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STORE4HUC

ASSESSMENT OF THE CONSTRAINTS FOR ESTABLISHMENT OF ENERGY STORAGES AND ACTION PLAN FOR FURTHER STEPS

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Content

1. Introduction

This deliverable deals with the assessment and the identification of gaps and constraints as well as with the assessment of the potentials of energy storage and energy managements systems in HUC. Moreover, recommendations for action have been worked out together with the local stakeholders in the second deployment desk meeting. This serves as action plan for further activities toward effective pilot implementations and also as an indication for other future pilots in HUCs.

The document is separated in a transnational and in a national part. In the transnational part, the national situations are compared with each other and general (transnationally) valid findings are pointed out. In the national part the situation of every pilot and region is described in detail. The technical, economic and legal constraints are worked out and the potential of the particular pilot for replication in other historical urban centres (HUC) is evaluated. As there is no pilot in Germany, the Germany part deals with the general situation in that country.

2. Transnational part

The transnational part is a comparison of the five regional parts. As the pilots as well as the legal situation are different between the countries/pilots, there are a lot of constraints and recommendations which are especially valid for the particular pilot. Nevertheless, there are some findings which apply in a similar way for all.

2.1. Assessment of the constraints

2.1.1. Technical constraints

The technical constraints are strongly varying between the pilots, because they are using completely different technologies. In Slovenia for example, where a paraffin-based latent heat storage is used, finding a suitable product on the market as well as finding a suitable investment construction works contractor was challenging. In Italy, where an electrical storage in combination with a photovoltaic system will be installed, there was no problem finding suitable products on the market, but it was complicated to study for their application to the pilot due to the peculiarity of the plant itself (slope elevator) and its location. In Croatia, a carport PV solution combined with an in-house battery fulfilling the fire safety regulation have been identified and will serve as good practice example. The both pilots in Austria and Slovenia, which are connected to the district heating system have to deal with specifications based on this but also between these two pilots there are major differences related to the used storage type, the location of the storage and so on.

However, it can be stated, that storage technologies which need less space are basically advantageous for the integration in a HUC from the technical perspective, as space is often limited in historical buildings and any construction work often needs special permits. If the storage is located outside, as it is the case in Weiz, there can be some restrictions regarding to the landscape image. Smaller storage sizes would be beneficial from the technical perspective, but the economic consequences have to be also considered accordingly.

Moreover, the installation of photovoltaic systems is much more complicated in HUC. In Croatia for example the biggest technical constraint was to find a solution on how and where to install the photovoltaic power plant, since it must not be mounted on the roof of the building. The only possible solution for the construction of a photovoltaic power plant due to conservation requirements is the construction of a canopy in the parking lot whose roof will be used to accommodate the photovoltaic modules. In Austria, the situation is similar if the building is listed. Modern photovoltaic technologies, which looks like roof tiles and allows different colours could be an alternative in the future. In Germany for example there are already some good practice examples implemented. However, in many countries the law does not differ between different types of photovoltaic systems yet.

2.1.2. Economic constraints

Every participating country has reported higher investment costs due to implementation in a HUC. These higher costs are often resulting from space constraints which hinder the ideas of the pilot implementation but are not allowed to change and because of additional requirements for the used technologies. Space-saving storage technologies like latent heat storages for example are more expensive than conventional water storage tanks. The same accounts for red PV roof tiles which would blend in better with the surrounding landscape.

In Croatia there are also higher initial costs due to the need to obtain a building permit. Obtaining a building permit requires the development of an installation project and the development of various studies to meet conservation requirements and special conditions. Moreover, there are higher initial costs due to time spent on the preparation of all necessary documentation as initially calculated in order to meet all the special conditions at this listed site. In Lendava there are also some additional costs related to the preparation of the *Project for the implementation document* (PZI). An official building permit was not required for this type of construction work. In Weiz there are also some additional costs for the creation of the historic monument and landscape protection zone report.

In addition to that there are some economic constraints which are specifically related to the respective pilot. In Lendava, there are for example higher initial investment costs due to implementation of an innovative storage solution (paraffin-based storage), which is still not matured. The feasibility is still not practically tested. The Italian pilot is facing high costs in regard to the energy efficiency intervention not tackled by national and local financial incentives. In Bračak, there are much higher initial investment costs in HUC because, due to conservation conditions it is not allowed to install a photovoltaic system on the roof of the building but another solution must be sought such as a carport that will be built through the implementation of the Croatian pilot project.

2.1.3. Legal constraints

The legal constraints are different in every country and sometimes also within one country like in Germany, where the protection of historical monuments is in the sovereignty of the federal states, i.e. each federal state has its own law for the protection of historical monuments, thus one solution in Bavaria may not be possible to be implemented in Baden-Württemberg. Moreover, there is a difference on the degree of preservation. In some countries it is a difference if a building is listed itself or if it is “only” located in a HUC. If the building itself is listed also changes on the inside have to be approved while for buildings which are not listed in general only changes which are visible from the outside are limited.

There is a lack of clear regulation on energy market based on energy decentralization and peer to peer energy trading (energy communities) which prevents the spread of energy storage in general. There is one European directive about the establishment of energy communities but most countries have not yet implemented it in their national legislation.

In Italy, the rules for the protection of historical centres can be considered as barriers to the installation of renewable energy system (as photovoltaic plant) but usually do not affect the spread of energy storages.

In Slovenia, additional permits due to monument and local image protection laws related to Cultural Heritage Protection (Institute for the Protection of Cultural Heritage of Slovenia) were not needed. It was not planned to damage the building envelop; therefore, other solutions have been taken (e.g. installation of a heating pipe underground).

In Austria, a specially adapted design of the visible facades with regard to colour and geometry of the storage was necessary. A minimally invasive integration was requested, in order not to influence existing natural conditions such as trees and bushes.

In Croatia, the Law on Protection and Preservation of Cultural Heritage prohibits any action that could directly or indirectly change the properties, shape, meaning and appearance of a cultural property, the installation of a photovoltaic system on the roof of a protected building is impossible. Therefore, the only possibility was to install the photovoltaic system at a canopy in the parking lot next to the castle on the same cadastral plot.

2.2. Assessment of the potentials of energy storage and energy management systems in HUC

To be able to reach the European climate targets, new and innovative energy systems are necessary which often includes some kinds of energy storages. Historical urban centres should be more considered in such measures. The four Store4HUC pilot plants show four different ways how modern storage solutions can be integrated in HUC. The use cases are different, but every pilot plant has a high potential for replication. In Austria for example the number of cities with historical city centres currently amounts to 44. In addition, 38,367 monuments are protected in Austria. The hot water storage pilot from Slovenia is especially suitable in cities like Murska Sobota, Ptuj, Benedikt, Maribor that already use the energy of thermal water and have developed networks/systems. The slope elevator pilot in Italy could be an opportunity to improve some of the services like the urban public transport and consequently the environmental quality of cities (air quality). There are already thoughts about a second pilot plant in Cuneo. The Krapina-Zagorje County in Croatia is rich in historical urban sites, old castles, and manors that have the status of a cultural property. Most of these facilities are in a poor condition and the use of energy storage systems and energy management systems should be considered when renovating them. Moreover, such a practice could be replicated throughout the Republic of Croatia, especially in the reconstruction of the City of Zagreb after the March 2020 earthquake.

