Interreg
EUROPEAN UNION
Danube Transnational Programme
CSSC LAB

PROMOTING CITY STORAGE AND SECTOR COUPLING SOLUTIONS

CSSC Lab Guidebook

Project co-funded
by the European Union (ERDF, IPA, ENI).

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Introduction

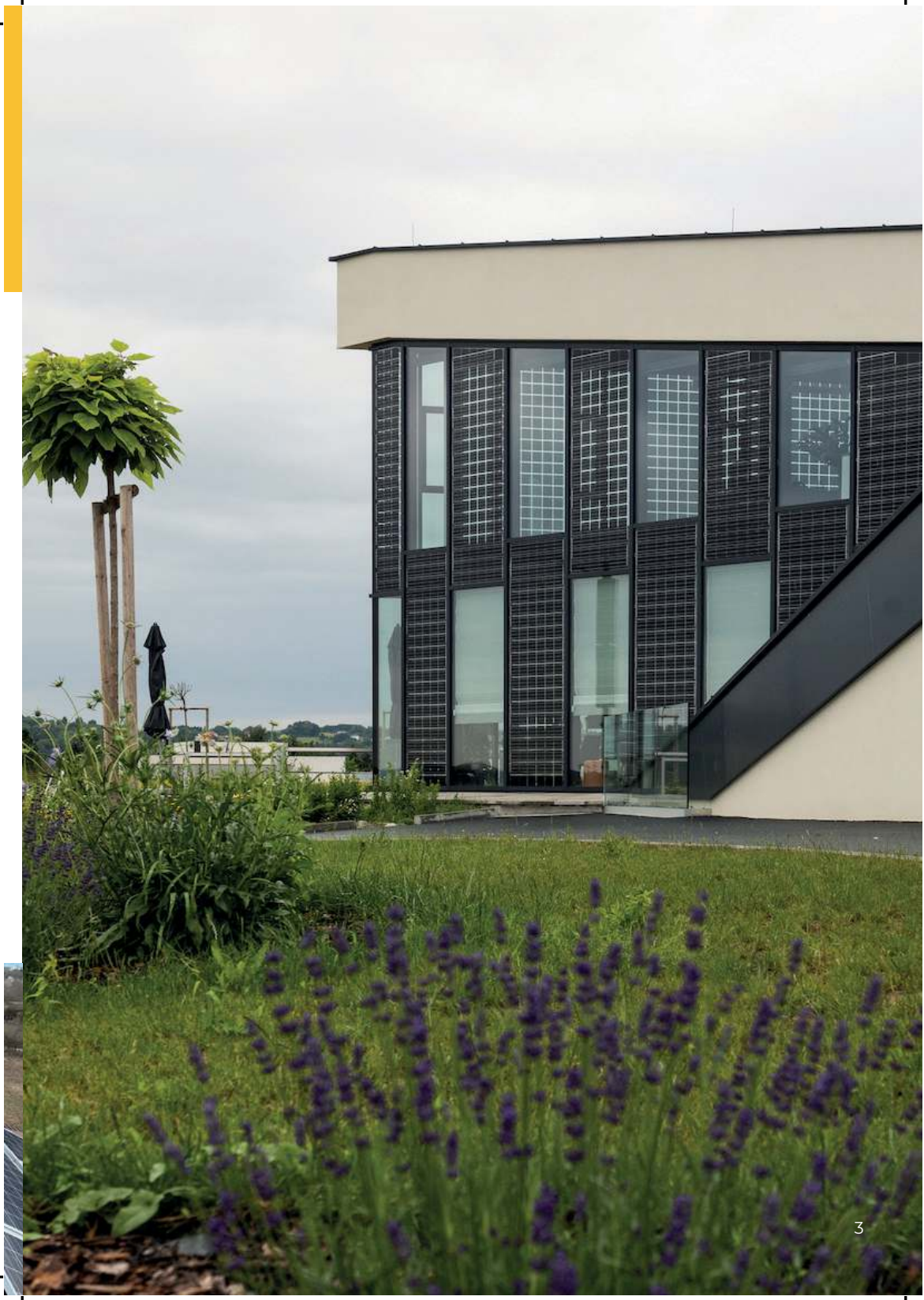
Purpose of this guidebook

This guidebook was created to accompany potential replicator cities through the CSSC Platform and its content. The CSSC Lab project has acquired a wealth of knowledge throughout its lifetime and wishes to share this with its stakeholders. It has been written in such a way as to make the project know-how as accessible as possible.

What this guidebook is not:

- A step-by-step guide on how to install different CSSC technologies
- A financial guide on setting up demo centers
- A technical handbook

This document is not only available in English but its abstract has also been translated into 7 other languages.



About The CSSC Lab Project

City Storage and Sector Coupling Lab (CSSC Lab) is an INTERREG-financed project, which run from July 2020 to December 2022. It tests and supports the roll-out of innovative city storage and sector coupling solutions at the municipal level in Europe. For this, it relies on the know-how of its 17 project partners and 12 associated strategic partners. Since the partnership is made up of representatives from 11 Danube region countries including the Western Balkans, it demonstrates the relevance of city storage and sector coupling solutions in a variety of contexts.

It is widely recognised that there is immense potential for city storage and sector coupling in small and medium-sized cities in Europe. However, for this potential to be seized, capacities must be built at municipal level. Equipping local administrations with the necessary skills to implement city storage and sector coupling solutions will help boost such initiatives. This in turn will enhance energy security and energy efficiency locally while equally contributing to meeting the EU's climate targets.

In order to achieve this, CSSC Lab also supports the launching of 4 demo centers in four partner regions namely, Austria, Bulgaria, Croatia and Slovenia. Each lab tests a different technology and features a range of solutions for energy production, storage, utilisation and management. The main purpose of these centers is to serve as an example for municipal and city representatives as well as potential investors to encourage them to start similar projects at local level.

Other activities in the project such as the regional action planning process, the creation of model solutions and the capacity building programme for municipal actors will contribute to reaching the

project goal of enhancing the application of CSSC technologies in the Danube region. The CSSC Lab Platform is a key tool for capturing all this expertise and making it available to relevant stakeholders and interested parties.

Find more at:

www.cssclab.eu

@cssclab

Highlights from The CSSC Lab Project

Model solutions
Six model solutions have been identified, which are considered most appropriate for the cities in the region:

1. Heat pumps
2. Electric cars
3. Batteries
4. Latent heat storages in combination with photovoltaic systems
5. Sensible heat storages in combination with photovoltaic systems
6. Fuel cells combined with solar systems or heat pumps

Regional analyses
Analyses on the city storage and sector coupling (CSSC) potential of 10 countries were completed focusing on 19 target cities in Germany, Romania, Slovakia, the Czech Republic, Moldova, Montenegro, Bosnia and Herzegovina, Slovenia, Austria and Bulgaria.

CSSC matrix for city storage and sector coupling technologies
This tool makes it possible for municipalities to identify different city storage and sector coupling solutions for their given city type and to build on the experience of Danube region cities with similar characteristics.

cssclab.eu

Capacity building and training programme
A total of 8 modules have been developed:

1. Heat system – energy storage & sector coupling
2. Electrical system – energy storage & sector coupling
3. Emerging technologies & sector coupling applications
4. Use cases and good practice examples
5. Macro-economic energy market conditions
6. Micro-economic factors influencing economic efficiency of CSSC installations in urban settings
7. Economic assessment of practice examples
8. Business models and Financing solutions

Benchmarking Study
This study evaluates readiness of the targeted cities selected by the CSSC project partners regarding CSSC technologies. The evaluation is based on the current state of CSSC solution implementation, the types of technologies used and other information like the legal framework supporting CSSC.

The Guidebook for replicator cities
The Guidebook is the main reference frame on the online CSSC Lab platform and was created to accompany potential replicator cities in a structured way. There are also 7 language versions available for easier access on local level.

Key Concepts and Principles

City storage and sector coupling are growing in importance since there is an increasing urgency to decarbonise our economy. The European Union has made it its priority to move away from fossil fuels and to switch to renewable energy sources as far as possible to meet its energy needs. Geopolitical changes in Europe are likely to further reinforce the development away from importing oil and gas from outside the European Union.

While renewable energy is cleaner than fossil fuels, it also harbours numerous challenges. Wind and solar energy are intermittent, which means that they are not always available when energy demand is highest. To deal with this, storage solutions are needed, which make it possible to release renewable energy when it is required.

Storage

The five main storage technologies are as follows:

1. **Pumped Hydro Storage** – As one of the oldest and most widely used electricity storage technologies, this approach relies on pumping water uphill to a reservoir. Then, when electricity is needed, the water is released from the reservoir to start a turbine and a generator, which in turn produces energy.

2. **Thermal Energy Storage** – This is energy storage in the form of heat. It works by running an electric hot water boiler when electricity is abundant and using the hot water at a later point in time. This can also be applied to heating, refrigeration and air conditioning systems.

3. **Batteries** – Batteries can store electrical energy in the form of chemical energy. Moreover, they can also be employed for frequency control, the temporary shift of consumption, and the flattening of demand peaks. In addition, they can serve as local buffers to store variable renewable energy close to the source of production for later local use or be injected into the grid during times of high demand and high prices.

4. **Compressed Air Energy Storage** – In times of excess electricity, a reversible motor/generator unit is utilized to inject air into a storage vessel, which is then stored in the form of high-pressure air. Later, when electricity is required, the stored compressed air is released, heated and its energy is captured by turbines.

5. **Gas and liquid storage** – With this method, gas (mainly methane) or liquids are compressed or absorbed in porous material under low pressure. They are then released when energy is needed.

Key Concepts and Principles

Sector Coupling

Sector coupling has the potential of making our entire energy system "greener". It does this by replacing fossil fuels in sectors such as buildings, transport and industry through either end-use sector coupling or cross-vector integration. Combined, energy storage and sector coupling represent efficient ways to overcome the challenges posed by the integration of renewable energy sources into the energy system.

End-use sector coupling

This refers to using carbon-free electricity in end-use sectors. For example, electricity generated through solar power is fed into the transport, heating or industrial sector and used to replace fossil fuels. This is already happening with electric vehicles, which do not rely on gasoline to function. Another alternative is using electric heat pumps to substitute fossil-fuelled furnaces in the heating sector. For this to be rolled-out, electricity generation capacity must be invested in.

Cross-vector integration or "power-to-x"

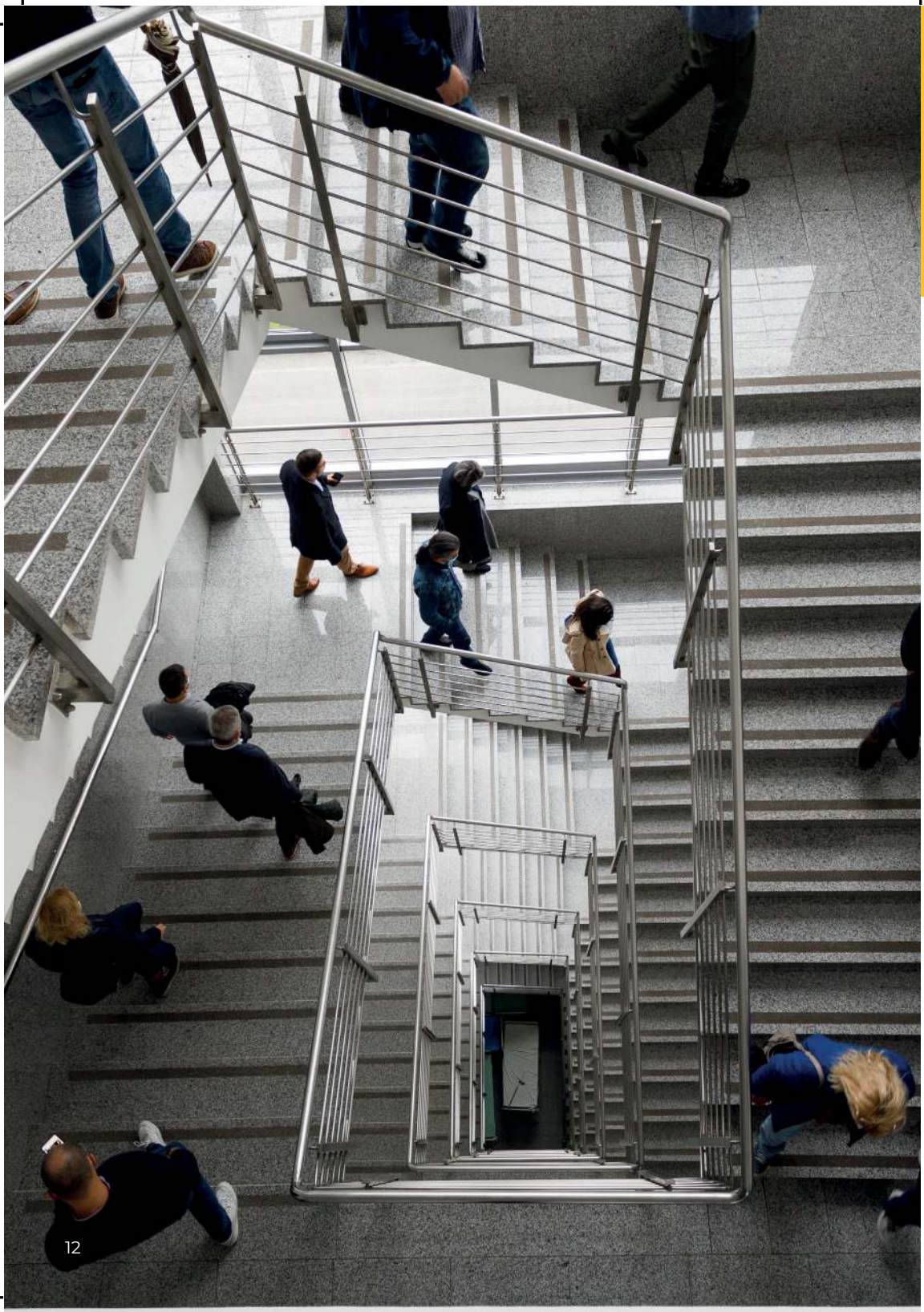
With this form of sector coupling, end-use sectors such as the transport sector indirectly run on green electricity. This is achieved by using renewable electricity to produce heat as well as gaseous or liquid energy carriers, which are then employed to fuel an end sector. For instance, clean electricity can used to create hydrogen, which in turn can be employed in the heating sector.

