, in respect with key ethical and technical guidance and recommendations on heritage interventions brought by most relevant European and international institutions that deal with heritage protection and conservation such as UNESCO, European Commission, Architects' Council of Europe and above all ICOMOS - International Council on Monuments and Sites, only global non-government organisation dedicated to promoting the theory, methodology, and scientific techniques to the conservation of heritage. All those international charters for the conservation and restoration of monuments, starting from The Venice Charter (1964) up to more recent The Valletta Principles for the Safeguarding and Management of Historic Cities, Towns and Urban Areas (2011), The Paris Declaration On heritage as a driver of development (2011) and most recent documents delivered in the framework of the European Year of Cultural Heritage 2018; Leeuwarden declaration on adaptive re-use of the built heritage: preserving and enhancing the values of our built heritage for future generations and European Quality Principles for Cultural Heritage Interventions insist on following:

- investments in cultural heritage that are bringing benefits across the four areas of sustainable development: economy, culture, society and the environment;
- re-use of heritage monuments that will make them sustainable and comfortable for modern use and in that way will bring to prolongation of their life;
- on multidisciplinary usage of knowledge and skills form different disciplines;
- on using a new solution to emphasise and strengthen cultural values and give added value to a monument or site;
- on bringing new functions to heritage monument that respond to community needs;
- on reuse of heritage sites that can generate new social dynamics in their surrounding areas and thereby contribute to urban regeneration;
- on smart renovation and transformation of heritage sites that can find new, mixed or extended uses.

The RED II Directive and the national policy frameworks identify the necessity to promote RES production plants integrated with energy storages, though a lack of common guidelines and standards is still registered as a limit for a massive dissemination of storages. The benefits of the storage installation as a support to the distribution and transmission networks, or the importance of energy communities for a more rational use of RES in the energy transition, for example, are not yet fully recognized.

Empowering citizens to become active participants in the energy transition is at the cornerstone of all EU climate and energy agendas. Despite the changes in the incentive distribution system for renewable energy, it is necessary to put in place enabling frameworks that encourage further investments and empower citizens to actively participate as prosumers. Another obstacle in the process of creating a space in the market for renewable energy communities to operate in it are the current and proposed state aid guidelines issued by the DG Competition. State aid guidelines need to be more democratic and allow renewable energy communities to access national support schemes for renewables.

The interest in establishing energy communities and cooperatives is affected by the lack of will by large investors to include local communities in renewable investment projects.

One of the replication bottlenecks is the public procurement procedure, which does not recognize the social factor of public investment, i.e. there is no additional valorization of the social element such as the involvement of citizens in the investment. Indicators regarding the social component of a public investment should be considered in the future revisions of national public procurement framework.

Energy storages, and photovoltaic systems as well as the smart building management systems are important for the development of a sustainable energy system in HUCs and these systems play an important role in Energy transition. The biggest obstacle to the improvement and greater use of renewable energy sources and energy storages in buildings under cultural heritage is the insufficiently adapted legal framework to new technologies.

Although scaling up of technological innovations in energy, buildings, transport, industry and agriculture sectors is required to ensure the transition to a cleaner energy system, technological advances need to be embraced by citizens to have the desired impact and fulfil climate ambitions. To achieve decarbonization goals, the EU and the member states are pushing for a holistic approach and are seeking to account for social innovation, citizen investment models and participation of all stakeholders in the energy transition. Empowering citizens to become active participants in the energy transition is at the cornerstone of all EU climate and energy agendas.

Citizen-led sustainable energy projects can be perceived as less attractive to traditional investors due to their complexity, limited profitability and an often-large number of involved stakeholders. Despite these initial challenges, local sustainable energy projects have more to offer and can bring considerable benefits to the local community, from triggering new sustainable energy measures and raising awareness of citizens, to creating local jobs and generating stable returns for the community’s investors. One of significant benefits is enabling better uptake of renewable energy through creating sense of ownership in general population and by providing citizens with opportunity to directly benefit form energy transition. These benefits, often overlooked by the initial challenges, make citizen energy communities ideal partners for the development of sustainable energy projects.

A multiple set of recommendations was identified to overcome the identified barriers to a greater diffusion of energy storages, some addressing the regulation authorities and other the public authorities and local communities.

There include legislative recommendations (new scope for next RED III Directive), economic/financial recommendations (incentivization schemes, funding for storage investments, conversion of traditional manufacturing value chains, remuneration of grid services), political (common guidelines, promotion of energy storage related measures in the sustainable energy tools), technical (capacity building and training).

USEFUL LINKS:

- https://www.iea.org/reports/energy-storage (IEA tracking report on storages, November 2021)
- https://ease-storage.eu/ (EASE, European Association for Storage of Energy)
- https://www.eba250.com/about-eba250/?cn-reloaded=1 (EBA, European Battery Alliance)