2.3. Recommendations for action

Policy recommendations

- It is recommended that storage measures are included in the strategic plans (national, regional and local).
- It is recommended to carry out upstreaming activities, such as meeting with the national public authorities (bodies) to influence on the strategy integration.
- It is recommended to raise the awareness of decision makers about the importance of the renovation of buildings under cultural heritage and the implementation of renewable energy sources, use of energy storages and energy management systems,
- It is recommended to create a legal framework for the restoration of buildings under cultural heritage and simplify procedures for the installation of energy storage systems, energy management systems and use of RES,
- It is recommended to legally define the possibility of installing renewable energy sources on the roofs of buildings that are under cultural heritage in such a way that such installation does not affect the visual identity of the building,
- The Law on the Protection and Preservation of Cultural Heritage needs to be adapted to the time of energy transition in order to facilitate the procedures for the installation of renewable energy sources in HUCs.

- The responsible ministries should be encouraged to publish the Public Open tenders for the subsidies to invest in the storages by public or private companies or physical persons.

<u>Recommendations for those who are planning to install a storage in a HUC</u>

These recommendations are part of the checklist in the Autarky Rate Tool to ensure a high dissemination.

- **Figure out whether the building is protected by the preservation order**

  The location in a historical urban centre (HUC) does not automatically imply that the building or the site is protected by the preservation order. If the building is protected you are generally more limited, but this does not mean that a storage integration is not possible. Nevertheless, the absence of protection by the preservation order does not automatically waive other possible restrictions.

- **Contact the office responsible for the protection of historic buildings and sites at an early stage**

  It is advisable to contact the authority in charge at an early stage and inform them about your plans. The situation has to be evaluated frequently and separately for every case. Thereby, it is more likely to find a good solution, that follows the preservation order, if you contact them at an early stage of your planning. Moreover, it can save a lot of planning costs for things which are not possible/allowed.

  Even if your building itself is not protected, but located within a HUC, it is advisable to contact authorities beforehand and check your situation.

- **What is protected by the preservation order?**

  It might make a difference whether the whole building is under protection or only a certain part of it. For example, if it is “only” the surface, a storage integration is often possible, while the installation of a photovoltaic (PV) system, which is commonly combined with storage integration, could be more complicated. However, there are some good best practice examples available which show some ways how a photovoltaic system could still be installed. For example, in Bračak (HR) the PV system is installed on the carport close to a protected building.

- **Which law is valid for you?**

  Be aware that the preservation order can strongly vary between different countries and sometimes also within countries. In Germany, for example, the federal states (Bundesländer) are in charge of the law. Therefore, you should take into account that if something is allowed in one federal state does not automatically apply for other federal states also. Therefore, make sure that you are aware of the applicable law for your site.

3. Regional part: Austria

3.1. Summary of the Austrian part

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

The boiler section of the heating plant is currently operated mainly in the disadvantageous partial or low load range due to the lack of a central heat storage tank. This leads to increased fuel consumption and pollutant emissions (CO, NOx, dust and volatile unburned CnHm). In addition, due to the lack of a central storage tank, the whole heating network is used as a thermal buffer to absorb the heat supplied by the boilers, particularly during 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 is constantly maintained at correspondingly high flow temperatures and unnecessary heat losses of the network (distribution losses) occur.

The innovative part of this project is the storage tank as well as the overall system improvement. At system level this will be performed via the implementation of a new control and load management unit of all system components (boiler plant, central storage, network and decentralised storage at the consumers) by mutual communication among them and by accessing to the control units of the decentralised storage of the consumers. Innovative is also the integration of the central heat storage in the historic monument and landscape protection zone.

The implementation of the fully integrated, intelligent load management of all system components in interactions with the central heat storage tank and the decentralised heat storage tanks at the customers' premises makes it possible to minimise the disadvantageous operating mode of the boiler plant and prevents the local heating network from being used as a thermal buffer. These planned measures thus increase the flexibility and energy efficiency of the entire biomass heating plant. Essentially, the following positive effects will be 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 in conjunction with the decentralised storage communication resulting in lower heat losses (distribution losses) and savings on pump energy
- Saving of primary energy (fuel savings) by increasing efficiency leads to 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

One of the main reasons for the lack of a storage tank and other measures to increase efficiency up to now is related to the location of the heating plant in the historic monument and landscape protection zone of Weizberg, where the church and the parish buildings are listed as historical monument and protected site. At present, the integration of large heat storage units and other measures for local heating networks in historical districts represents a high challenge due to the strict conditions imposed by the protection of the townscape and historical monuments. However, especially in these districts, which are protected as historic sites and monuments, there is a backlog demand in regard to energy efficiency and the use of renewable energy sources.

This project will demonstrate a possible solution to this problem by the innovative implementation of a central water buffer storage and a new load management system in the listed town centre of Weizberg. The constructional requirements for compliance with the protection of the townscape and monuments are to be fulfilled by new solution concepts. This project can and should therefore serve as an innovative good-practice facility and as a model for simplified technical and above all economic implementation at other protected sites and lead to a significant increase in the proportion of renewable energy sources in historic city centres.

This project thus demonstrates the use of an already widely tested technology (water buffer storage) for the hardly tested area of application in districts and buildings under monument or site protection. Furthermore, the new load management including mutual communication of all plant components at system level represents an innovative approach. For these reasons, the use of this storage solution goes beyond the state of the art and emphasizes the innovative character of this project.

3.2. Assessment of the constraints

Local analysis and discussions (see Deliverable D.T1.1.3) are already performed with all relevant parties to get a clear vision of the project and expected specific outcomes. A communication has been triggered with other municipalities in Austria and abroad via presentations in Bolzano and Graz on well visited conferences (before the COVID-19 pandemic) among other smaller ones. The intention is to promote renewable energy sources in combination with suitable energy storage application(s) in their local territory of historical urban sites and to work together with a highly professional technology provider on realisation.

<u>What are the main challenges?</u>

- Heating plant of the local heating network located in historic monument and landscape protection zone(s).
    - Boiler operating in disadvantageous partial or low load range, which leads to increased fuel consumption with related pollutant emissions (CO, NOx, dust and volatile unburned CnHm).
    - Heating network is used as a thermal buffer to absorb the heat supplied by the boilers.
    - Strict conditions imposed by protection of the landscape and historical monuments.
    - Especially in historic monument and landscape protection districts there is a backlog in demand of energy efficiency and the use of renewable energy sources.

<u>The solutions identified (today → after refurbishment):</u>

- Implementation of a new control with a fully integrated, intelligent load management with mutual communication of all plant components.
- Innovation of this project takes place with the implementation of the storage tank as well as on the system level.
- The following positive effects will be achieved per issue:
    - 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 communicating with the decentralised storage → Lower heat losses (distribution losses) and savings on pump energy
  - Saving of primary energy (fuel savings) by increasing efficiency → CO_2 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
  - The constructional requirements for compliance with the protection of the townscape and monuments are to be fulfilled by new solution concepts.
  - The project can serve as an innovative good-practice facility and a model for simplified technical and above all economic implementation at other protected sites and lead to a significant increase in the proportion of renewable energy sources in historic city centres.
  - The project demonstrates the use of an already widely tested technology (water buffer storage) for the hardly tested area of application in districts and buildings under monumental or site protection.
  - The new load management including mutual communication of all plant components on system level represent an innovative approach.
  - For these reasons, the use of this storage solution goes beyond the state of the art and emphasizes the innovative character of this project.