How The CSSC Lab Platform works

The main purpose of the platform is to highlight developed expertise in an interactive way and act as a “knowledge hub” where the main project’s outputs can be found. When opening the platform’s homepage, you will find an introduction to the platform, the link to the different demo centres (the core of the project), part of the CSSC definition and the link to the good practice examples.

Different sections on the yellow “bar menu” allow users to check more details about the project idea and partnership, inspect demo centers, get insights from developed documents throughout the project and keep track of news/publications from the project.

The first section is the “about us” section where you can learn about the platform, about the project and also see the different partners. Apart from being a descriptive part, it should provide a summary of our goals and the impact of our cooperation across the Danube region. Summary of impact of our cooperation, in a final version of the platform, should include a various defined parameters such as number of stakeholders involved, number of documents developed and demo centers integrated, as well as number of visitors on the platform – targets set for our project in project development phase



How The CSSC Lab Platform works

The core of the platform is compiled information about 4 demo centers through showcases of implemented CSSC technologies, availability of live data and additional materials which should enable visitors to check our proof of concept based on real-time information.

For each demo center you can find:

- Short description
- Technical specification of technology
- Concept / how it works?
- Planning and construction process
- Integration on online platform
- Live data

How The CSSC Lab Platform works

Demonstration Center 2

Stegersbach

Short description

Technical specifications

Concept

Planning and construction process

Integration on online platform

The Austrian demo center was launched in October 2021 as part of the solar.one building in Stegersbach, in the south of Burgenland. It is part of a larger competence center for renewable energy, which uses a range of different sector coupling and city storage technologies.

These include:

1. storing electricity in a Li-Ion and a saltwater battery.
2. storing heat and cool air in thermal heat storages.
3. heating and cooling the building thanks to a heat exchanger system/core activation
4. Equipment for mobile storage for electric vehicles

All these technologies are regulated by monitoring equipment (temperature and presence monitoring) as well as a load and flexibility management system to ensure the building receives the heat and electricity it needs.

By using this approach, the demo center is addressing a key problem. In typical photovoltaic systems, surplus solar energy is fed into the grid for a relatively low price and during times of limited sunshine, all (electric) energy has to be supplied from the grid. With the solutions tested in the demo site, a lot more of the energy generated can be used on site, considerably increasing the self-consumption ratio. In addition, the sector coupling solutions (heat pumps, EV charging) also allow for the utilization of electric energy in other sectors, like heating and mobility, which further increases the proportion of self-consumed energy.

While the PV system is not part of the demo site but of the whole competence center, it is still important to note that the entire building – which can host 200 people – has a generational capacity of 177 KW. This means that it can be entirely energy positive and depend solely on renewable energy sources. Since this amount of energy is sufficient to cover its own needs, the building could also hypothetically supply neighbouring buildings with excess PV power.

https://cssclab.eu/austria-demon-center-2/

The next section (CSSC) deals with a developed methodology approach including a regional action planning process, selected CSSC model solutions, an online tool, a set of comprehensive training materials and a capacity-building programme. Alongside the definition of CSSC, gathering good practice examples and promotional materials, this section aims to provide necessary know-how and establish a steady pipeline for future projects.

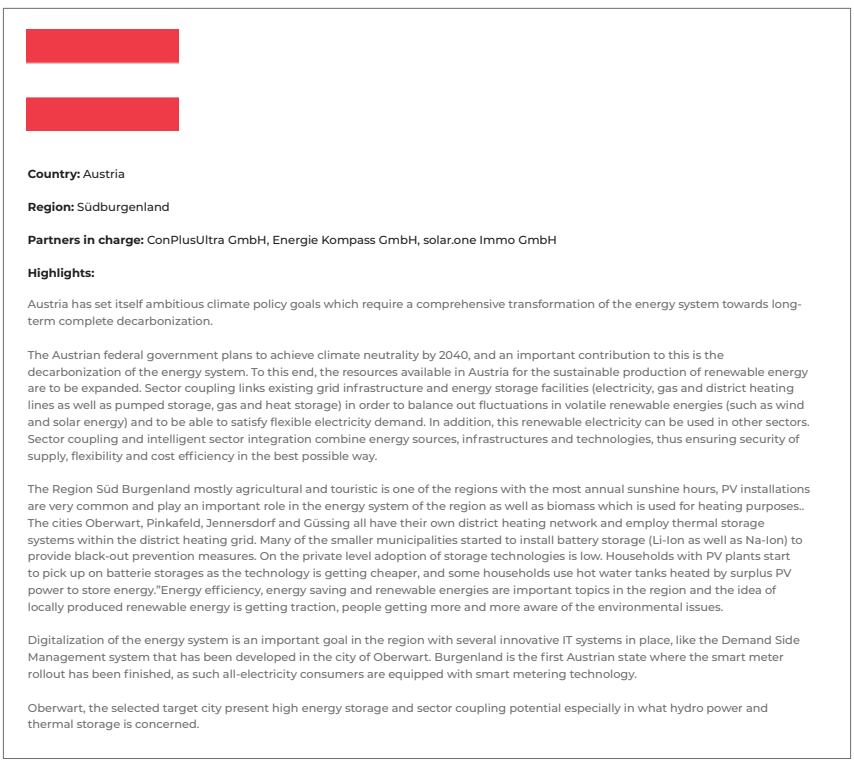
The first part of the section, the regional action planning process, brings highlights of performed analysis and benchmarking studies as a core of our initial work. In its final form, it will provide an overview of the main outputs of the planning process – regional action plans and transnational roadmap alongside highlights of stakeholder involvement which played an important part in setting up a proper legal framework for the promotion of CSSC technologies.

How The CSSC Lab Platform works

Regional analyses

Analyses on the city storage and sector coupling (CSSC) potential of 10 countries were completed focusing on 19 target cities in Germany, Romania, Slovakia, the Czech Republic, Moldova, Montenegro, Bosnia and Herzegovina, Slovenia, Austria and Bulgaria.

Abstract example: Austria



Country: Austria

Region: Südburgenland

Partners in charge: ConPlusUltra GmbH, Energie Kompass GmbH, solar.one Immo GmbH

Highlights:

Austria has set itself ambitious climate policy goals which require a comprehensive transformation of the energy system towards long-term complete decarbonization.

The Austrian federal government plans to achieve climate neutrality by 2040, and an important contribution to this is the decarbonization of the energy system. To this end, the resources available in Austria for the sustainable production of renewable energy are to be expanded. Sector coupling links existing grid infrastructure and energy storage facilities (electricity, gas and district heating lines as well as pumped storage, gas and heat storage) in order to balance out fluctuations in volatile renewable energies (such as wind and solar energy) and to be able to satisfy flexible electricity demand. In addition, this renewable electricity can be used in other sectors. Sector coupling and intelligent sector integration combine energy sources, infrastructures and technologies, thus ensuring security of supply, flexibility and cost efficiency in the best possible way.

The Region Süd Burgenland mostly agricultural and touristic is one of the regions with the most annual sunshine hours, PV installations are very common and play an important role in the energy system of the region as well as biomass which is used for heating purposes.. The cities Oberwart, Pinkafeld, Jennersdorf and Güssing all have their own district heating network and employ thermal storage systems within the district heating grid. Many of the smaller municipalities started to install battery storage (Li-Ion as well as Na-Ion) to provide black-out prevention measures. On the private level adoption of storage technologies is low. Households with PV plants start to pick up on batterie storages as the technology is getting cheaper, and some households use hot water tanks heated by surplus PV power to store energy."Energy efficiency, energy saving and renewable energies are important topics in the region and the idea of locally produced renewable energy is getting traction, people getting more and more aware of the environmental issues.

Digitalization of the energy system is an important goal in the region with several innovative IT systems in place, like the Demand Side Management system that has been developed in the city of Oberwart. Burgenland is the first Austrian state where the smart meter rollout has been finished, as such all-electricity consumers are equipped with smart metering technology.

Oberwart, the selected target city present high energy storage and sector coupling potential especially in what hydro power and thermal storage is concerned.

https://cssclab.eu/regional-potential-for-cssc-implementation/

Benchmarking Study

This study evaluates readiness of the targeted cities selected by the CSSC project partners regarding CSSC technologies. The evaluation is based on the current state of CSSC solution implementation, the types of technologies used and other information like the legal framework supporting CSSC.

Country: Croatia

Target City: Zaprešić

General data

Size of the target city: 53.81 sq km

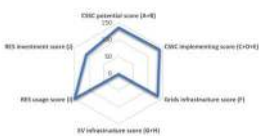
Population of the target city: 25000

Profile of the target city: traffic hub

Website: www.zapresic.hr/naslovnica

Highlights:

The CSSC evaluation of potential at municipal level was positive for both energy storage and sector coupling. There were 5 CSSC initiatives with impact at local level, 4 CSSC solutions providers. 5 policy tools with impact over CSSC. Local energy carrier grids readiness revealed very good infrastructure quality, with coverage ranging from 20% for district heating to 80% for electricity grid. Methane grid also has a coverage of about 65%. There are 2 public charging stations for electric vehicles in the city. There are no 100% electric buses in operation yet. About 15 percent of local energy consumption is provided from renewable sources. The yearly budget allocated to RES and CSSC at municipal level is about 11% from total investment budg



https://cssclab.eu/benchmarking-study/

How The CSSC Lab Platform works

The second part of the methodology gives insights into the process of creation of six model solutions, which are considered most appropriate for the cities in the region. Elaborated model solutions aim to accelerate the realization of CSSC solutions for municipalities and to describe the choice of different technical options that can be chosen. Throughout the process of its development, the project consortium prepared several baseline documents such as matrix, model cases and factsheets of available technology which were used in collaboration with stakeholders.

Type of relevant CSSC technology

Storage technologies	Power to heating (and cooling)
Pumped hydro	Fuel cell
Compressed air energy storage	P2H in DH - CHP & P2H modules
Sensible heat storage	CHP
Latent heat storage	P2H module - heating rod
Flywheels	P2H - electrode boilers
Supercapacitors	Supercapacitors
Batteries	**Power to mobiliy**
Li-ion batteries	P2Mobility: battery-powered electric vehicles
Lead acid batteries	**Power- to-Gas**
Redox flow batteries	Power-to-hydrogen (natural gas grid, low-temperature electrolysis)
Sodium based batteries	Power-to-methane (natural gas grid, methanation)

https://cssclab.eu/model-cases/

Factsheets on CSSC technologies
All the CSSC technologies assessed as suitable for the cities in the Danube region are described in more detail through concise factsheets. In preparation for the creation of these factsheets, more detailed information on each technology was compiled based on selected factors.

CSSC Matrix
For the Typologisation in the matrix, a number of categories were selected considered relevant for the implementation of CSSC technologies. The following were singled out as particularly relevant: The area covered (in km2), the population size, the profile and the shape of the chosen city. As a result, five representative city types were identified for the project area.

Model cases
This part of the CSSC platform sums up the technologies and gives an overview about existing CSSC solutions which helps in analysis and evaluation of those in order to have a closer look at the most relevant technologies

How The CSSC Lab Platform works

Specified model solutions

Based on the model cases, six model solutions suitable for small and medium-sized municipalities in the project area were selected in a multi-stage selection process together with the project partners and associated partners. In surveys and expert interviews, the technologies were evaluated, for example in terms of their innovative character, availability, transferability and feasibility in the respective partner countries. Finally, a score-system was used to select those technologies that appear to be most suitable and feasible for cities in the project area. Finally, the following technologies were selected:

1. Heat pumps
2. Electric cars
3. Batteries
4. Latent heat storages in combination with photovoltaic systems
5. Sensible heat storages in combination with photovoltaic systems
6. Fuel cells combined with solar systems or heat pumps

Elaborated model solutions aim to accelerate the realization of CSSC solutions for municipalities and to describe the choice of different technical options that can be chosen. The solutions are a guideline for different city actors to find criteria for what is important to realize a CSSC solution and which technical solution fits to the city (see city types). The proposed model solutions are on the one hand innovative and ambitious in the realization, but on the other hand easy to implement in the actual conditions of the municipality. The model solutions are transferable to and from each participating country.

