

Transformation of existing urban district heating and cooling systems
from fossil to renewable energy sources

Renewable Energy Sources in District Heating and Cooling
**Summary report of the regional strategies and
action plans**



The solar thermal installation SolarCAD II of Geneva Industrial Services (SIG). Photo: Verenum AG (Stefan Thalmann)



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1. INTRODUCTION

RES-DHC aims to promote a wider introduction of Renewable Energy Sources (RES) in the District Heating and Cooling (DHC) sector and to support the transformation of existing urban DHC system to RES in six participating regions.

After identifying barriers to renewable DH market development through surveys conducted in all regions, local teams elaborated, with the expertise of regional stakeholders, an impact-oriented regional strategy that propose solutions and measures to overcome the barriers identified. The best measures were discussed and assessed in order to select the most efficient ones in a point of view of feasibility. Thanks to this process, regional strategies were transformed into detailed action plans adapted to the local framework conditions, enhancing their potential impact in terms of market development.

This report presents the summary of the regional strategies and action plans. Each planned measure has been described and planned in detail in a factsheet (one per measure) that will be completed during the testing and implementation phase and then made publicly available.

Reading these summaries, it appears clearly that some topics are common to all regions and synergies can be found in the planned measures. For example, the idea of transformation plans to help district heating operators to increase their share of renewable energies in the energy mix is common to Germany, Switzerland and Poland. This will be the topic of intensive international exchange and even if the results must be adapted to the local conditions, all teams can benefit from the others inputs. On the other hand, due to the different local conditions, some challenges encountered are very specific. Therefore, it appears wise to develop the action plans at regional level.

The main abbreviations used in this document are:

DH: District Heating

DHC: District Heating and Cooling

LTDH: Low Temperature District Heating

RES: Renewable Energy Sources

RSAG: Regional Stakeholders Advisory Group

2. STYRIA – GRAZ, AUSTRIA

The city of Graz (295,500, inhabitants, 127.58 km², thereof 40% green space)¹ is located in the south-east of Austria in the province of Styria. The main share of heat is provided by highly efficient combined heat and power plants, gas-fired peak load boilers as well as industrial waste heat and large-scale solar thermal plants. In 2018, an average annual heat demand of 1,100 GWh/a, with a peak load of approx. 450 MW_{th} (thermal), was provided in the district heating supply area of the city of Graz over a route length of 412 km.

Basically, stakeholders and knowledge holders, who can contribute to the implementation of measures and decisions, include regional energy suppliers, regional authorities, which can be supported by energy agencies and research institutions. It is advantageous to temporarily bring in extended stakeholders like interested expert groups as well as inhabitants of the whole region for specific topics.

In a first step the “Graz way” to decarbonize the district heating and cooling sector was analyzed by the regional partners. Based on this the regional stakeholder advisory group discussed widely how to follow this fruitful path towards 100% renewable energy sources in district heating and cooling until 2040. All potential measures were explained in detail and a special matrix was developed to prioritize by the technical experts of the regional stakeholder advisory group in terms of knowledge, resources and interests.

2.1. Regional strategy and action plans - Summary

In the city of Graz, the pipeline-bound heat supply in the densely populated areas has a high significance. Due to the large number of decentralized heat suppliers based on different energy sources, a very high security of supply can be guaranteed even in case of failure of individual units.

The objectives of district heating supply in Graz are to ensure security of supply while maintaining economic compatibility for the citizens of Graz and the best possible ecological compatibility. Due to the basin location and special climatic conditions in Graz, particular importance is attached to the ecological aspects. With regard to local air pollution, three pollutants are to be considered:

- Problem 1: Particulate matter (PM) Relevant for all solid fuel firing systems.
- Problem 2: Nitrogen oxides (NO_x) Relevant also for gas firing systems
- Problem 3: Benzo(a)pyrene (BaP) Relevant for biomass firing systems².

The impact of highly fluctuating market prices of individual energy sources on the price of heat can also be reduced.