<u>What are the possible storage solutions for the biomass heating plants in historical environments?</u>

- Sensible energy storages
  - Conventional water tank storages

    From the technical and economic considerations, a conventional water tank is the most promising solution. Water tank storages are a matured and cost-efficient, widely used technology in the residential and district heating sector.

  - Vacuum-super isolated water tank

    In case only biomass boilers are the only heat source, no other RES like e.g. solar thermal are available, hence long-term storage systems are not needed. A vacuum super-isolated water tank with a storage volume of 38 m³ would cause additional investment costs of +25 % compared to a conventional water tank.

- Latent energy storages
  - Hybrid storage consisting of macro-encapsulated PCM (phase change material) and water as storage medium combined in a conventional steel tank

    Advantage that needed volume is minimised, because of higher energy density. Reduced space requirement would be advantageous for HUCs. Disadvantage of additional costs of +92.5 % for a volume saving of 5 m³ compared to a conventional 40 m³ water tank.

- Thermochemical thermal energy storages (TES)
  - Still in R&D process – not feasible economically for the moment.

Economic constraints – in general:

- Additional investments necessary for implementation in HUCs.
- Positive environmental effects versus higher investment costs.
- Water buffer storage systems are at the moment still the most cost- and energy-efficient solutions.

Legal constraints:

- The area of the heating plant (Gst. Nr. 1185/1, KG 68266 Weiz, EZ 2153) is located in a protected area according to the zoning plan (see Figure 2) in the historical city centre of Weizberg.
  - Protection of HUCs is subject to the Building and Regional Planning Act of the Länder (counties) and the Austrian Monument Protection Act. Preservation of the local image is confirmed by a local image expert in the context of building permits.
- The planned extension directly influences the existing landscape and requires therefore:
  - To implement the operations rooms, mostly underground, below ground level.
  - Utilization of existing buildings to cover the extension and associated restrictions regarding the dimensions of the extension.
  - Specially adapted design of the visible facades with regard to colour and geometry while complying with the requirements for weather resistance.
  - Minimally invasive integration, in order not to influence existing natural conditions such as trees and bushes.
- Implementation of the new control system with coherent load management through mutual communication requires access to the control system of decentralised hot water storage tanks at the consumer's sides.
  - This agreement has already been reached with the corresponding consumers by extending the heat supply contract and the maintenance agreement.

Other constraints:

- All persons on the regional/local level have to find joint solutions

3.2.1. Technical constraints

Figure 1 shows a pre-selection and the feasibility of possible storage solutions for the biomass heating plant Weizberg[1,2]. The considered storage solutions were subdivided into sensible, latent and thermochemical thermal energy storages (TES). Technologies that are not feasible, including the reasoning, can be found in red in Figure 1. The analysis of possible storage variants showed that additionally to the conventional water tank storages, two more storage variants are conceivable for the given project. On the one hand a hybrid storage consisting of macro-encapsulated PCM (phase change

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[1] EASE, EERA, EUROPEAN ENERGY STORAGE TECHNOLOGY DEVELOPMENT ROADMAP, 2017. https://eera-es.eu/wp-content/uploads/2016/03/EASE-EERA-Storage-Technology-Development-Roadmap-2017-HR.pdf (accessed April 1, 2019).

[2] M. Sterner, I. Stadler, eds., Energiespeicher - Bedarf, Technologien, Integration, 2., korrigierte und ergänzte Auflage, Springer Vieweg, Wiesbaden, 2017.

T. Beikircher, Superisolierter Heißwasser-Langzeitwärmespeicher - Abschlussbericht, Technische Informationsbibliothek u. Universitätsbibliothek, 2013. doi:10.2314/gbv:749701188.

material) and water as storage medium combined in a conventional steel tank and on the other hand a vacuum-super isolated water tank.

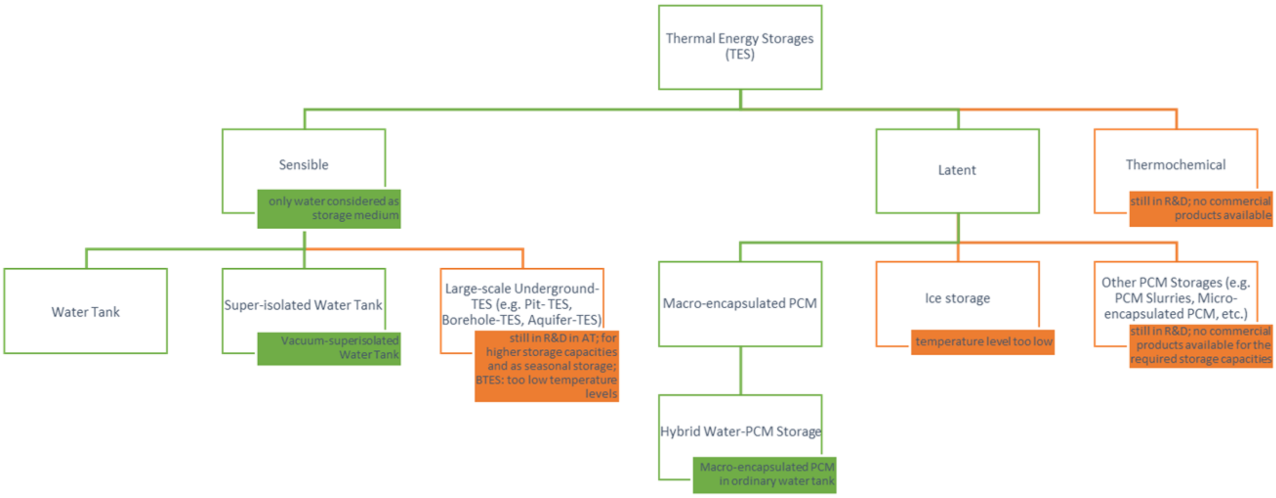

Figure 1. Storage possibilities for the biomass heating plant Weizberg. Red: Not-feasible; Green: Feasible

Vacuum super-isolated water tanks can store energy more efficiently (lower heat losses – heat conduction 4 to 10 times lower) compared to conventionally insulated water tanks[3,4]. Thus, they can be used as long-term storage systems (weekly or monthly). However, the heating plant in Weizberg is operated with biomass boilers as the only heat sources. There is no other available volatile RES (e.g. solar thermal), which would require a long-term storage. Therefore, there is no need for a long-term storage. Furthermore, a vacuum super-isolated water tank with a storage volume of 38 m^3 would cause additional initial investment costs of +25 % compared to a conventional water tank[5].

The hybrid storage with macro-encapsulated PCM has the advantage that the needed volume for the storage because of the higher energy density could be decreased. A reduced space requirement of the storage would be advantageous for the integration in a HUC. However, the additional costs of +92.5 % for a volume saving of a 5 m^3 compared to a conventional 40 m^3 water tank are not economically feasible.

From the technical and economic considerations mentioned above it emerges that under these conditions the implementation of a conventional water tank can be considered as the most promising solution.

Water tank storages are a mature and cost-efficient technology. Therefore, they are widely used in the residential and district heating sector.