MS 1 - Heat Pumps (Air based)

MS 2 - batteries

MS 3 - latent heat storage

M4 - sensible heat storage

MS 5 - fuel cells

MS 6 - electris cars

Specified model solutions slideshow

https://cssclab.eu/specified-model-solutions/

Furthermore, this part served as a starting point for the development of tools which make it possible for municipalities to identify different city storage and sector coupling solutions for their given city type and to build on the experience of Danube region cities with similar characteristics.

CSSC Lab online tool

This online tool is developed through the CSSC Lab project, which stands for City Storage and Sector Coupling (CSSC) Lab and financed by INTERREG. It is freely accessible to the public. The aim of this tool is to provide a quick check of suitable CSSC solutions for your municipality without requiring lots of technical information. It is user-friendly and informative for the beginners in CSSC solutions.

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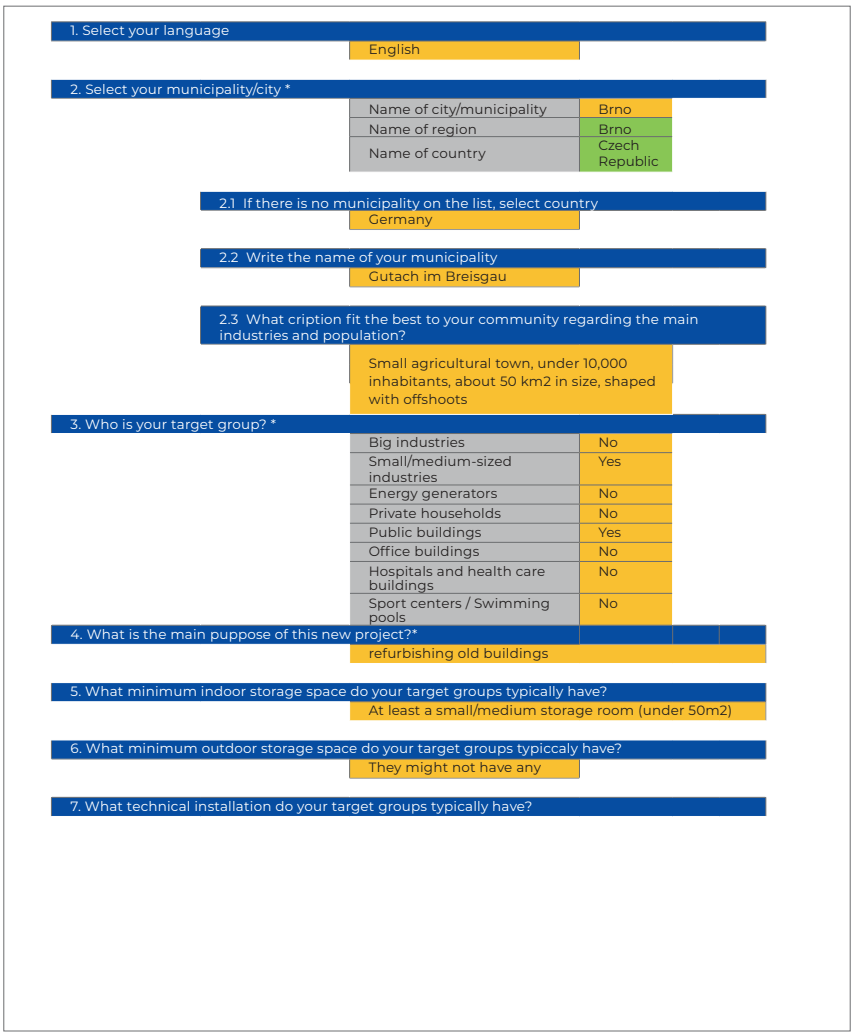
This tool is based on the available information of common technical requirements of CSSC solutions, our experience from our demo centres and our assessments based on the provided input. The main target groups are primarily the small-/medium-sized municipalities in Danube region. Therefore, it may not be always applicable for other communities in other contexts. Technical requirements and the economic efficiency are both considered when evaluating the suitability of CSSC solutions for the given criteria. This tool is not intended to replace the professional assessment from technicians and experts, as it requires much more technical information. If you are inspired by this tool to initiate a CSSC project in your community, please consult the professionals for the detailed planning of your project.“

https://cssclab.eu/cssc-lab-online-tool/

How The CSSC Lab Platform works



https://cssclab.eu/cssc-lab-online-tool/

CSSC Lab Online Tool

Results

Interreg
Danube Transnational Programme
CSSC LAB

Short description

This online tool is developed through the CSSC Lab project, which stands for City Storage and Sector Coupling (CSSC) Lab and financed by INTERREG. It is freely accessible to the public. The aim of this tool is to provide a quick check of suitable CSSC solutions for your municipality without requiring lots of technical information. It is user-friendly and informative for the beginners in CSSC solutions. As part of CSSC Lab project, our main target groups are municipalities in Danube region. After inserting some basic information, you will be provided with CSSC solutions which might suit your municipality and other useful resources. The output can be downloaded by the users as pdf for future reference. Please first choose the language you wish to proceed with this tool.

Disclaimer

This tool is based on the available information of common technical requirements of CSSC solutions, our experience from our demo centres and our assessments based on the provided input. The main target groups are primarily the small-/medium-sized municipalities in Danube region. Therefore, it may not be always applicable for other communities in other contexts. Technical requirements and the economic efficiency are both considered when evaluating the suitability of CSSC solutions for the given criteria. This tool is not intended to replace the professional assessment from technicians and experts, as it requires much more technical information. If you are inspired by this tool to initiate a CSSC project in your community, please consult the professionals for the detailed planning of your project.

Selected municipality	Brno
County/Region	Brno
Country	Czech Republic

City type description	Touristic metropolis, more than 100, 000 inhabitants, larger than 100 km2 in size

Main purpose of the project	refurbishing old buildings
Indoor space	At least a small/medium storage room (under 50m2)
Outdoor space	They might not have any

How The CSSC Lab Platform works

Included target groups:	Included target groups: Small / medium-sized industries, Public buildings
PV installations in target area:	PV installations in target area: rooftop solar panel, solar thermal system, heat pumps

Ranking of measures		
MS 1	Heat Pumps	Not fit
MS 2	Batteries	Fit the best
MS 3	Latent heat storages in combination with photovoltaic systems	Fit the best
MS 4	Sensible heat storages in combination with photovoltaic systems	May be fit
MS 5	Fuel cells combined with solar systems or heat pumps	Fit the best
MS 6	Electric Cars/infrastructure	Fit the best

Capacity building materials

Check out our training materials on CSSC aspects!

Legislation

Check out relevant legislation on CSSC aspects in your country!

Contact points

Check out relevant contact points for CSSC aspects in your country!

More about CSSC Lab

Check out more info about our project!

https://cssclab.eu/cssc-lab-online-tool/

Last, but not least, the third part of the methodology includes comprehensive training materials (both technical and economic ones) and the capacity-building resources such as video materials and tests. In its final form, this part will also include the main lessons learnt among the included stakeholders and their feedback through the assessment toolkit.

The other sections cover blogs, events and publications.

Capacity building and training programme
A total of 8 modules have been developed:

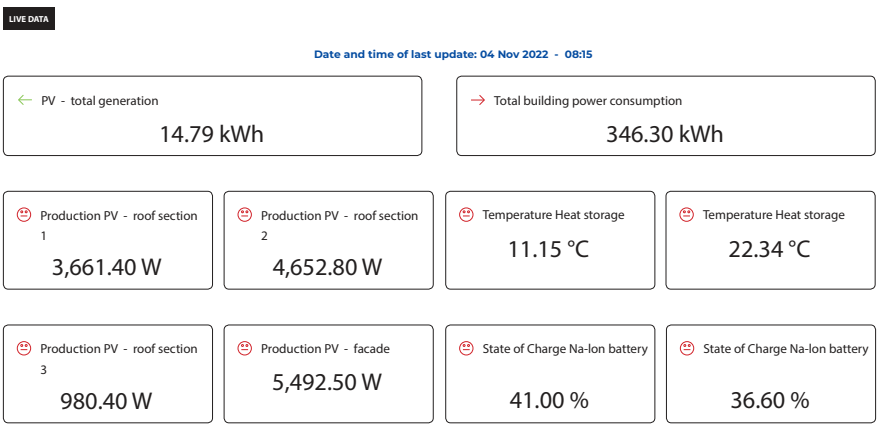
1. Heat system – energy storage & sector coupling
2. Electrical system – energy storage & sector coupling
3. Emerging technologies & sector coupling applications
4. Use cases and good practice examples
5. Macro-economic energy market conditions
6. Micro-economic factors influencing economic efficiency of CSSC installations in urban settings
7. Economic assessment of practice examples
8. Business models and Financing solutions

The highlight of live data

One of the main features of the platform is the possibility to check the real-time data from installed sensors in 4 different demo centers through created communication with their energy management systems. Live data can be divided into two parts, whereas the first part give the last up-to-date status of sensors. These values are refreshed every 15 minutes.

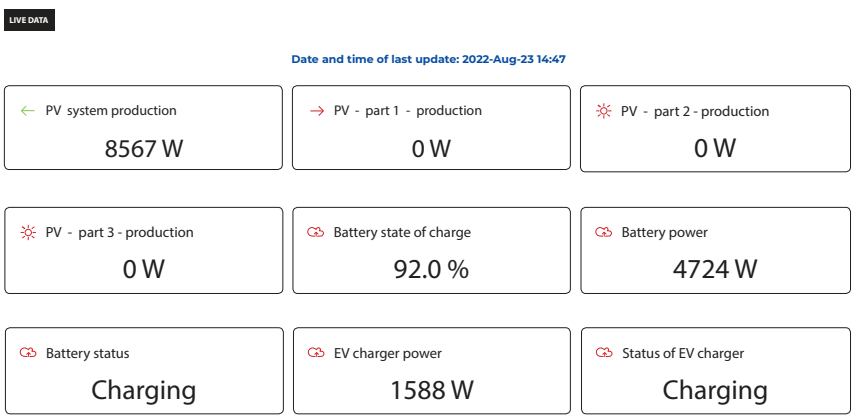
How The CSSC Lab Platform works

Austrian demo center



https://cssclab.eu/austria-demon-center-2/

Bulgarian demo center



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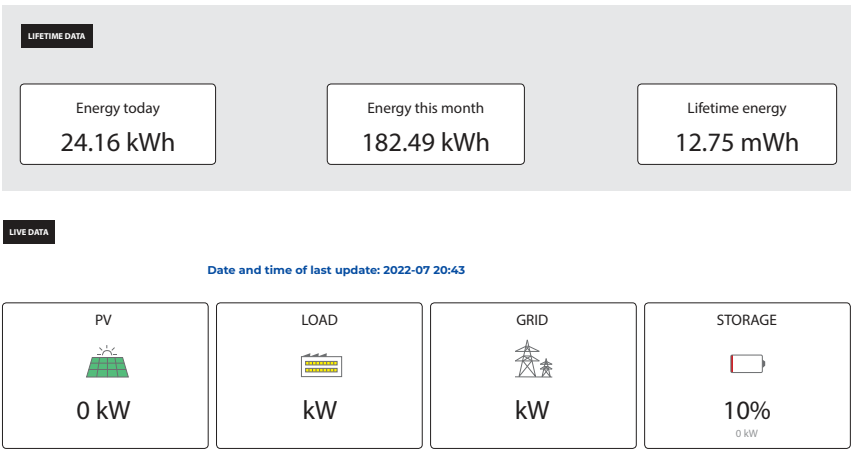
Slovenian demo center

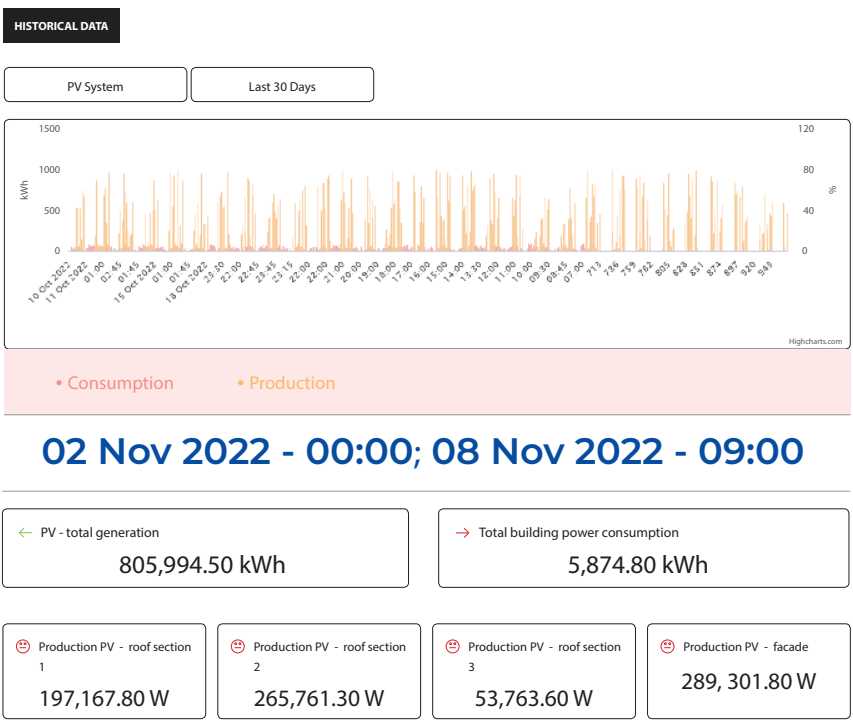


https://cssclab.eu/slovenia-demo-center-2/

How The CSSC Lab Platform works

The second part is dedicated to an overview of historical data where users, based on implemented equipment in each demo center, can check the impact of different CSSC technologies on a certain day, week or month. These graphical overviews come with calculated values for the whole selected/observed period.