Decarbonization in heat supply in particular offers great potential for the Graz district heating network through the integration of waste heat from commerce and industry, heat based on renewable and regionally available energy sources such as biomass and (summer) solar energy supplemented by environmentally friendly technologies such as heat pumps powered by natural electricity, power-to-heat plants and geothermal energy.

One obstacle to district heating expansion in low-density settlements is the fact that network expansion incurs high investment costs for the operator and is hardly economically viable due to the very low heat demand from customers.

¹ Stadt Graz, „Homepage der Stadt Graz,“ [Online]. Available: https://www.graz.at/cms/beitrag/10034466/7772565/Zahlen_Fakten_Bevoelkerung_Bezirke_Wirtschaft.html. [11.02.2021].

² Stadt Graz, „Homepage Stadt Graz Umweltamt, Arbeitsgruppe “Wärmeversorgung Graz 2020/2030,“ [Online]. Available: <https://www.umwelt.graz.at/cms/beitrag/10084666/7301688/>. [11.02.2021].

The market segment for district heating is the densely built-up urban districts with a building stock that does not have the very highest heat engineering standard. It is difficult for the district heating supplier to offer district heating if the density is too low. Additional market disadvantages exist for district heating if customers also want air conditioning and build their own plants for this purpose, which can be operated in heating and cooling mode¹.

The current model of a few large producers will change to a multitude decentralized systems which use renewable energies and waste heat on site.

Currently, there are no legal transmission rights for the installation of district heating pipelines, as there are for water and wastewater pipelines, which can lead to very complicated negotiations in densely built-up areas. These legal transmission rights would greatly simplify grid expansion.

Other barriers to renewable energy are the very limited peak output of solar thermal power in late autumn and winter time, and the question is still on if winter power generation can be truly renewable. Long-term storage systems could be part of the solution.

2.2. Measures for the Region of Graz

The region of Graz follows a brief plan for implementing 100% renewable energy sources in district heating by 2040.

1. One measure is the **development of district heating scenarios for the years 2030/2050**, which are to be done as base for the future “Masterplan” for the Graz district heating system. The Masterplan aims towards the highest possible share of alternative energy sources (renewable & waste heat incl. combined heat and power & environmental heat), further increases in energy efficiency in buildings, customer plants and in the overall district heating system as well as maintaining the security of supply (with combined heat and power, waste heat, thermal solar heat, etc.) and for the provision of the required heat demand even on cold winter days. The measure will focus on finding different ways (scenarios) for supply and expansion of the Graz district heating network. Together with subcontractors experienced in network simulation the Graz project partners will work on those scenarios proactively. Target groups for this measure are regional energy suppliers and regional authorities.
2. One key technology for implementing different sources of renewable energy is **thermal heat storage**. Economic & energetical investigations for storage systems are to be carried out within this measure. Seasonal storages (Pit Thermal Energy Storage) (for scenarios) as well as the operational thematic (Tank Thermal Energy Storage as day/week buffer) will be investigated. One barrier might be if there is enough space “within” the City of Graz limits (area). This barrier could be overcome by develop a possibility to use the top surface of the storage for an urban purpose. Possible sources nearby the potential storage areas also need to be investigated to minimize heat transport losses. Also, geological investigations for underground storage systems regarding the actions of decarbonization of district heating network are planned.
3. The task of **district cooling** is in a kind of starting state. There evaluations of the competitiveness of district cooling and the development of innovative/ecological cooling concepts (local cooling networks, neighborhood solutions, micro-networks, etc.) for dense urban areas are planned, including the possible use of absorption chillers within the district

¹ H. Schnitzer, „Wärmeenergie für Wohngebäude in Graz - Möglichkeiten und Diskussionsgrundlage, Bericht an das Umweltamt der Stadt Graz,“ Graz, 2014.

heating network in Graz. The survey is intended to serve as a guideline or decision-making basis for the implementation of a future economic district cooling system in Graz.