3.2.2. Economic constraints

Additional initial investments are largely related to the implementation of the storage facility in a historic city centre with protected status and listed buildings and the associated difficulty and cost-intensive

[3] T. Beikircher, Vakuumsuperisolation (VSI): Stand der Forschung und Entwicklung zu höchsteffizienter Dämmung und Wärmespeicherung im Gebäudebereich sowie in der energieeffizienten Industrie, (2017). https://www.hs-karlsruhe.de/fileadmin/hska/EIT/Aktuelles/seminar_erneurbare_energien/Sommer_2017/Folien/29032017VSIBeikircher.pdf (accessed July 22, 2019).

[4] M. Rottmann, Isolierung von Hochtemperatur-Wärmespeichern, (2019).

[5] T. Beikircher, Superisolierter Heißwasser-Langzeitwärmespeicher - Abschlussbericht, Technische Informationsbibliothek u. Universitätsbibliothek, 2013. doi:10.2314/gbv:749701188.

construction requirements. However, these are to be contrasted with the positive environmental effect achieved for protected historical town centres, which is only made possible by this additional investment.

In terms of energy, the water buffer storage systems are a proven technology and can be considered the most cost-efficient solution compared to other storage technologies due to the high number of charging cycles (almost daily complete charging and discharging of the storage, see section 3.2.1). Additional investment enables positive environmental effects for protected historical town centres and storage technology is the most energy-efficient solution at the moment.

The additional costs caused by the historical monument and landscape protection zone at the HUC Weizberg are limited, as excavation work was generally necessary due to the location. Also, the additional costs regarding the specifications for the material of the panelling are relatively low. In addition, the costs for the creation of the historic monument and landscape protection zone report are in the mid three-digit range. In general, however, RES and EE measures in Austria's HUCs have to be integrated into buildings or the terrain, which results in additional costs compared to the simplest possible solution.

The benchmark technologies and concepts analysed show that the efficient use of local potentials of sustainable energy systems will have positive economic effects.

3.2.3. Legal constraints

The area of the heating plant (Gst. Nr. 1185/1, KG 68266 Weiz, EZ 2153) in the historical city centre of Weizberg is located in a protected area according to the zoning plan (see Figure 2). In Austria, the protection of historic sites and monuments in historic urban centres or other districts is subject to the Building[6] and Regional Planning Act[7] of the Länder and the Austrian Monument Protection Act[8]. In this context, the preservation of the local image and of historical monuments in the respective local image protection zones[9] is preserved by a local image expert in the context of building permits. Structural changes in protected areas therefore require a building permit including a positive assessment of the protected area.

Figure 2. Excerpt from the zoning plan for the focus area Weizberg (Source: zoning plan No. 1.0 - Stadtgemeinde Weiz, as at: 26.09.2019, Original: http://www.weiz.at/files/stadt-weiz/dokumente/Verordnungen/fwp_weiz_kl_1.pdf)

[6] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrStmk&Gesetzesnummer=20000070

[7] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrStmk&Gesetzesnummer=20000069

[8] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10009184

[9] http://www.umwelt.steiermark.at/cms/beitrag/10025584/686638/

The planned extension of the pilot Weizberg (see Figure 3) for the accommodation of a heat storage tank, a machine room, a switch room, a retaining wall as well as the associated changes in the terrain on the southwest side of the boiler house, behind the laying-out hall, thus directly influence the existing townscape. Therefore, the following requirements have to be fulfilled by special structural measures as given in section 3.2 and visualised up to a certain extend by a schematic figure (see Figure 4):

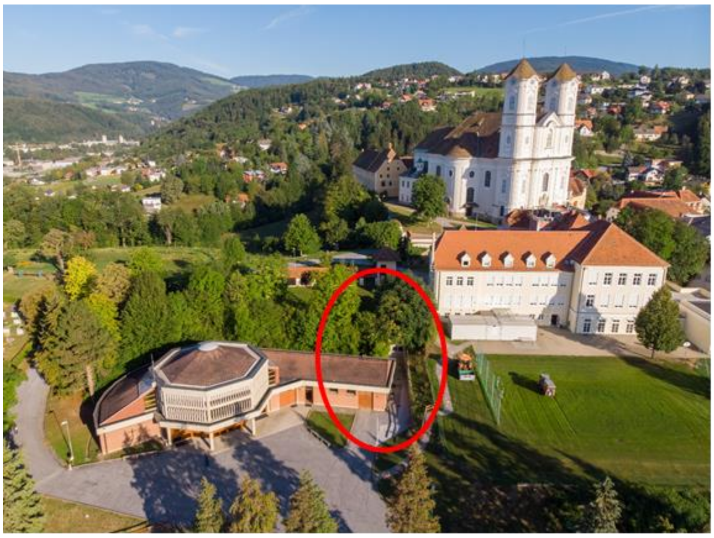

Figure 3. Storage location

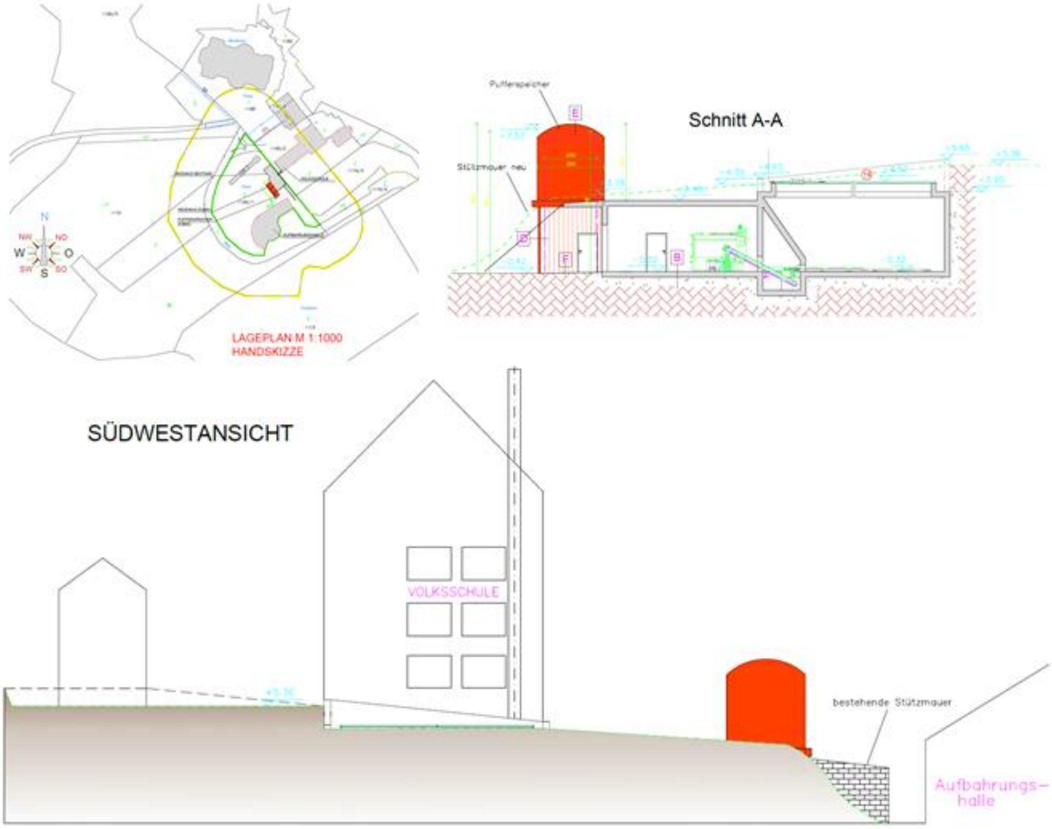

Figure 4. Draft plans of the implementation of the storage

The innovative structural integration of the storage facility in the historic urban centre, which is protected as a landscape protection zone, is intended to meet all these requirements and to ensure that the extension blends in unobtrusively with the overall view and does not have any negative effects on the landscape.