Exemplary graphs for Austrian demo center



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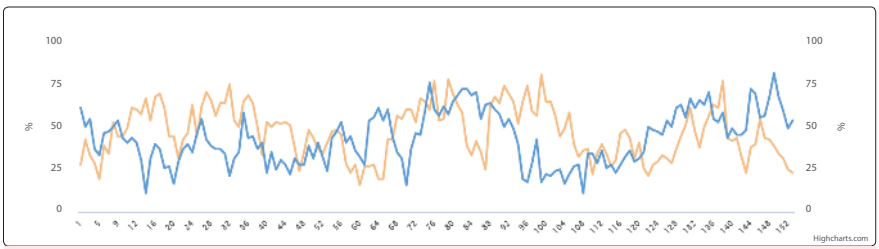
HISTORICAL DATA

Batteries | Last 7 Days



• State of Charge Na-ion battery • State of Charge Li-ion battery

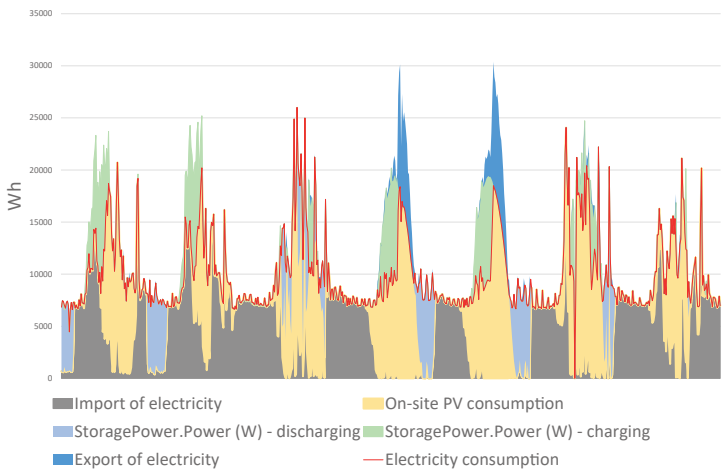
02 Nov 2022 - 00:00; 08 Nov 2022 - 09:00

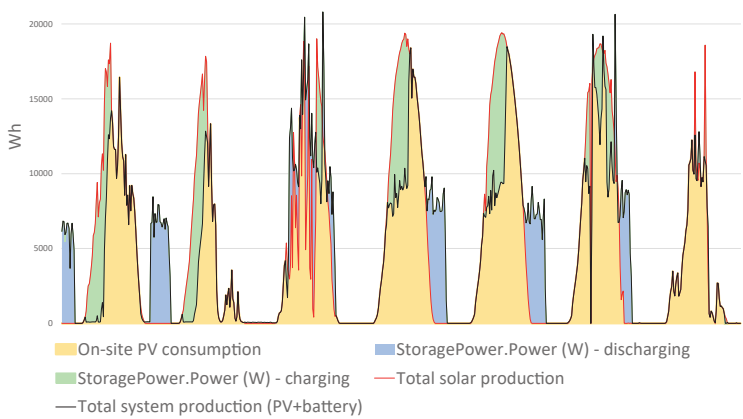
State of Charge Na-Ion battery	State of Charge Li-Ion battery
50.44 %	46.59 %

https://cssclab.eu/austria-demon-center-2/

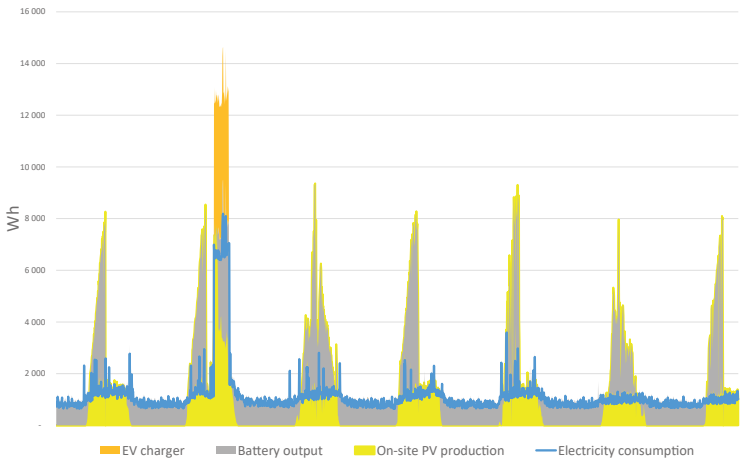
How The CSSC Lab Platform works

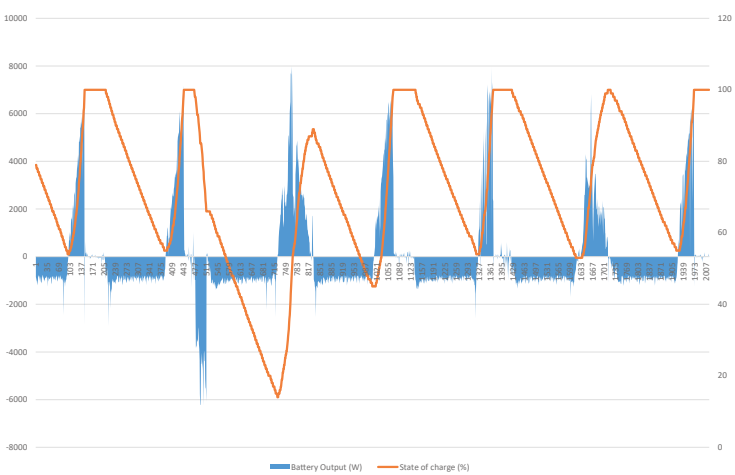
Exemplary graphs for the Slovenian demo center





Exemplary graphs for the Bulgarian demo center*





Current State of play

Across Europe, differences can be noted in terms of the use of city storage and sector coupling. Generally speaking, CSSC technologies are being used more frequently in Western than in Central and Eastern Europe. Nevertheless, there is a noticeable increase in the interest at local level across the region and citizens' initiatives are mushrooming as energy independence is growing in popularity.

Even if the EU targets are partly guiding this motivation, the conditions on the ground across the CSSC Lab region vary substantially in terms of legislation, financial capacity and political engagement. While most interest is at local level, energy policies are drawn up at national level, which is resulting in bottlenecks. In addition, it is challenging for municipalities to access funds as CSSC technologies are still deemed costly.

Despite the fact that energy storage and sector coupling provide an important means to reducing greenhouse gas emissions and realising the EU's climate change goals, there are still many uncertainties in terms of technology, market readiness, economic competitiveness, and regulatory requirements.

The following trends can be observed:

1. Large scale pumped hydro, battery and thermal storage projects are being implemented at different scales throughout the CSSC Lab region. However, these are mainly employed to balance the energy system and complement the production of renewable energy.

2. The most common uses of sector coupling relate to power to thermal (heat pumps) and power to mobility (electric vehicles).

3. Energy storage is growing rapidly worldwide, with most of the growth coming from lithium-ion batteries. Pumped hydropower and flywheels are also becoming increasingly popular. Mechanical and ice storage projects are also being carried out.

4. Micro-grids are gradually emerging in regions where renewables are financially competitive vis-à-vis fossil fuels and storage is affordable.

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[1] A microgrid is a self-contained system containing generation, storage, and load and is controlled and managed locally. It can operate as an independent islanded system or connected to a utility grid.

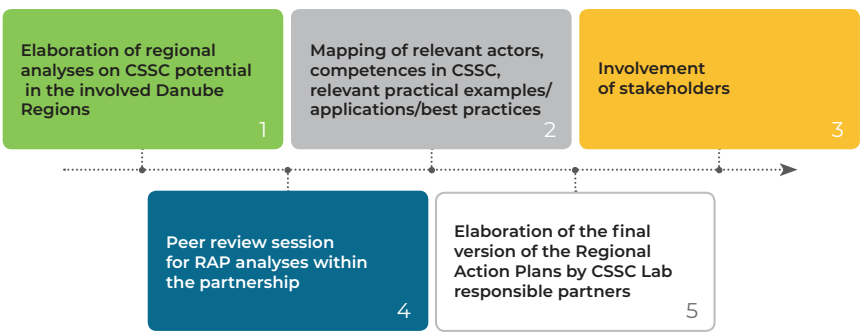
How CSSC Lab sees regional planning

The CSSC LAB project aims to contribute to the energy security and energy efficiency of the involved Danube regions by supporting the development of their city storage and sector coupling (CSSC) solutions accelerating the take-up of the CSSC technologies within the targeted cities. The project methodology sets the path to reach this goal by implementing concrete steps that lead to one of the main outputs of the project namely, the elaboration of regional action plans whose overall goal is to boost local renewable energy production and use.

The CSSC Lab action plans cover different size areas depending on the identified needs and potential of development influenced also by the national specific.

The CSSC Lab regional action planning approach is a multi step process covering a wide range of interlinked activities. These were set up to overcome the gaps and barriers hindering the planning process given the incipient nature of the CSSC development in the involved regions:

Main steps:



Elaboration of regional analyses on CSSC potential in the involved Danube Regions (institutional frameworks, energy policy instruments), completed by the project partners

- The regional analyses were completed for 11 region, showing their city storage and sector coupling (CSSC) potential. The reports focused also on 19 target cities selected based on their representativeness of their respective regions as well as their CSSC potential.
- The analyses showed relevant info on the existing use and potential applications of different types of CSSC technologies.

Mapping of relevant actors, competences in CSSC, relevant practical examples/applications/best practices

- The CSSC Lab project partners gathered comprehensive data related to energy storage technologies and sector coupling concepts in the involved regions compiling a map of already existing CSSC related knowledge. The mapping includes relevant regional actors (utilities, city administrations, R&D organizations, energy agencies etc.) and their competences in the field; relevant practical examples of CSSC in the various cities of the project regions complemented by other best practices identified also on EU level.

Involvement of stakeholders

- The CSSC Lab partners built the STK involvement activities based on the premises that the development of such innovative field as CSSC is dependent on the engagement of

STKs and quality interactions with them. The activities were all deployed having in mind 2 objectives: to better address the development of CSSC domain in the project regions and to support the regional action planning process by jointly identifying main planning directions and proposing adequate measures. The STK involvement activities resulted in valuable input and helped project partners in the identification of their regional action plan measures.

Peer review session for RAP analyses within the partnership

» To ensure the quality of the regional action plan measures, peer review sessions were conducted by the CSSC Lab partnership. The goal was to determine whether the plans fall within the project` scope and to check whether the measures are qualitative and respond suitably to the status quo and potential of CSSC in the respective regions. During the sessions the project partners conducted a joint analysis on the RAP draft versions already drafted finding suitable joint directions towards the development of the CSSC domain in the partner regions.

Elaboration of the final version of the Regional Action Plans by CSSC Lab responsible partners

» There are 11 regional action plans elaborated comprising of more than 30 measures covering a wide range of CSSC related measures.

What is the main objective of RAPs

The scope of the regional action plans (RAPs) is to foster the development of CSSC domain and to accelerate the take up of the CSSC technologies in the target regions. The RAPs set concrete actions and measures to bring CSSC applications into real cases in the partner cities across the project region.
The main objectives of the regional action plans according to regions:

The Zagreb County / Urban Agglomeration Zagreb (Croatia)	To implement CSSC technologies which should increase the rate of decarbonisation of the electricity/heating sector, also having positive influence on energy security.
Südburgenland (Austria)	To increase the installation and utilisation of distributed renewable energy sources (mainly PV), storage systems and sector coupling solutions by promoting the adaption of Renewable Energy Communities.
Spodnje Podravje (Slovenia)	To present measures to increase the use of energy from renewable sources, energy storage and the merging of sectors. These together with the development of smart grids enable the implementation and further development of energy communities.
North East Bulgaria	To increase the net zero buildings in, mainly through building integrated PV, battery storage, EMS (energy management system), sector coupling.