4. As systemic measures in the field of district heating, reduction of temperature and supply by return in the area of Graz is very important. It is planned to **evaluate district heating supply via return by finding matching supply and demand** next to each other to get the most economic implementation. Investigations are being carried out for heat supply. One possibility is to supply buildings from the existing network return flow (no reversal of the flow direction, sufficient mass flow, all year round, etc.). Therefore project partners as well as experienced subcontractors will work closely together to investigate the high potential areas for an economic implementation. One main barrier will be to define a point where it is economically feasible to supply a building or quarter by an existing return flow and especially if this is possible all over the year.
5. In terms of **user integration**, there the aim is to sustainably strengthen awareness through various communication modules and thus to inform existing and potential heating customers and show them advantages and opportunities of district heating. For this purpose, an evaluation of a one-stop shop as a contact point should be carried out. Under the theme "Get out of oil" or "Connect heating systems of new buildings and convert heating systems of existing buildings to district heating", subsidy schemes, communication and marketing strategies are being considered. Awareness-raising is to take place on the topics of "What is waste heat"? "What is the benefit for the customer of lowering the room temperature (e.g. reduction of heating costs, CO₂ savings)?" or "Benefits for low return temperatures" as well as "benefits of professional maintenance".

3. SZCZECIN AND WEST POMERANIA, POLAND

The RES DHC project in Polish case focuses on the small district heating system, located in Połczyn-Zdrój. Połczyn-Zdrój is a health resort located in the middle of West Pomerania in Poland. On this case, the Polish RES DHC team wants to search the best possible solution for decarbonization of Polish district heating systems (particularly small ones). After identifying the barriers for RES implementation in DH, a template with those barriers has been developed. Then, during a series of workshop meetings each barrier has been discussed and potential solutions were written down. Next step was to prioritize them and afterwards, the ones with the highest priority and the biggest potential for implementation has been chosen. Most important target groups of actions in the project are: the customers, design offices, local and regional authorities, and media of all kinds.

3.1. Regional strategy and action plans - Summary

Polish DH is still dominated by coal and it requires both new technologies and change of attitude when it comes to end users. In case of Połczyn-Zdrój, there is one boiler room fueled by gas and oil and 2 boiler rooms powered by coal. It influences the heat prices for the customers (emissions). The other problem is the low number of households and other buildings connected to the DH network. The individual heat sources are based on coal as well and are mostly responsible for bad air quality in the city. Our aim with both strategy and action plans is to show, that some changes have to happen if we want to have better future for us and our children. The biggest challenge for RES in Poland is lack of knowledge. Our stakeholders are not aware of benefits RES can give them, and citizens are still distrustful, when it comes to new solutions. We want to educate people, show them best practice from other countries, include them in discussion and in the planning process for RES. Our stakeholders list includes citizens, local authorities, spatial planners, other DH networks, media (both local and regional) etc.

During the work on the project, the biggest barriers for RES development in Poland were identified. For each of them, possible mitigation actions were developed. In the end, Polish team choose 6 measures to improve the situation of RES in district heating in Poland:

1. Increasing RES and CHP share in DH systems – main goal is to adjust the systems to EU climate policy and lower the CO₂ emissions. First step is to identify the funding possibilities for such changes. The biggest challenge here is the CAPEX, because high CAPEX means high heat prices for the customers. Main target group of this measure are final customers; thanks to lower emissions and efficient systems, prices can be more competitive (compared to individual heating) and the air quality in chosen locations can improve. Socially responsible spatial planning for RES locations – the goal is to establish good contact with developers and investors in order to adjust the investment plans to the development plans in locations where our company is present. That way it is possible to connect more customers and therefore to increase the number of buildings using DH and lower individual heat sources. Biggest challenge here is to convince local stakeholders to district heating based on RES. The target group for this measure are spatial planners and urban developers, as well as local authorities.
2. Mass use of RES – scale effect – this is the possible response to the high CAPEX challenge. Finding a good, scalable and replicable solution would be the best way to lower the investment costs and to speed up the decarbonization process. The main challenge in this case is the fact, that there are no 2 identical systems, and it will be difficult to find a “fit – for – all” solution. Main target group of this measure are experts and designers of district heating solutions.
3. Marketing and PR of DH as ecological solution – the idea is to educate all kinds of stakeholders about the district heating and its benefits, both for economy and climate. It is a possibility to present the best practice from other systems and to show, that this kind of



solutions actually works. The main target group of this action are media of all kinds and basically, everyone. The aim here is to educate as many people as possible.