In order to enable the implementation of the 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), access to the control system of the decentralised hot water storage tanks at the consumers is necessary. This agreement has already been reached with the corresponding connected consumers by extending the heat supply contract and the maintenance agreement.

3.2.4. Other constraints

What is very important is that all involved and related actors at regional/local level are in line with the spirit of the Store4HUC project. For example, this project is fully integrated into the regional climate and energy strategies of the city of Weiz, the KEM Weiz-Gleisdorf and the Catholic Church of Styria. For this reason, it was possible to find a solution together with the experts of the protection of the landscape and the building authority of the municipality of Weiz, which is feasible for all parties involved and in terms of the protection of the town and the historical monuments and at the same time realisable. This interaction between the actors for the constructive finding of solutions is necessary and is often more important than technical and economic constraints.

3.3. Assessment of the potentials of energy storage and energy management systems in HUC

As a result of the pilot Weizberg, the integration of a central heat storage unit and new load management to increase efficiency can be made possible, following the Weizer model, in districts under a preservation order and listed buildings, and therefore at numerous locations, through an off-road integrated construction of the plant and through access to the regulation of the consumers.

The number of cities with historical city centres in Austria currently amounts to 44[10]. In addition, 26 monuments[11] are protected in Weiz, and 38,367 in Austria[12]. Therefore, this innovative integration has a high market and replication potential.

In the next few years, the plant in question will therefore serve as an innovative good practice plant and as a model for simplified technical and above all economic implementation at protected sites and may lead to a significant increase in the proportion of renewable energy sources and higher efficiency of local heating networks.

3.4. Recommendations for action

With the innovative approach described in this chapter before, it has been shown that flexibility and sustainable energy solutions in general, but especially for biomass heating plants in historical and listed districts, are both economically and technically feasible.

[10] https://de.wikipedia.org/wiki/Liste_von_St%C3%A4dten_mit_historischem_Stadtkern#%C3%96sterreich

[11] https://bda.gv.at/fileadmin/Dokumente/bda.gv.at/Publikationen/Verordnungen/Steiermark/Verordnung_-Weiz.pdf

[12] https://bda.gv.at/denkmalverzeichnis/
https://bda.gv.at/fileadmin/Dokumente/bda.gv.at/Publikationen/Verordnungen/Steiermark/Verordnung_Weiz.pdf

The aim of this project is to integrate the planned water buffer tank in Weiz unobtrusively into the overall picture. It can thus be shown that large thermal energy storage systems will in future also be a technically and economically viable option for the provision of heating and cooling in buildings or districts under preservation order, especially with regard to the integration of renewable energy sources. Only the integration of the central heat storage unit will also enable the implementation of fully integrated, intelligent load management, which will lead to a significant raise of flexibility following the demand while being more efficient than the today system.

In regard to recommendations for policy actions on joint planning of the local legal frame in Weiz, it can be said that the actors at the Weizberg biomass heating plant are satisfied with the solution worked out. However, it has to be mentioned that this solution does not correspond to the original request of Biomasseheizwerk Weizberg with results of additional costs. For example, the size and colour of the buffer storage tank as well as the materials of the panelling had to fulfil a list of requirements. Within the procurement process the design has to be adapted according to the requests of the local monumental protection officer. All in all, if one looks beyond the compromises made, the procedure and future implementation in Weiz can be considered a good solution and should and can serve as a lighthouse for other regions of Europe.

4. Regional part: Italy

4.1. Summary of the Italian part

The project is aimed at optimising the energy resources necessary for the operation of the lift by means of a storage system, in which electricity will be stored and from which it will be used when needed. The storage will be utilised to recover the energy dissipated during the braking phases and produced during the elevator rides with maximum load unbalance, as well as the energy that will be supplied by a small solar field that, for the pilot project, will be installed along the inclined elevator's runway.

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

This system has the potential to be replicated in other sites, from a technical point of view but meets some obstacles where the constraints of protection of historical centres are more restrictive.

Another problem that has affected and slowed down the development of the project is related to the time given by the bureaucracy necessary for the approval of the project in the institutional offices.

Despite this, the pilot action has been an opportunity to evaluate both the obstacles and the opportunities represented by the regulatory framework and to launch comparison tables of local and national institutions aimed at facilitating the dissemination of these systems in compliance with environmental and landscape regulations.

4.2. Assessment of the constraints

This chapter deals with the technical, economical and legal constraints as well as other constraints for establishing storages in HUC in Italy.

4.2.1. Technical constraints

- The renewable technologies used in the efficiency project are mature and relatively cheap technologies on the market (photovoltaic panels and storage batteries), it was more complicated to study for their application to the pilot due to the peculiarity of the plant itself (inclined elevator) and its location.

4.2.2. Economic constraints

- High costs of the energy efficiency intervention, due to lack of incentives at national and local level to support the energy storage systems' installation and due to implementation in a HUC and space constraints limit hinder the ideas of the pilot implementation.

4.2.3. Legal constraints

- Actually, there are no barriers and regulatory constraints concerning protection of architectural and environmental heritage that prevent the installation of energy storage in HUC but new regulation and law at national level must be developed in the field of energy trading. The lack of clear regulation on energy market based on energy decentralization and peer to peer energy trading prevents the spread of energy storages.

- The rules for the protection of historical centres can be considered as barriers to the installation of a renewable energy system (such as a photovoltaic plant) but usually do not affect the spread of energy storages.
- On the basis of the current urban development plan (approved by D.G.R. 40-9137 of 07/07/2008), the area enclosing the inclined lift subject to energy efficiency interventions falls almost entirely within the "TVAP - Territories with environmental and landscape value" established by the PRGC (art. 79), as it is a large part of the eastern side of the plateau on which Cuneo lies, with the exception of the area on which the top station is located, which falls within the area of the outdoor spaces of the historic city, classified as "System of bastions: Lungo Gesso, Lungo Stura and pedestrian paths". A permission for the energy generation unit (PV modules) has been required for the installation.

4.2.4. Other constraints

This pilot project is fully integrated in the strategy of the city of Cuneo in favour of sustainability and protection of environmental resources (PUMS - Sustainable Urban Mobility Plan and SECAP - Sustainable Energy and Climate Action Plan). The strong interaction between the energy efficiency intervention on the pilot action and the Municipality strategy in terms of sustainability has contributed to quickly and constructively overcome some constraints that would have made the authorization and constructive process longer.

4.3. Assessment of the potentials of energy storage and energy management systems in HUC

- The implementation of energy storage and energy management systems in HUCs could be an important driver to stimulate the installation of RES systems in these contexts and also the creation of energy communities, based on sharing of renewable energy.
- The storage system integrated with the inclined lift drive shall meet the following functional requirements:
    - to prioritise instantaneous self-consumption during the period of peak production of the photovoltaic system;
    - to store the energy produced by the photovoltaic system and not instantaneously consumed;
    - to use a portion of the energy produced to limit the peaks of absorption from the mains in case of need;
    - to ensure an emergency power supply in the event of a power failure from the ENEL network, allowing the completion of the lift ride and an additional period of operation before the disruption of service, during which the surveillance personnel can take the necessary measures.
- The diffusion of energy storage in historical centres could be an opportunity to improve some of the services like the urban public transport and consequently the environmental quality of cities (air quality)
- This technology can enable energy decentralisation and increase energy production from renewable sources and achieve complete decarbonisation.