How CSSC Lab sees regional planning

Alba County (Romania)	To increase the local use of RS energy by implementing CSSC technologies in cities; to boost the creation of EC especially among prosumers
South Bohemian Region (The Czech Republic)	To initiate and sustainably develop the potential of renewable energy technologies (photovoltaics) with an emphasis on energy storage and sector coupling through an integrated and community-based approach.
Bratislava Old Town Borough (Slovakia)	To identify the necessity and opportunities in the region related to CSSC. To be a guideline for the region on how to implement CSSC solutions to support and implement RES and CSSC applications.
Baden-Württemberg (Germany)	To be a strategic guideline for Baden-Württemberg on how to implement CSSC solutions to support the energy transition on a municipal level. Focus is to facilitate the decision-making process in LAs and municipal councils. To help the implementation of projects in the urban planning processes.
Sarajevo Canton (Bosnia & Herzegovina)	To define the development level of CSSC domain as well as the future opportunities for CSSC evolution.

Niksic (Montenegro)	To identify the current state of cities` energy consumption & production. To define a plan for future energy needs. To identify the potential for the efficient distribution/ production/ use of energy, and use of local sources to meet energy needs of Niksic.
Cahul District (Moldova)	To raise knowledge of stakeholders in Moldova, especially in Cahul region but also national stakeholders relevant to the CSSC Lab project topics, on the necessity and opportunities to support and implement RES and CSSC applications. To offer best practices from EU member state countries that could be adopted in Moldova as well.

Overview of planned actions per regions / partners (table or graph would be nice)

The Zagreb County / Urban Agglomeration Zagreb (Croatia)	• Integrated climate-energy-spatial planning • Elaboration of Energy Efficiency Action Plans for Zagreb County • Integration of CSSC applications in smart village/city concept • CSSC application in (smart) agriculture • Modernization and decarbonization of district heating systems in Zagreb County
Südburgenland (Austria)	• Establishment of REC in the region. • Promotion of home battery storage systems to REC participants

Overview of planned actions per regions/partners

Spodnje Podravje (Slovenia)	• Creation of one stop shop for RES projects • Promotion of home battery storage • Implementation of energy storage in DH system
North East Bulgaria	• Establishment of energy cooperatives in Bulgaria • Creation of the first prosumer municipality
Alba County (Romania)	• Implementation of CSSC applications in Alba Iulia • Introduction of CSSC measures in the energy action plans of LAs in Alba County • Set up of a consultancy service for prosumers in Alba County for installing CSSC technologies
South Bohemian Region (The Czech Republic)	• Creation of a regional platform for community energy development • Establishing local energy communities • Initiation of dedicated regional funding tool for municipalities • Building a knowledge base for CSSC
Bratislava Old Town Borough (Slovakia)	• Elaboration of energy audit of buildings under municipality administration and their reconstruction according to the results • Promotion of the use of built areas for solar energy • Capacity building and raising knowledge in the CSSC domain • Increase of efficiency in energy purchase - central suppliers, energy auction, etc.

Baden-Württemberg (Germany)	• Removing Barriers in accessing promotions from the federal state • Setting up CSSC training methods for stakeholders • Elaboration of a recovery plan for citizen energy in Baden-Württemberg
Sarajevo Canton (Bosnia & Herzegovina)	• Knowledge raising activities among public government, municipalities and institutions, as well as among citizens about CSSC, energy efficient solutions and their benefits • Implementation of a CSSC demo project/ site in Bosnia and Herzegovina, Sarajevo Canton • Implementation of activities to set up CSSC in smart villages • Modernization of DHS network in Sarajevo
Niksic (Montenegro)	• Installation of (3000) photovoltaic systems ”Solari 3000+ Solari 500+” • Landfill remediation for methane extraction to produce electricity with • Sanation of residential buildings • Construction and installation of a solar park • Construction of Wind farm Gvozd
Cahul District (Moldova)	• Local action plan to increase energy efficiency at local level in Cahul District • Promoting sector coupling and energy storage among regional stakeholders in Moldova • Photovoltaic Park at the Cahul water pumping station

Building Capacities in the Danube region

Background

Different training modules are available on the CSSC Platform to help build capacities in the region.

The overall **aim** of training contents is to provide training participants with basic knowledge to allow them to develop, define and select CSSC implementation projects according to the specific demand of their own cities.

These are of **two levels**:

- Basic
- Advanced

Basic sessions: The focus here lies on a short introduction of the technical aspects of sector coupling and energy storage as well as the economic and managerial CSSC aspects.

Advanced sessions: These contain detailed presentations of energy storage and sector coupling technologies and the developed model solutions. In the advanced sessions, special focus is given to the economic assessment of CSSC model solutions (M7) and business models and financing solutions(M8).

The target groups of the basic and advanced trainings are:

1. institutional intermediaries such energy agencies at different governance levels
2. municipalities such as technical experts from infrastructure departments

In addition, **coaching sessions** are proposed:

Coaching is implemented in the form of bi-lateral meeting between local project partners and representatives of municipalities and will focus on the practice transfer of CSSC knowledge to real applications.

City coaching sessions are open to all cities, which would like to replicate CSSC solutions in the Danube region. It is not only open to CSSC Lab participating cities.

Model solutions that are implemented in the CSSC LAB project are used as practice examples in the coaching sessions.

Training modules

These can be split along two main themes:

1. Technical aspects of Sector Coupling and Energy Storage

M1: Heat system: energy storage & sector coupling
– The first module in the series gives an overall overview of sector coupling and energy storage with the focus on the challenges of the EU energy strategy for the coming decades. It then moves on to the field of heating.

M2: Electric system: energy storage & sector coupling
– This module focuses on electricity storage and sector coupling solutions with an emphasis on the applicability of the technologies at the city level.

M3: Emerging technologies & sector coupling applications
– The module presents innovative energy storage and sector coupling technologies.

M4: Use cases and good practice examples
– The last module contains use cases and good practices collected in the partner regions.

2. Economic and managerial CSSC aspects

M5: Basic understanding of macro-economic energy market conditions
– The module, which is the first in a series of economic modules provides an overview of EU energy markets, the Energy Union and the Green Deal.

M6: Micro-economic factors influencing economic efficiency of CSSC installations in urban settings
– This module gives an overview of the Electricity market in the EU with a special focus on the specific situation in the partner countries.

M7: Economic assessment of practice examples
– This module concentrates on the evaluation of CSSC projects, presents different evaluation methods and examples. The second part of this module introduces a simple tool for economic assessment.

M8: Business models and financing solutions
– This module introduces 4 different financing options for projects related to sector coupling and energy storage. Project financing, Energy Performance Contracting, Crowd Investing and Leasing are presented in detail.

Formats

The **format** varies for the different course levels:

Level	Suggested duration of training	Training modules
Basic	1 day (5 -7 hours)	Module 1, 2, 4, 5, 6
Advanced	1 – 2 days	Module 1, 2, 3, 4, 5, 6, 7, 8

The training materials take the form of PowerPoint Presentations and can be adjusted to local needs. All material is in English.

Trainings can either be held face-to-face or online depending on the pandemic situation. The impact this has on the different formats is presented below:

1. Face to face trainings

OPTION 1

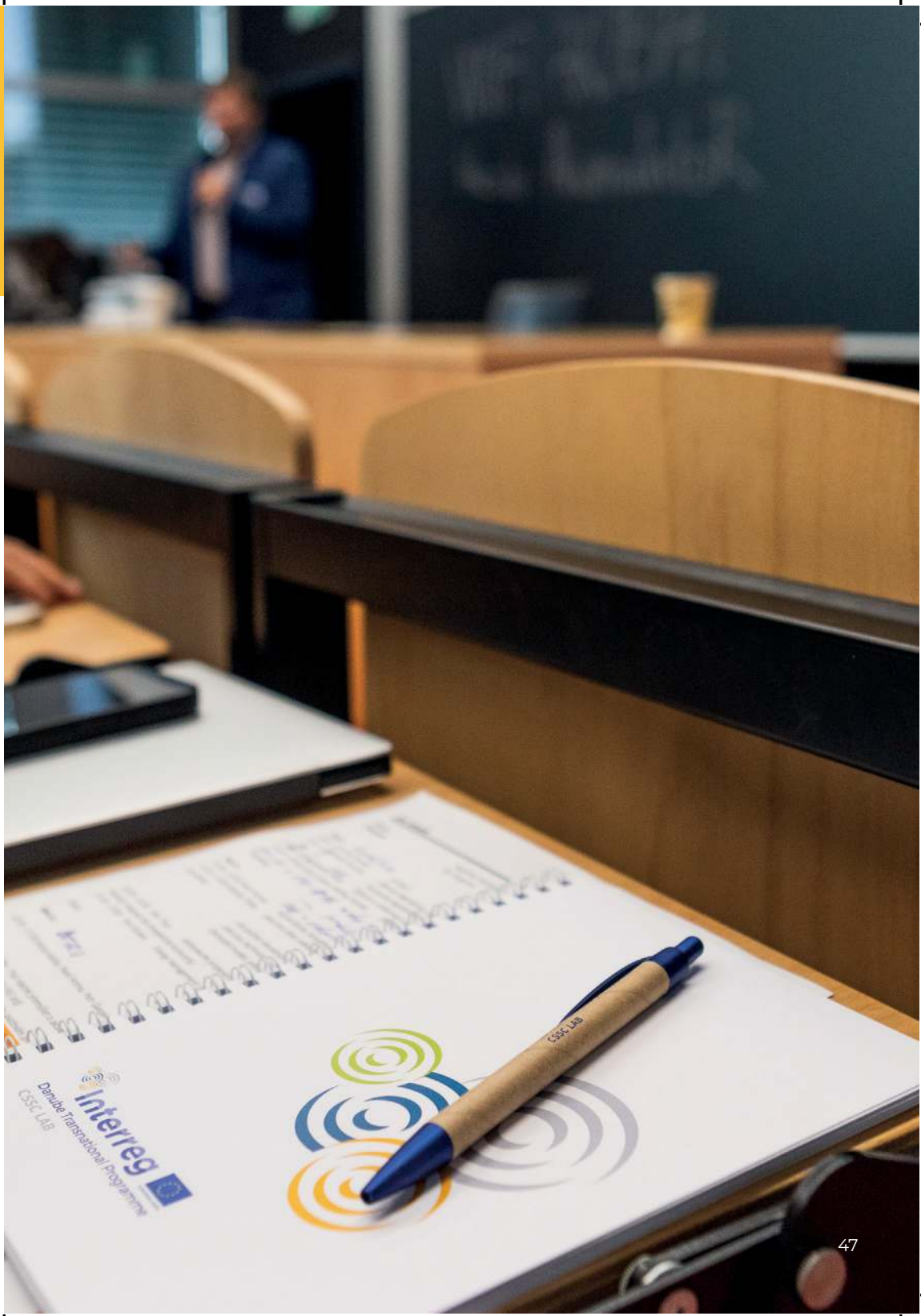
Basic trainings are conducted as 1-day trainings. For the basic trainings, only the materials from following modules are used: M1, M2, M4, M5 and M6. The focus is on the short introduction of technical aspects of sector coupling and energy storage as well as the economic and managerial CSSC aspects. Partners are free to select only the technologies most relevant for their regions from the technical part of the presentations.

Local advanced trainings go into detailed presentations of energy storage and sector coupling technologies and the developed model solutions. In the advanced sessions, special focus is given to the economic assessment of CSSC model solutions (M7) and business models and financing solutions(M8). These training sessions are longer than the basic sessions, namely, 1 or 2 days. If the advanced training sessions last two days, they can be divided in a way where the 1st day covers technical CSSC aspects and 2nd day the economic CSSC aspects.

OPTION 2

Before conducting the basic training sessions, partners send out a survey to their local target groups (potential training participants) in order to get feedback on which topics are most relevant to them. Based on the results, partners implement the 1-day basic training covering only the most relevant topics.

Based on the feedback from the basic sessions, partners prepare the advanced session. Partners decide on the content that complements the gained knowledge from the basic trainings and provide the participants a “full picture” of the technological and economical aspects of CSSC. As in OPTION 1, the advanced training sessions are longer than the basic sessions, namely, 1 or 2 days. If the advanced training sessions last two days, they can be divided in a way where the 1st day covers technical CSSC aspects and 2nd day the economic CSSC aspects.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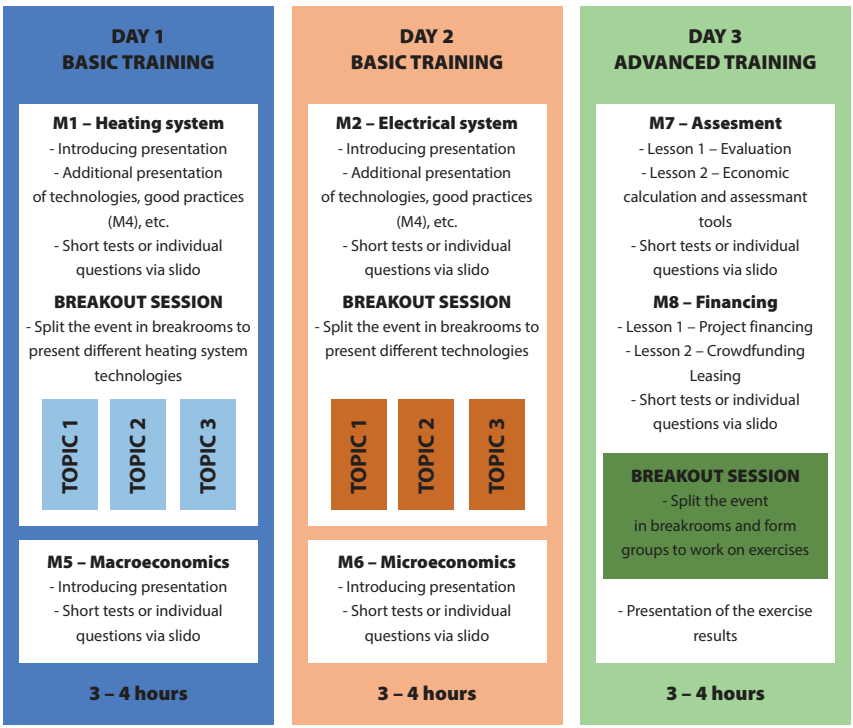
2. Online trainings

In the case of potential Covid-19 restrictions, partners may have to adjust their strategies and organize the training sessions online. In this document 2 options for the implementation of online trainings are proposed.