4. Economic incentives for LTDH – in this measure it is planned to create a business model that is beneficial to the clients, that want to use LTDH. Lowering the grid temperature makes it possible to use RES in the system. The main target group here are developers, investors and designers.
5. Decarbonization of large systems – best practice – large systems, like Szczecin, present a challenge when it comes to decarbonization. In this action, Polish team wants to find solutions from other countries, where large systems have been at least partially decarbonized. Knowledge transfer will help to find the best solution for SEC systems in Poland. The main target group for this action are designers and district heating experts.

4. IREN, ITALY

A list of the possible measures and actions was developed jointly by the two Italian project partners, IREN and Ambiente Italia. The scope of the implementation actions includes some of the district heating networks managed by IREN in different regions located in the north of Italy. The target groups of the measures are quite wide and are described in details in the next paragraph, where the key actors to be addressed are reported for each measure.

The priorities were then assigned to the measures through an email consultation process with the members of the Italian Regional Stakeholder Advisory Group (RSAG), set up within the project, by means of a ranking methodology.

The outcome of this consultation was a list of 5 actions to be carried out. Furthermore, 2 more measures, with a lower priority level, were selected. The actions to be carried out aims at overcoming different categories of barriers: legal/policy/permitting, economic/financing, technical, organizational and lack of knowledge and awareness.

4.1. Regional strategy and action plans - Summary

The actions address several barriers and application fields, such as the legal and political ones, the lack of know-how and knowledge, as well as the organizational and economic obstacles. In fact, the introduction of renewables in the district heating sector in Italy is still slowed down by the lack of adequate incentives (especially in comparison with the alternative technological solutions), the too long, complex, intricate and sometimes unsuccessful permitting and bureaucratic procedures, as well as the lack of technical knowledge of solutions and examples and, finally, the lack of awareness of the benefits of district heating in some crucial stakeholder groups such as public bodies (Municipalities, Regions, etc.), final users, etc.

1. The first measure aims at the **simplification and standardization of the permitting procedures** for the project development of district heating networks run on renewables; such a result can reduce time and costs while increasing the probability of project success and local acceptability. The target groups of this action are: the members of the above mentioned RSAG, the municipalities where IREN district heating networks are operating or new networks could be installed, or renewable energy plants serving these networks could be planned and, finally, the local stakeholders (consumer associations, citizen committees, etc.) in the same territories.
2. The goal of the second action is to improve the incentive framework, since district heating from renewables is not adequately represented in the many incentive opportunities available in Italy. This action, therefore, aims to bridge this gap by proposing practical solutions for its correction in different fields and at different levels: incentives for buildings, White Certificates, reduced VAT, etc, thus also making projects more bankable. The key target groups addressed will be: the most relevant national actors (Energy Systems Manager, Ministries, etc.) and key trade associations, such as industrial associations representing renewable energy producers.
3. The third measure is an **information campaign** where local authorities, end users and utilities in the sector need to be adequately informed about the real potential, costs and benefits of renewables in district heating. The aim will be reached through a bunch of tools and messages: factsheet on 'false myths' about district heating and renewables (for consumers and public authorities), information on the real potential of district heating from renewables and waste heat (for public authorities). Information for consumers on participation models (cooperatives, crowdfunding, collective shares, energy communities, etc.) and

alternative business models (e.g. Green pricing of heat). Real figures of renewables in district heating (for planners and other technical stakeholders), summary sheet on the benefits of district heating from renewables (for all stakeholders).