4.4. Recommendations for action

The discussion conducted with the other stakeholders during the meetings of the Deployment Desks of Store4HUC - and the accompanying path for the accession to the new Covenant of Mayors and implementation of the SECAP (Sustainable Energy and Climate Action Plan) - has brought out the usefulness of conducting case studies and pilot projects in this particular period. In spite of the current regulation of the energy market that does not provide for peer to peer trading opportunities - this way slowing down the deployment of storage devices - a new system of rules and regulations is currently under study that is likely to change the situation in the short to medium term, promoting the development of Energy Community in the territory of the Piedmont Region. For the Cuneo area, the presence of a pilot project already implemented in a historic centre scenario will be an important element to be considered in the decision-making processes that shall be addressed at local level. In addition to the specific case of the pilot experiment involving the inclined lift - thanks to the participation of the Municipality of Cuneo in Store4HUC - the territory will also benefit from the experiences acquired in other European areas and the tools implemented as part of the project. With the realization of the pilot project, a first experimental phase will be completed that will open to new, more articulated interventions of energy efficiency through storage systems that will, among other things, contribute to the supply of some public services and to the increase of energy production from renewable sources for improved air quality and decarbonization process.

The policy recommendation:

- Involvement of all stakeholders from the beginning of the project.
- Strong interaction between local and regional strategic plan for sustainability and the pilot action to create shared interest and greater synergies.
- A strong boost to the installation of energy storage could be given by new incentive policies implemented at regional and national level.
- To carry out upstreaming activities, such as meeting with the national public authorities (bodies) to influence on the strategy integration.

5. Regional part: Croatia

5.1. Summary of the Croatian part

In Croatia, as well as in the Krapina-Zagorje County, the requirements related to energy storage, energy management systems and installation of photovoltaic systems in locations that are under cultural protection are related to the constraints prescribed by the Ministry of Culture and Conservation Departments. Constraints are defined by the Law on Protection and Preservation of Cultural Heritage. The law prescribes the prevention of any action that could directly or indirectly change the properties, form, meaning and appearance of a cultural property. It is also obligatory to protect and preserve cultural goods in their pristine and original condition, and to pass on cultural goods to future generations. As each historical site is special and different, there are no clear guidelines developed by the Ministry of Culture so that investors do not know what obstacles they will encounter when implementing such systems. This is a very limiting factor as it is difficult to predict the final amount of investment. Also, in Croatia, little is generally invested in HUC, so most historical urban sites are left to decay. In the Krapina-Zagorje County, only Bračak Manor has a central energy management system installed, and with the implementation of the Store4HUC project will be the first building under cultural heritage to have an energy storage with a photovoltaic system and energy consumption monitoring system in this area.

5.2. Assessment of the constraints

This chapter deals with the technical, economical, and legal constraints as well as other constraints for establishing storages in HUC in Croatia.

5.2.1. Technical constraints

The main technical constraint was to find a solution on how and where to install the photovoltaic power plant, since it must not be mounted on the roof of the building. For the time being the only possible solution for the construction of a photovoltaic power plant due to conservation requirements is the construction of a canopy of the parking lot whose roof will be used to accommodate the photovoltaic modules.

It was also difficult to find the right place in the building to install the battery system due to the requirements of fire protection. It is further complicated by the fact that the building was built in 1889 and the layout of the premises is not intended for the installation of a battery system.

5.2.2. Economical constraints

Higher initial investment costs in HUC are expected because due to conservation conditions it is not allowed to install a photovoltaic system on the roof of the building but another solution must be sought such as a carport that will be built at the Croatian pilot project of Bračak Castle.

Higher initial costs have to be calculated due to the need to obtain a building permit. Obtaining a building permit requires the development of an installation project and the development of various studies to meet conservation requirements and special conditions.

The higher initial costs resulted due to the time spent on the preparation of all necessary documentation in order to meet all the special conditions at the site, which is under the cultural heritage protection.

5.2.3. Legal constraints

Since the Law on Protection and Preservation of Cultural Heritage prohibits any action that could directly or indirectly change the properties, shape, meaning and appearance of a cultural property, the installation of a photovoltaic system on the roof of a building is impossible. Therefore, it is necessary to look for other solutions and the conservation department accepted the construction of a canopy in the parking lot next to the castle on the same cadastral plot. In order to achieve that, it is necessary to obtain a building permit. Obtaining a building permit means that it is necessary to prepare an installation project and meet the special conditions of public bodies involved in the procedure. Specifically, for the pilot project Bračak it was necessary to meet the special requirements of the Conservation department, Civil protection service, Sanitary inspection, Distribution system operator and Natural gas distributor.

5.2.4. Other constraints

The need for manual excavation due to the numerous underground installations in order to make the foundations for the canopy whose roof will be used for the installation of photovoltaic modules. It is also necessary to bring power cables from the photovoltaic system that will be located in the parking lot to the castle whose distance is 20 meters.

5.3. Assessment of the potentials of energy storage and energy management systems in HUC

Krapina-Zagorje County is rich in historical urban sites, old castles, and manors that have the status of cultural property. Most of these facilities are in a poor condition and the use of energy storage and of energy management systems should be considered when renovating them. Also, photovoltaic systems should be used to generate electricity to create efficient energy communities based on renewable energy sharing. Energy renovation of old buildings that are under cultural protection plays an important role in the energy transition and reduction of carbon dioxide emissions. Such a practice should be replicated throughout the Republic of Croatia, especially in the reconstruction of the City of Zagreb after the earthquake in March 2020.

5.4. Recommendations for action

The actions from the pilot perspective:

- It is necessary to raise the awareness of decision makers about the importance of the renovation of buildings under cultural heritage and the implementation of renewable energy sources, use of energy storages and energy management systems,
- It is necessary to raise the level of knowledge about the importance of using energy storage and energy management systems and the use of renewable energy sources,
- It is necessary to create a legal framework for the restoration of buildings under cultural heritage and simplify procedures for the installation of energy storage systems, energy management systems and use of RES,
- It is necessary to legally define the possibility of installing renewable energy sources on the roofs of buildings that are under cultural heritage protection in such a way that such installation does not affect the visual identity of the building,
- The Law on the Protection and Preservation of Cultural Heritage needs to be adapted to the time of energy transition in order to facilitate the procedures for the installation of renewable energy sources in such localities.

6. Regional part: Slovenia

6.1. Summary of the Slovenian part

In each new investment, we may encounter certain limitations, especially when the field is not sufficiently matured. Additional restrictions may be faced when the investment is carried out in historical protected areas. In Slovenia, we are facing time-consuming planning and implementing processes due to implementation in a HUC and using an innovative storage solution. The bureaucratic process is slowing down the whole process of any technical solution. In Pomurje, the lack of geothermal experts is evident and should be improved in order to facilitate the similar pilot projects in terms of storages in connection with geothermal energy. The costs indeed increased due to the HUC restrictions and economic feasibility will be defined after the operation start.

The paraffin storage has the potential to be replicated on other sites. Especially where the geothermal energy is already exploited.