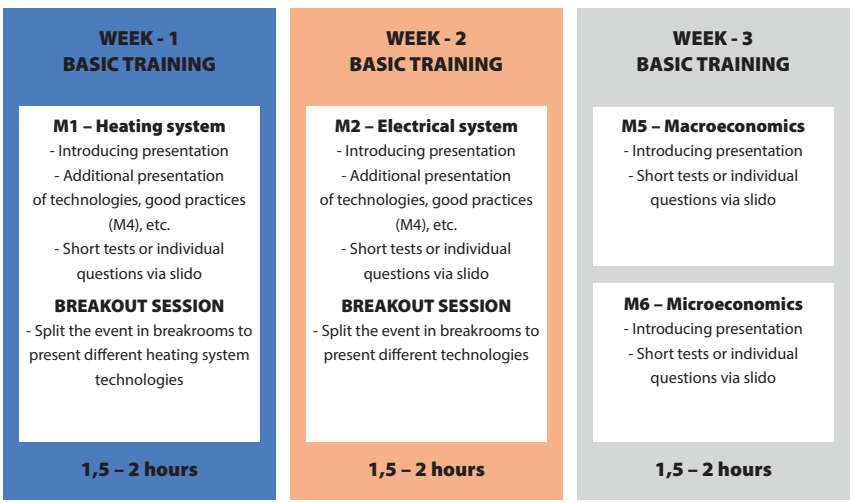
OPTION 1

3-day online trainings (3 – 4 hours per day). 2 days dedicated for the basic training and 1 day for advanced training. On the 1st day, the technical aspects of sector coupling and energy storage and on the 2nd day Economic and managerial CSSC aspects should be presented. The advanced session upgrades the knowledge from the first two days and the focus lies mainly on the economic assessment of CSSC model solutions (M7) and business models and financing solutions (M8). The partner organizing the training decides whether the online training takes place 3 days in a row or if the training will be divided in two separate parts (basic and advanced).


DAY 1
BASIC TRAINING
M1 – Heating system
- Introducing presentation
- Additional presentation of technologies, good practices (M4), etc.
- Short tests or individual questions via slido
BREAKOUT SESSION
- Split the event in breakrooms to present different heating system technologies
TOPIC 1
TOPIC 2
TOPIC 3
M5 – Macroeconomics
- Introducing presentation
- Short tests or individual questions via slido
3 – 4 hours
DAY 2
BASIC TRAINING
M2 – Electrical system
- Introducing presentation
- Additional presentation of technologies, good practices (M4), etc.
- Short tests or individual questions via slido
BREAKOUT SESSION
- Split the event in breakrooms to present different technologies
TOPIC 1
TOPIC 2
TOPIC 3
M6 – Microeconomics
- Introducing presentation
- Short tests or individual questions via slido
3 – 4 hours
DAY 3
ADVANCED TRAINING
M7 – Assesment
- Lesson 1 – Evaluation
- Lesson 2 – Economic calculation and assessmant tools
- Short tests or individual questions via slido
M8 – Financing
- Lesson 1 – Project financing
- Lesson 2 – Crowdfunding Leasing
- Short tests or individual questions via slido
BREAKOUT SESSION
- Split the event in breakrooms and form groups to work on exercises
- Presentation of the exercise results
3 – 4 hours

OPTION 2

The trainings can be organized over a period of several weeks. The trainings can be conducted once a week and cover only 1 or 2 modules per session. The duration of each session is 1,5 – 2 hours max.



WEEK - 4
ADVANCED TRAINING

M7 – Assesment
- Lesson 1 – Evaluation
- Lesson 2 – Economic calculation
- Lesson 3 – Assessment tools

- Short tests or individual questions via slido

1,5 – 2 hours

WEEK - 5
ADVANCED TRAINING

M8 – Financing
- Lesson 1 – Project financing
- Lesson 2 – Crowdfunding Leasing
- Lesson 3 – Assessment tools
- Short tests or individual questions via slido

BREAKOUT SESSION
- Split the event in breakrooms and form groups to work on exercises

- Presentation of the exercise results

1,5 – 2 hours

CSSC Model Solutions

Name of solution:	Heat Pumps

Short description of model solution

A heat pump is a thermal system which could heat or cool buildings or domestic water by exchanging the heats with a refrigeration cycle. It transfers the heat to where it is needed without the application of external power. When used to cool a building, it functions as an air conditioner by transferring heat from the inside to the outside and operates in reverse when heating up a building. Heat pumps are also often used in district heating systems. Heat pumps require little maintenance and heating costs are low. However, the acquisition costs can be high. They can be used in both new and old buildings. Heat pumps are used in the building sector; electric cars etc. Green electricity should be used for climate-friendly operation. Heat pumps are high in energy efficiency, which take about 75% of the energy needed for heating from the environment and only remaining 25% of the energy is provided by electricity. This makes the heat pump the most climate-friendly form of heat generation, fuels are not required.

Degree of efficiency	%	0,33 kWhel per kWhth
Availability	TLR*	4-9
Investment costs	€ / kW	NA
Lifetime	cycles	NA
	years	15-20
Scalability		High
Replication potential		High

Recommendation of RES installation complied to the solution

photovoltaic system, sensor and controll system, batteries or heat storage

Name of solution:	Batteries

Short description of model solution

Renewable energy installations experience fluctuations in energy production due to the weather and sunlight. Batteries store the extra energy production and enable its later usage when production is low. This optimize the self-consumption of renewable energy for buildings. The big variety in sizes and capacities makes them suitable for most kinds of buildings. Lithium-ion batteries are suitable as buffer storage for renewable energies, for load management, for grid services and in emergency power supply. They are also used in mobile applications such as electromobility, notebooks and aviation. They also have high energy efficiency and relatively manufacturing costs due to the quantities in production. However, the lifecycle of batteries has to be considered. their production and deposit are still controversial due to the environmental and social impact especially on the global South.

Degree of efficiency	%	90-97
Availability	TLR*	8
Investment costs	€ / kW	170-600
Lifetime	cycles	400-1900
	years	15
Scalability		High
Replication potential		High

Recommendation of RES installation complied to the solution

photovoltaic system, sensor and controll system

CSSC Model Solutions

Name of solution:	Latent heat storages in combination with photovoltaic systems

Short description of model solution

latent heat storage system is a thermal system which stores the excess heat during the low-heat-demand hours and release it when the demand is high. In latent heat storage system, the energy required for a phase change is stored in addition to the sensible heat. In practice, this is usually the solid-liquid transition. This phase change happens at a constant temperature which is similar to freezing or melting process (which absorbs or release energy without significant change in the temparature). Water is often used as the liquid storage medium for space heating. Even though it is used in some buildings for sports and hospitals (as shown in our good practices), the technology is maturing and costs are relatively high.

Degree of efficiency	%	75-90
Availability	TLR*	4-9
Investment costs	€ / kW	80-160
Lifetime	cycles	5000
	years	NA
Scalability		medium
Replication potential		High

Recommendation of RES installation complied to the solution

photovoltaic system, heatpump (e.g. geothermal power plant), sensor and controll system

Name of solution:	Sensible heat storages in combination with photovoltaic systems

Short description of model solution

sensible heat storage system is a thermal system which stores the excess heat during the low-heat-demand hours and release it when the demand is high. The energy is stored by the difference in storage material temperature. The insulation is thus of central importance. It is considered cost-effective, established, proven and simple technology. Sensitive heat storage is necessary for the use of geothermal energy, heat pumps and to make cogeneration more flexible, and represents an opportunity for district heating. The storage medium is often water. Sensible heat storage systems are often used in building services for the operation of buffer storage tanks. However, they are also suitable as seasonal storage units. Depending on the design, impacts on nature and the landscape are to be expected.

Degree of efficiency	%	45-75
Availability	TLR*	9
Investment costs	€ / kW	80-130
Lifetime	cycles	5000
	years	NA
Scalability		Medium
Replication potential		High

Recommendation of RES installation complied to the solution

photovoltaic system, heatpump, sensor and controll system

CSSC Model Solutions

Name of solution:	Fuel cells combined with solar systems or heat pumps

Short description of model solution

Fuel cells use hydrogen, which produces thermal and electrical energy through a chemical process. There are low-temperature and high-temperature fuel cells, as well as stationary and mobile applications. Fuel cells can be used for off-grid power supply and to supply buildings with heat and electricity (fuel cell heating systems) as well as to power vehicles. One advantage of the fuel cell is its self-sufficient application; electrical and thermal energy are generated directly on site. It is efficient and low in pollutants. The devices are very low in wear and maintenance. Installation, operation and maintenance are not very complicated. Fuel cell heating systems require a natural gas connection, a buffer storage tank and a central heating system with central water heating. Hydrogen filling stations are required for vehicle propulsion; the technology is only climate-friendly if the hydrogen is produced using surplus renewable electricity. So far, the investment costs are high and the operating experience in field tests is low. The service life is comparatively short, and there are few suppliers. However, these disadvantages could become less important in the future due to the fas development in this technology.

Degree of efficiency	%	43-53
Availability	TLR*	8
Investment costs	€ / kW	2305
Lifetime	cycles	NA
	years	NA
Scalability		High
Replication potential		Medium

Recommendation of RES installation complied to the solution

photovoltaic system to create hydrogen, sensor and controll system, batteries

Name of solution:	Electric Cars/infrastructure

Short description of model solution

Battery-powered electric vehicles are powered by electrical energy from a battery, usually a lithium-ion battery. Vehicles include, for example, battery-powered cars, buses and motorcycles. Once the battery has been discharged, it must be recharged at electric charging stations. Electric vehicles can make an important contribution to more climate-friendly traffic when their energy consumption is from renewable energy sources. They are around 3 to 4 times more efficient than conventional vehicles. Another positive aspect is that no emissions are produced when driving. It improves the air quality in cities and reduce noise pollution. The topic of „second life“ for their batteries is considered promising; after the battery has been used in the vehicle, it can be used for electricity storage after a few years at significantly lower investment costs. The investment in its infrastructure, such as the coverage of charging stations is crucial for its success.

Degree of efficiency	%	45-75
Availability	TLR*	9
Investment costs	€ / kW	80-130
Lifetime	cycles	5000
	years	NA
Scalability		Medium
Replication potential		High

Recommendation of RES installation complied to the solution

photovoltaic system, sensor and controll system, batteries

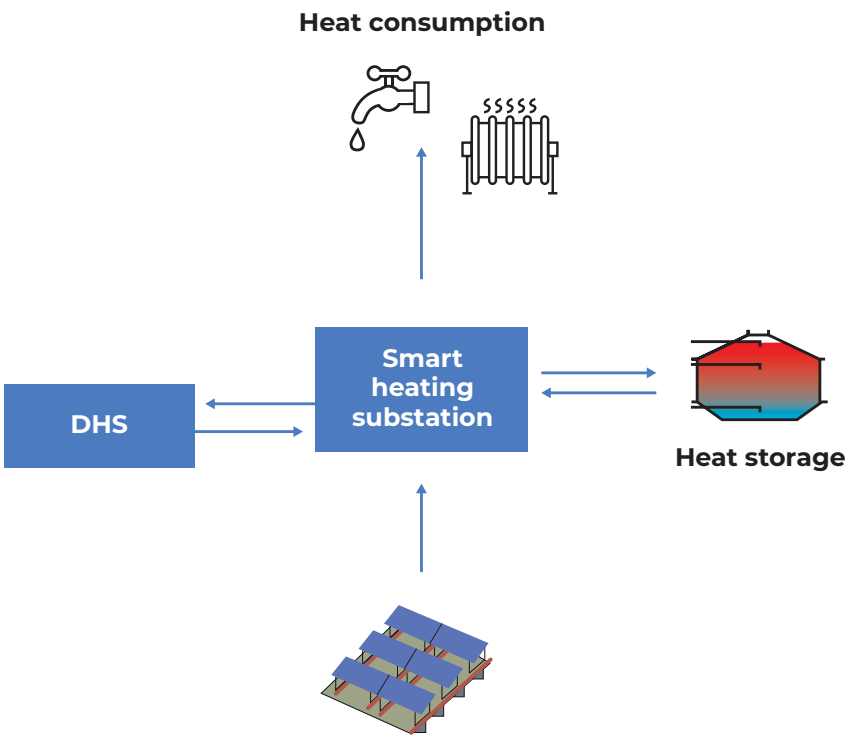
Learning from the Demo Centres

DEMO CENTER IN ZAGREB COUNTY (CROATIA)

The first demo center in the city of Zaprešić, Zagreb County was planned for launching during the project duration but ended up being delayed due to numerous barriers encountered in the project development phase. The Croatian aimed to be the first heat prosumer in Croatia, making it possible for a public building (respectively a public high school) to capture thermal energy for its own consumption by using solar thermal collector systems and to feed surplus heat into the local District Heating System (DHS).

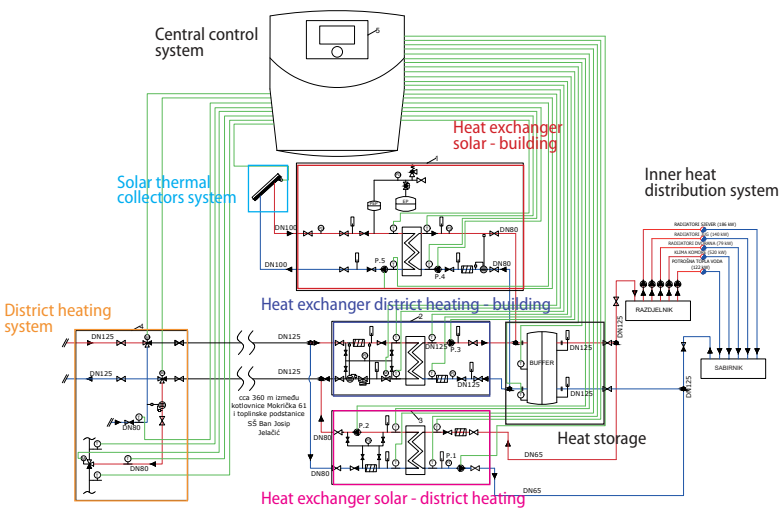
The technologies being tested should have included:

1. Thermal collectors' system for capturing heat
2. Smart District Heating Substations configuration to enable a proper exchange of heat
3. Heat storage (hot water tank)
4. Sensing and monitoring equipment, advanced regulation, and central control systems



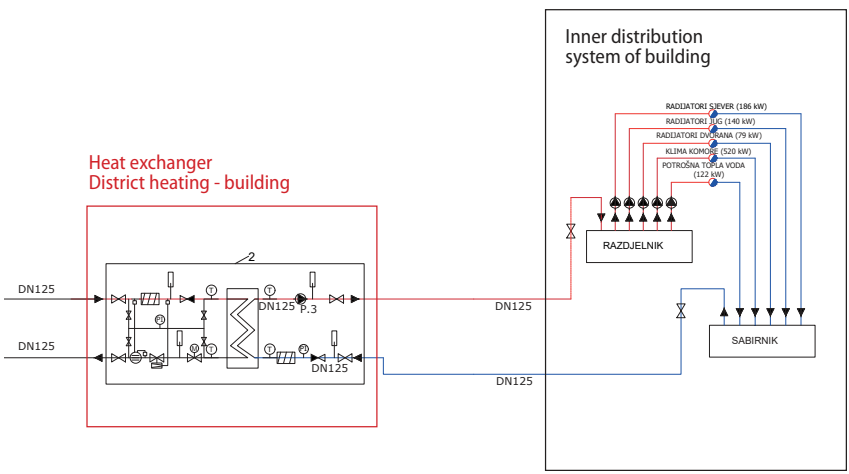
How do all these different parts fit together?

The purpose of a specific set of substation components would be to regulate the bidirectional (two-way) exchange of heat between the public (heat prosumer) building and DHS. Using developed management and control programmes, the smart substation through its set of heat exchangers would use captured solar energy on collectors directly for the building's space heating (and domestic hot water), store it in thermal heat storage (water tank) or send it to local DHS as excess heat through regulated valves, pumps, and other equipment. This decision would come based on continuously monitored parameters and central control system. Conversely, during low production periods, the school receives thermal energy from the DHS once its own reserves have been exhausted. This allows for compensating for any shortages during times of bad weather or peak usage.



This smart heating solution, to its full extent, has been facilitated through close collaboration between included local energy company, city and county, energy agency and international manufacturers of equipment. Although the agreement of switching to renewable heat sources has been made throughout the project, due to numerous limitation factors, the demo center in its concept had to be changed and delayed. First, a detailed revision of roof/building stability forced the project consortium to move the solar system to the ground which completely changed the concept and resulted in the simplification of the solution where the solar thermal system and related heat exchangers, as well as heat storage, have been excluded, leaving only the connection to DHS in the boiler room. In a situation like this, included local energy company opted out of large-scale utilization of solar energy on a nearby field which will influence with even greater impact on heating.

However, the bidirectional exchange is lost since the solar energy will firstly feed the DHS boiler room from which it will be delivered to the public building (and other buildings). Furthermore, since the building currently possesses an individual natural gas boiler room, no renovation of the boiler room is available until the current gas distribution contract does not expire (end of January 2023). After this contract, the low price of gas limited by the governmental order will put a barrier on implementation. Included stakeholders agreed to purchase the necessary equipment and future implementation activities which will be carried out after the project duration. The equipment includes sensing and monitoring devices. Regarding the solar project, due to its size and complexity, it is expect to happen in Q4 2023.



Why is this approach useful?

First of all, the school will manage to lower its reliance on fossil fuels for heating, switching from gas to solar thermal energy. It will therefore directly reduce its carbon footprint. In its initial concept, including storage facilities in the system would allow the usage of additional heat during low production times. This helps avoid wastage and maximises the amount of green energy it consumes. Also, the bidirectional exchange would feed excess heat into the DHS and uses it as larger heat storage which can distribute this renewable heat to other users, making the entire DHS greener.

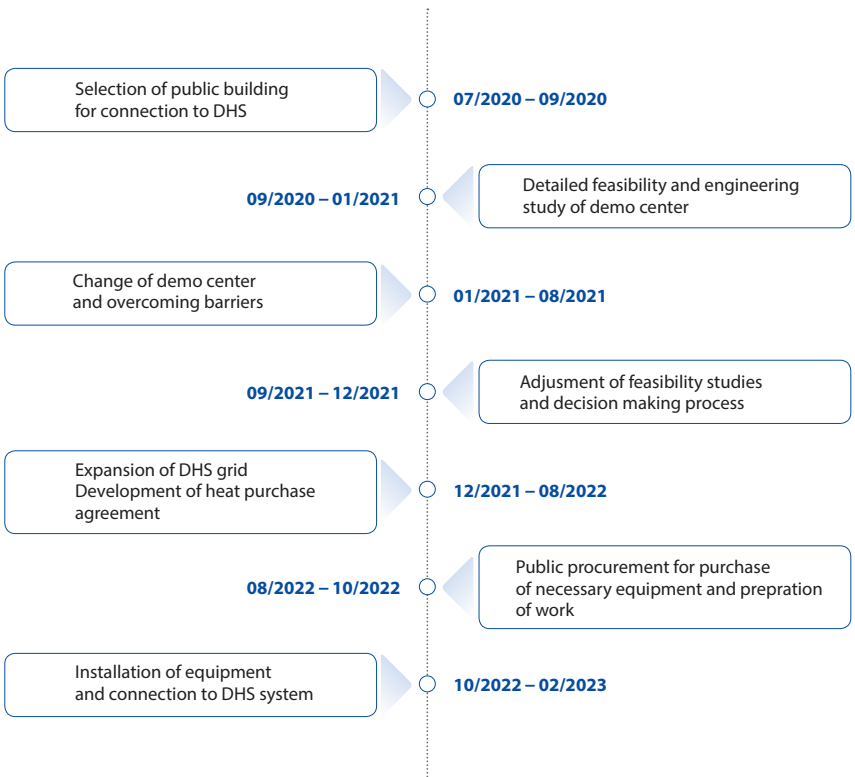
In the modified concept, the importance of solar energy becomes even higher as integration on the nearby green field will enable larger utilization of renewable heat. In this way, the technical solution in each building's boiler room becomes much simpler, where the solar system is connected firstly to DHS which can then distribute the exact amount of renewable heat to each customer. Since the whole large-scale system will be available for meeting the heat demand of the school, it is assumed that around 80% of all heat will be green. This significantly lowers the investment costs but ends up losing the bidirectional exchange of heat within each boiler room.

The thermal energy captured will be used to heat a high school in Zaprešić, which is owned by the regional public authority and maintenances through gathered taxes. Furthermore, this pilot will help raise awareness levels regarding renewable energy among the school's students, its staff and the approximately 1000 gym users also accessing the building. Communication activities

Learning from the Demo Centres

by CSSC Lab on the demo site will further contribute to greater environmental consciousness at local level.

Interested in replicating this approach? Learn from our timeline:



DEMO CENTERS IN STEGERSBACH (AUSTRIA)

The Austrian demo center was launched in June 2021 as part of the solar.one building in Stegersbach. The demo center is part of a larger competence center for renewable energy, which uses a range of different sector coupling and city storage technologies.

Learning from the Demo Centres

The technologies being tested include:

1. Li-Ion and saltwater batteries for storing electricity
2. Thermal heat storages for storing heat.
3. A heat exchanger system/core activation for heating and cooling the building
4. Equipment for mobile storage for charging electric vehicles
5. All these technologies are regulated by monitoring equipment (temperature and presence monitoring) as well as a load and flexibility management system to ensure the building receives the heat and electricity it needs.

How do all these different parts fit together?

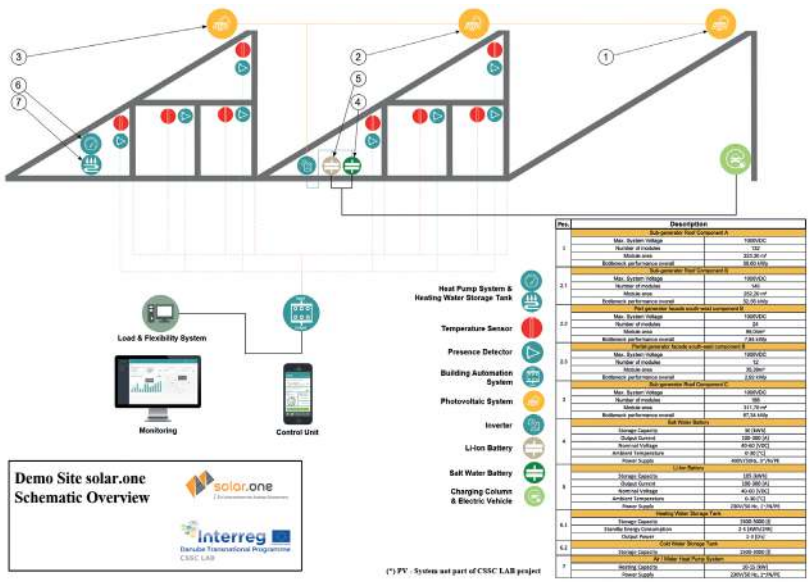
Electricity is generated with photovoltaic panels and stored in the Li-Ion and saltwater batteries for later usage. At the same time, heat from the sun is captured in thermal heat storages.
The electricity is partly employed for sector coupling for e-mobility (charging e-vehicles) whereas the heat exchanger system ensures that heat can be used to either heat or cool the building (power2heat).

Why is this approach useful?

First of all, this approach is carbon-neutral and environmentally friendly. However, there is another benefit of combining all these different solutions. In typical photovoltaic systems, surplus solar energy is fed into the grid for a relatively low price and during times of limited sunshine, all (electric) energy has to be supplied from the grid. This means that producers do not benefit a lot financially from their photovoltaic systems and are also not independent in

terms of their own energy consumption requirements. However, the approach used in this demo center makes it possible to use a lot of the energy being generated on site and to also use electricity for other sectors (heating and mobility).

Stegersbach is a relatively rural municipality with 2700 inhabitants, which is also using the center for different events. The entire building can host 200 people and has a generational capacity of 200KW. This means that it can be entirely energy positive and depend solely on renewable energy sources. Since this amount of energy is sufficient to cover its own needs, the building could also potentially supply neighbouring building with excess PV power. However, for this to become a reality, the necessary legal frameworks still need to be put in place.