Policy recommendations are related to the upstreaming of the measures and support for national, regional and local integration into the strategic plans.

6.2. Assessment of the constraints

This chapter deals with the technical, economical and legal constraints as well as other constraints for establishing storages in HUC in Slovenia.

6.2.1. Technical constraints

- Finding a suitable product on the market is challenging. Paraffin based storage is a rare product on the market. Just a few companies deal with it. This fact is another point that slows down the process. It was very important to perform a market appraisal on storage applications and later on to calculate the right figures.
- Low output (return) temperatures on district heating of geothermal energy can be the fact that could jeopardize the efficiency of the investment. Therefore, the heating oil boiler remains as a backup in case there will be too low temperate in the winter season.
- Due to the pilot specifics, it is difficult to find a suitable construction works contractor for the pilot.

6.2.2. Economic constraints

- Higher initial investment costs due to implementation of an innovative storage solution (paraffin-based storage) which is still not fully matured. All features are still not practically tested.
- Higher investment costs due to implementation in a HUC (it is requested nothing to be changed in the premises of the library due to the space constraints which limits and hinders the ideas of any pilot implementation).
- Due to the specifics of the pilot, the investment became more expensive, additional costs were incurred. Economic justification will be shown after the implementation and start of the heating season.

6.2.3. Legal constraints

- Additional permits due to monument and local image protection laws related to Cultural Heritage Protection (Institute for the Protection of Cultural Heritage of Slovenia). It is required not to damage the building envelop; therefore, other solutions have to be taken (e.g. install a heating pipe underground).

6.2.4. Other constraints

- Low technical knowledge about the existing district heating system. In Pomurje region we are lagging behind when it comes to the geothermal energy although the exploiting of it has the biggest potential in Slovenia.
- Low involvement of the experts from the geothermal field. Such expert should be constantly available, at least from the municipal side should be appointed, with experiences in similar projects.

6.3. Assessment of the potentials of energy storage and energy management systems in HUC

- The hot water storage pilot is especially suitable in cities that already use the energy of thermal water and have a developed network/system of geothermal water (e.g. Murska Sobota, Ptuj, Benedikt, Maribor). It is also suitable in cases where the water temperature is higher. Of course, it is also important where the water connection is located, whether it is in the middle of the grid or at the end of the grid where the water temperature is already lower.
- The potential is also in facilities where there is a lack of space, as paraffin storage has a smaller volume. This advantage could be used in spatial issues in monument-protected buildings. Such a storage can justify a higher cost.
- The municipality Lendava hopes for the pilot to become the best-practice in terms of implementing innovative storages in HUCs with no pollution.
- The potential is in increasing energy efficiency and share of RES of HUCs in the municipality of Lendava. The connection to the geothermal grid is the logical continuation of municipality to increase the exploitation of the geothermal energy. The municipality is supporting the transition from heating oil to other cleaner and renewable energy sources also in other (public) municipal and owner-occupied buildings.
- The functions and properties of the paraffin storage are favourable (characteristics are as follows: Storage volume: 63 litres; Volume of paraffin: 50 litres; Length x width: 25 cm x 25 cm; Height: 100 cm; Strength of storage material: 0.8 cm polypropylene; Weight: 50 kg; The paraffin melting point: 43 - 46 ° C; Curing point: 43 - 42 ° C; Max. operating temperature: 85 ° C; Total capacity: 2,82 kWh)

6.4. Recommendations for action

The actions from the pilot perspective:

- Detailed knowledge of the legislation within protected buildings.
- Good calculations of data, better knowledge on the topic, detailed knowledge of the existing geothermal remote network, knowledge of the substation (temperatures, pressure, distances) in order to calculate the capacities of the storage.
- To specify the works for public procurement and select the construction works contractor.
- Start with the installation and construction work.

The policy recommendation:

- Involvement of all stakeholders from the beginning of the project;
- Storage measures to be included in the strategic plans (national, regional and local);
- The responsible ministries to publish the Public Open tenders for the subsidies to invest in the storages by public or private companies or natural person.
- To carry out often upstreaming activities, such as meeting with the national public authorities (bodies) to influence on the strategy integration.

7. Regional part: Germany

7.1. Summary of the German part

Cities are key players in implementing the laws on energy system transformation passed by the German Federal Government. They are key addressees for the implementation of energy efficiency targets within ambitiously short time frames. As Germany is a federal state, the laws related to monument protection vary from state to state as well as the energy distribution grid, posing a challenge to municipalities to find the crossroads and common point of monument protection and reaching climate goals in the same time. For cities to be able to tackle this call to action, the demanding task of energy efficiency improvement must be reconciled with the objectives of preserving the architectural integrity of historic city centres. In doing so, the objectives of climate protection should be brought into line with the concerns of monument protection and integrated urban development geared to preserving the architectural heritage. In addition, there is a great potential for increasing energy efficiency in close proximity to all historic town centres. Neighbourhood-related approaches offer excellent opportunities for action that are accessible to the municipalities in order to achieve the ambitious energy targets in the historic city centre without overburdening the buildings. The possibilities of using renewable energies to generate heat and electricity for the neighbourhood, increasing energy efficiency through heat generation and supply across properties or building blocks, the use of sustainable generation, distribution and storage technologies can be made use of for historic urban neighbourhoods. Sensible measures for municipal and private existing buildings that are compatible with the preservation of historical monuments and building culture must be identified and integrated into an overall strategy.

7.2. Assessment of the constraints

This chapter deals with the technical, economical and legal constraints as well as other constraints for establishing storages in a HUC in Germany.

7.2.1. Technical constraints

Standardization issues

- Heat storage systems are not necessarily connected to any grid; therefore, registration and approval is not necessary. However, for planning and implementation there are the standards of the professional associations (DIN, VDI, DVGW etc.) which are regarded as recognized state of the art and which should be observed.

- In HUC there are problems with the structural integration of the various storage facilities into the existing system.

Conceptual planning challenges

There can be problems if the energy concept requires that new additional energy storage pipes have to be laid to the existing ones. Especially in historical town centres there are often archaeological finds which are then "excavated" and possibly have to be preserved. Then the laying of a local heating pipe through the foundation of a medieval house can become difficult.

Design issues

Design challenges vary according to the type of energy storage and the position of the added technology (exterior or interior of the building). E.g. Solar thermal modules are usually always black. Therefore, it would not be possible to get a permission for red roofs of listed buildings, thus the related energy storage cannot be installed. Although various solutions exist for external renewable energy collector such as tube solar collectors, positioning and integrating the energy storage systems in urban surroundings still require solutions not yet standardized.

Material issues

Among the most important assessment criteria for the compatibility of building measures with historic monuments are the most unaltered possible transmission of the substance worthy of preservation and the preservation of the appearance. This requires measures that require only minor substance interventions and are reversible if possible. Particularly in connection with energy improvements, material continuity and suitability are of great importance, since "modern" building materials can lead to a structural imbalance in the building structure and to physical and structural damage. In the case of construction work on historic buildings, care must be taken to ensure that the building structure, usually a materially homogeneous stock, for example in terms of statics and building physics (moisture behaviour), does not become unbalanced but remains balanced.

7.2.2. Economic constraints

Various budgets available across the sectors

Sustainable energy supply in the building sector has been better received by the churches than in the municipal sector. Cities and municipalities' financial limits are still decisive. An investment in the municipal sector must be refinanced in around 10 years for it to be eligible for approval. And since the majority of municipalities do not have a balanced budget, the freedom is rather limited.