Learning from the Demo Centres

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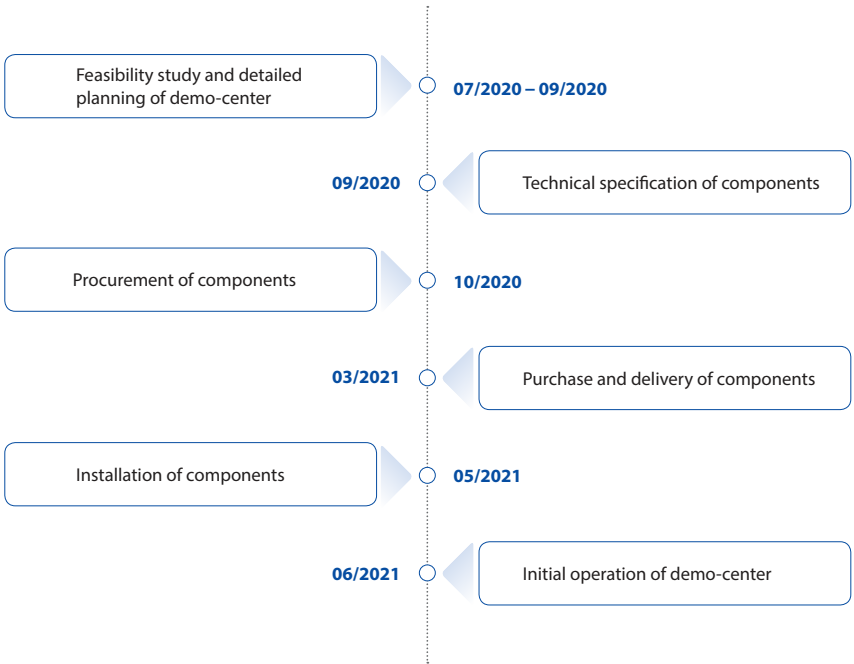


DEMO CENTER IN DESTERNIK, SLOVENIA

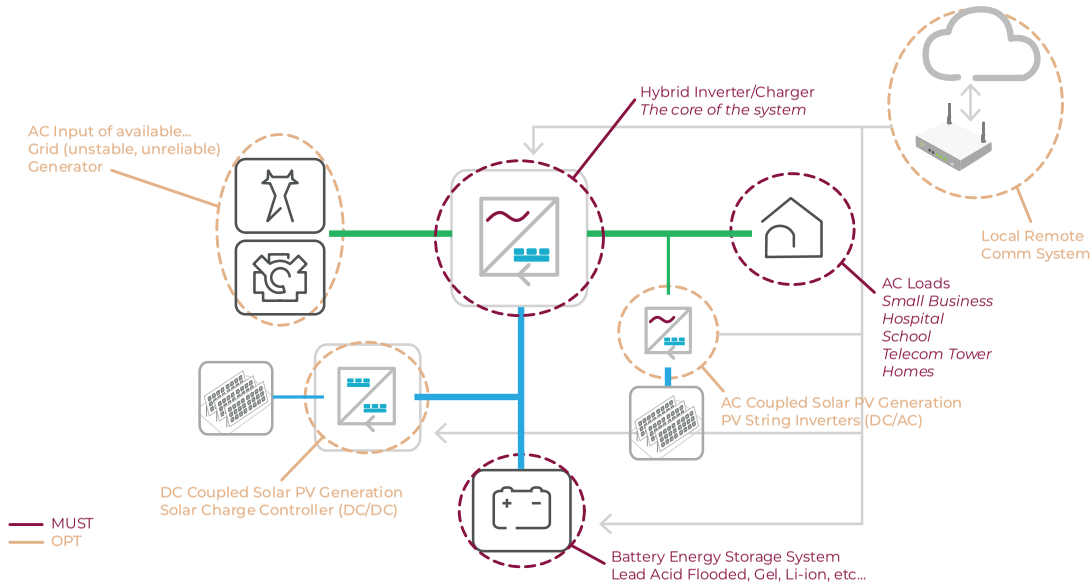
The Slovenian demo center opened in Desternik, Slovenia in July 2021. The demo center is based at a municipal building and includes technologies which test:

1. The generation of electricity through photovoltaics
2. The storage of electricity in a battery
3. The charging of electric vehicles.

How do all these different parts fit together?

Electricity is generated with photovoltaic panels and can be stored in the battery for later usage. When electricity production is high, excess electricity will be fed into the net metering system, making it possible for other residents of Desternik to use the electricity. The electricity will also be made available for the charging of electric vehicles at a local charging station, which will be accessible to the general public. This means that the residents of the municipality will directly benefit from the investment.

The site will also contain all the equipment needed to control and manage the electric loads from the grid, PV system and the batteries. The demo site will continue using electricity from the grid, it will supplement it with its own electricity generated by means of solar panels. This is a highly effective way of dealing with the variability of sun light across seasons and times of day. Employing batteries will greatly reduce the strain on the grid because the municipal building will be able to use its own electricity during times of peak demand. This will contribute to the creation of a smarter grid and help Desternik become a smart village.

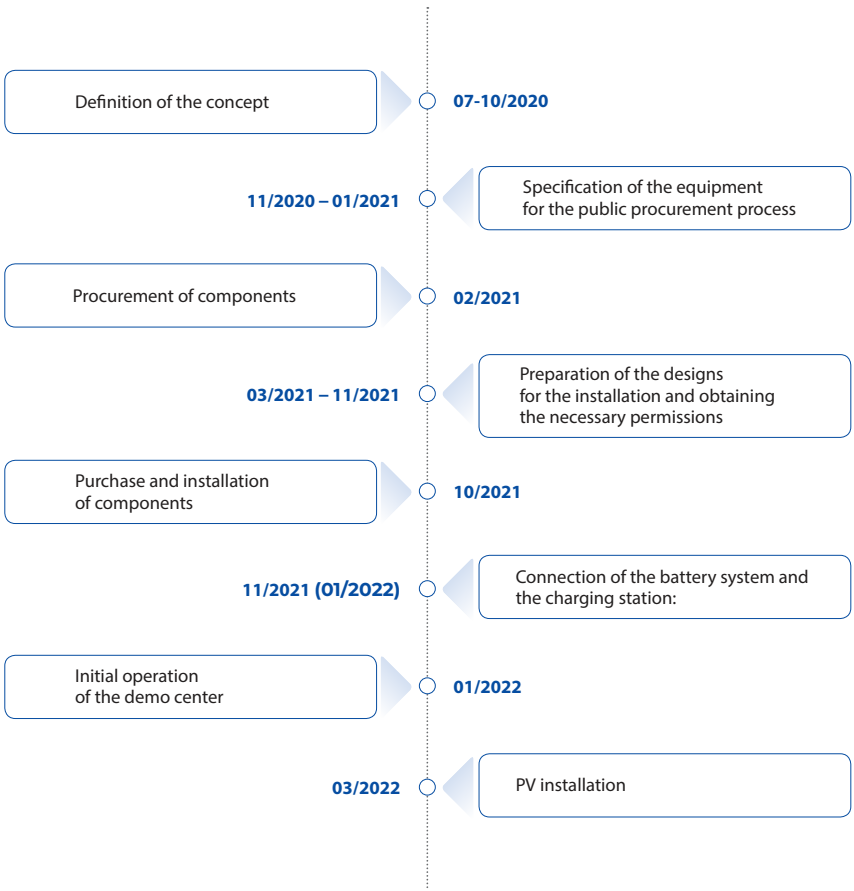

AC Input of available...
Grid (unstable, unreliable)
Generator
Hybrid Inverter/Charger
The core of the system
Local Remote
Comm System
AC Loads
Small Business
Hospital
School
Telecom Tower
Homes
AC Coupled Solar PV Generation
PV String Inverters (DC/AC)
DC Coupled Solar PV Generation
Solar Charge Controller (DC/DC)
Battery Energy Storage System
Lead Acid Flooded, Gel, Li-ion, etc...
MUST
OPT

Why is this approach useful?

Desternik is a rural municipality with 2617 residents, situated in the Northwest of Slovenia. In addition to helping push forward the green transition, this approach also shows that even small municipalities like Desternik can put systems in place to cover the energy needs of municipal and also potentially residential buildings.

The whole logic behind the approach should also help foster the roll-out of electric vehicles in the municipalities. Two charging stations have already been installed in the municipality and a whole network is now being planned. Future grid development will require actions from all consumers in order to balance the grid in terms of peak loads. These kinds of municipal initiatives mark the first step in changing citizens' behaviour towards taking the strain of the grid.

Interested in replicating this approach? Learn from our timeline:



Learning from the Demo Centres

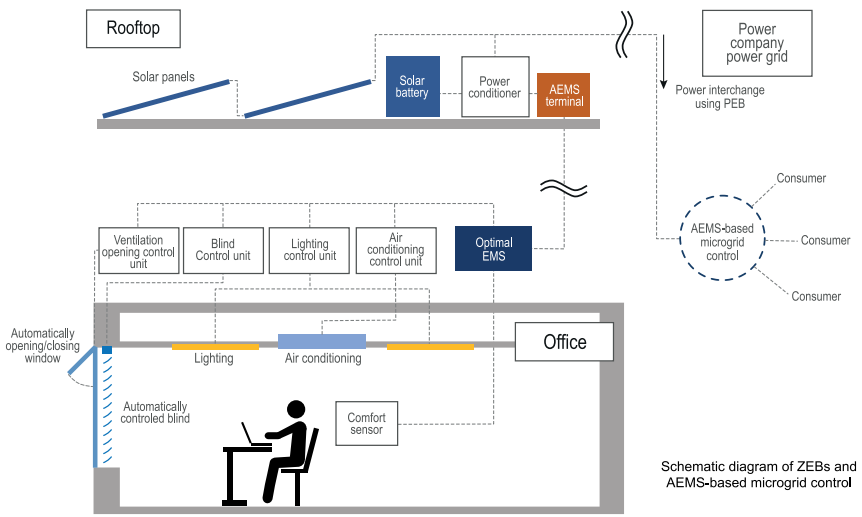
DEMO CENTER IN VARNA, BULGARIA

The Bulgarian demo center was opened in Varna in January 2021 and meets all of the energy needs of the municipal building.
It tests:

- The use of solar energy for electricity and heating through photovoltaics
- The use of biomass for heating
- The storing of electricity in a battery
- The use of solar heat for heating

How do all these different parts fit together?

Solar panels were installed on the roof of the office building and the electricity generated is being stored in batteries. This is used to meet the electricity needs of the building as well as for the charging of electric vehicles close-by. The biomass heating unit serves the purpose of heating the building while the solar hot water PV system ensures that hot water is available.
Combining all these solutions, the office building is entirely self-sufficient and does not depend on the local electricity distribution system.



Schematic diagram of ZEBs and AEMS-based microgrid control

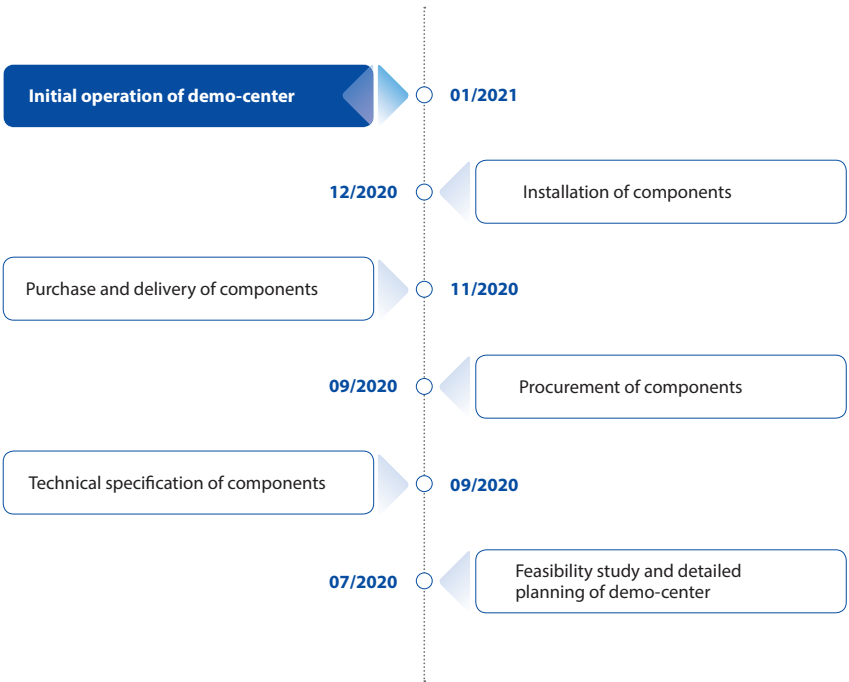
Why is this approach useful?

It allows for a total of 1500 EUR to be saved annually, whereas it generates 8000 kWh electricity from renewable sources and 10000 kWh heat biomass energy. At the same time, the users of the building benefit from more stable electricity supply and constant energy prices. This is especially relevant given that Varna's electricity network has seen price spikes and power cuts in recent years. These sector coupling and city storage solutions help avoid these shortcomings, benefitting both the office users and the environment.

Most of the office staff members go to work by car and therefore use the adjacent electric charging station on a regular basis. However, the community at large also has access to these facilities provided they install the necessary application on their mobile phones. This will further support the boom of electric vehicles observed in Varna in recent years, which has been part of the efforts to promote smart mobility in the city. In fact, making more charging stations available to the residents of Varna is essential to reduce current air pollution levels, which undermine Varna's attractiveness as a tourism destination.

This initiative has a high replication value as building owners in Varna are increasingly looking for alternatives to reduce their reliance on the grid and will be able to see how photovoltaics and biomass heating systems work in practice. Moreover, as the local government is greatly committed to raising air quality in the city, it is likely that this exact model of an energy self-sufficient building combined with a charging station for public use can be replicated on other sites.

Interested in replicating this approach? Learn from our timeline:



CSSC Lab Team 2022

CSSC Lab Platform

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