Cost issues with photovoltaics

Unfortunately, the high costs of special red PV-panels make these systems economically inefficient and private investors as well as e.g. the local perishes refrain from installing these systems. Red PV roof tiles would be perfect, but these are even more expensive than standard-sized red PV panels.

Investment security

A big difficulty is planning security because an investor will only know the actual requirements very roughly. Therefore, a modular, expandable concept is recommended.

7.2.3. Legal constraints

Federal Law and State Law

As Germany is a federal state, laws in this area differ from state to state. The protection of historical monuments is in the sovereignty of the federal states, i.e. each federal state has its own law for the protection of historical monuments, thus one solution in Bavaria may not be possible to implement in Baden-Württemberg.

Listed buildings vs historical monument areas

Each federal state has its own law for the protection of historical monuments. As a result, there are different legal requirements for the restoration and modernisation of cultural monuments.

There are also different legal regulations depending on the federal state and the degree of preservation of the city centres. Often not all buildings are listed, i.e. there is more room for manoeuvre for the interior of the buildings. However, changes to the external appearance of "non-cultural monuments" in historical areas are often subject to approval (e.g. through design statutes).

Laws regarding building vs Laws regarding climate protection measures

Building measures for climate protection at cultural monuments often are in conflict with the legal regulations for the protection of historical monuments.

Missing regulations

The requirements regarding planning storage facilities may be in conflict if the energy supplier is not the owner of the buildings to be supplied.

7.2.4. Other constraints

Scaling and local differences

Although Energy storage systems are likely to be of particular interest for individual and ensemble supply systems and local heating solutions, upscaling is difficult.

The law hands over the final responsibility for grid stability to the respective distribution system operator. Currently, there are more than 900 distribution system operators in Germany. Every electrical production unit and every electrical storage unit has to be registered with the distribution system operator. Large units also need a permission to operate before being connected to the grid. Therefore, a large electrical storage system with high power output may be allowed in one region but not allowed in another region, due to grid issues.

Classification of the building and its effect in the surrounding

Cultural Monuments (with Registry entry in the Register of Monuments) are also protected in regard to their effect in their neighbourhood, i.e. changes in the appearance of surrounding. Furthermore, there are designated zones according to § 19 DSchG[13], such as historical city centres where one external change has its effect on the neighbourhood, making it impossible to add e.g. solar thermal collectors or PV modules. The solar thermal collectors are always black. It is not possible to get a permission in case of red roofs of listed buildings.

It is not easy in principle to obtain permits under monument protection law for PV systems in HUCs. What is decisive first of all is how the cultural monument is classified, e.g. in Baden-Württemberg, whether it is a cultural monument according to § 2 DSchG or a cultural monument of special importance (§ 12 DSchG). Cultural monuments of special importance enjoy special protection in Baden-Württemberg through their entry in the Register of Monuments. A further aspect is the nature of the cultural monument and how much original substance and possibly listed substance from other more recent style epochs is preserved. Each decision is an individual decision of the competent authority.

Permits for installations take time

It is a case-by-case decision of the responsible authorities, because each cultural monument is individual. Basically, the storage elements which are housed in the adjoining rooms in the basement of a cultural monument and have no appreciable effect on the appearance and the historical substance, can rather be regarded as being compatible with the storage installation.

[13] http://www.denkmalliste.org/denkmalschutzgesetze.html

7.3. Assessment of the potentials of energy storage and energy management systems in HUC

The climate protection goals for Germany are very ambitious: the heat energy use has to be reduced by 20 percent by 2020. By 2050, primary energy consumption in buildings should be reduced with 80 percent and a climate-neutral building stock should be reached.

Energy neighborhood concepts in the historical town centre

A potential use of Store4HUC solutions is currently discussed in the field of extending the area of activities from single buildings to entire neighbourhoods. To think beyond the individual building, requires the creation of integrated, neighbourhood-related concepts for the intelligent energy refurbishment in historical urban centres. The energy quarter concept shows, which technical and economic measures are necessary to cover existing energy saving potentials in the historic city centre and which concrete measures can be taken to reduce CO_2 emissions in the short, medium and long term. All relevant urban planning, monument preservation and preservation measures are taken into account, aspects of building culture, housing economy and social aspects are considered. Strategies and solutions for energy-efficient renovation and urban renewal is summarized in the concept development. These strategies and concrete investment and non-investment measures are supported by financing plans. Funding for such concepts may be supported by the KfW-Bank (Kreditanstalt für Wiederaufbau or "Credit Institute for Reconstruction", a German state-owned development bank.)

In cities where a district or local heating network in or around the historic city centre already exists, the potential for connecting or expanding the existing systems with a consistent energy/heating supply with the inclusion of renewable energies often achieve considerable savings potentials.

7.4. Recommendations for action

Best results and greatest satisfaction of all parties involved can be achieved by early consultation and coordination of renovation and modernization measures. In doing so, energy consulting, monument protection, urban planning, financing and personal requirements can all be taken into account. In most cases, the first point of contact is the city administration, in particular the building authority and the remediation officer or carrier. In case of a joint project, it has been found that it’s necessary to include the monument protection department and the energy management agency as well as the building authority to be able to conduct initial consultations with the required quality. Neither the building authority nor the redevelopment authorities can take over the tasks of architects and qualified energy consultants, but they can explain the necessary procedures and indicate the involvement of qualified experts. This requires knowledge about requirements and possibilities of energy efficiency in buildings and neighbourhood as well as the corresponding funding opportunities.

The quality of the planning and implementation process can be further promoted through energy efficiency specialists and in future the optimum use of subsidies can be ensured by all those involved. Here, the employees and representatives of the city administration can, above all, perform coordinating functions and demand and support the qualification of local architects and energy consultants, but also of qualified local and regional companies and craftsmen. Advising the owners of historic buildings requires a special knowledge of the effects of modern techniques and technologies at historic buildings and their proper application. In order to prepare planners, architects, energy consultants and craftsmen for these requirements, it is necessary to check their relevant qualifications. Especially in the field of energy-related building refurbishment, profound and convincing advice is essential. Existing training and further related offers for qualified energy consulting for historic buildings can be used to build up regional or local expertise for the tasks of urban energy renewal.

Buildings as active elements in energy networks

A holistic approach is promoted by experts when looking into retrofitting listed buildings. Recommendations to this approach include:

- Increased energy efficiency through retrofitting of the energy system of the building (where possible and in accordance with the preservation laws)
- Development and integration of innovative technologies
- Integrating neighbourhood-related technologies for storing and distributing renewable energies
- Intelligent energy management, which is dependent on internal neighbourhood production and stocks of surplus energy from the supply networks to use them directly or indirectly by heat conversion (power-to-heat).

Innovative measures in support of energy system transformation objectives

- Interior Insulation Systems,
- Surface heating systems (wall, floor and/or ceiling),
- Building-integrated heat storage with phase change materials and latent heat storage systems,
- Thermal and electrical activation of components in the outer building shell (as far as compatible with the preservation of historical monuments),
- Extraction and integration of locally available RES,
- Use of heat pumps,
- Energy-efficient building operation in connection with Smart Home,
- Regulation and control algorithms to increase energy efficiency in the listed buildings.