4. The fourth measure is related to the **study of thermal storage solutions connected to the use of non-programmable renewable energy sources**. The scope of action will include the use of different technologies for thermal storages for enabling the regularization of production from renewable energy sources, thus allowing their energy and economic optimization, will be studied and possibly implemented. For this action, the key actors to be involved are the RSAG member and the managers of IREN district heating networks.
5. Finally, the fifth action focuses on the **bankability of projects**, by collecting and systematizing real data for performance and maintenance of renewable energy plants serving district heating networks, referring to specific cases that have been in operation for many years in Italy and throughout Europe. The data to be researched will indicatively be: energy producibility and its evolution over time, maintenance needs, typical failures, operating costs, maintenance costs, personnel needs, risk management, etc. The energy sources and technologies on which to focus will be solar thermal, biomass, geothermal, waste heat and high-efficiency cogeneration. In addition, data will be collected on the operation of special thermal storage, such as those operating on a seasonal basis. Though this action will mainly target the RSAG members, possible other communication recipients and ways of involvement will then be defined according to the needs, possibilities and opportunities also in relation, as already mentioned, to the third action concerning the information campaign.

5. BADEN-WÜRTTEMBERG, GERMANY

In Germany, the RES-DHC project focuses on Baden-Württemberg as model region and addresses an authority-based approach. Therefore, the elaborated actions to increase RES in DHC take the policy situation and framework in Baden-Württemberg into account. Available data shows that less than ten percent of the thermal end-use energy is provided by DHC systems in Baden-Württemberg. The share of renewable energy sources in those DHC systems is still low and account for around six percent of the energy production. To activate investments into transformation processes and to improve the framework conditions for RES in DHC in line with needs, two SWOT analyses were elaborated within the baseline survey quite at the beginning of the RES-DHC project. The analyses result in possible overarching starting points as networking, know-how transfer, best practice examples, derivation of guidelines and strategies and form the basis for the action plan. As key stakeholders for the transformation process municipalities, energy suppliers and consumers were identified.

5.1. Regional strategy and action plans - Summary

Based on the findings of the baseline survey, ten measures focusing on organizational barriers and lack of knowledge were elaborated. These ten measures were discussed with the members of the regional stakeholder advisory group (RSAG) to not only address the chances and risks identified, but also to meet the needs of the stakeholders and to improve the effectiveness of the measures. By using the method developed within the RES-DHC project, the measures were prioritized by means of time, impact and opportunity. After the evaluation together with the RSAG, seven measures for implementation were identified.

These seven measures will be initiated and implemented within the next project phase:

1. A methodical approach of transformation plans will be developed and practically tested together with DH system operators. This methodical approach will include lessons learnt and recommendations for the DH community as well as policy recommendations to implement further support mechanisms. The evaluated results will be published and disseminated to assist replicators and to initiate more transformation plans in DH systems.
2. Under the slogan “DH companies fit for RES in DHC”, a series of events according to the needs of utilities and DH operators will be carried out. The organized events will aim to increase the stakeholders’ knowledge on RES in DHC and to create a platform for exchange of experiences and networking.
3. A helpdesk will be provided at the German RES-DHC website. This application fosters direct help and support from the RES-DHC experts on decarbonizing DHC systems. Stakeholders can easily connect the RES-DHC experts and ask their concrete questions. The RES-DHC project partners will provide precise information on the requests. Thus, problems will be solved faster and RES DHC projects will be accelerated.
4. The qualitative assessment of municipal heat planning aims to improve the obligated municipal heat planning in Baden-Württemberg. Therefore, criteria for an assessment will be elaborated and tested directly within municipalities that establish a heat plan. The evaluated results will be published and disseminated to assist following municipalities in their heat planning process.
5. A collection of practical technical information on the integration of solar thermal systems into DH systems will be elaborated including best practice examples. This measure aims to provide particular information on the hydraulic integration of solar thermal systems into DH systems. This specific knowledge transfer addresses DH technicians and planners to assist their concrete implementation of solar district heating systems.
6. A screening approach identifying solar thermal plant locations will be developed. The screening will show the evidence of regional areas, which are useful for solar thermal plants,

and policy recommendations regarding land allocation will be elaborated. This measure addresses policy-makers to increase the share of solar thermal energy on the regional level by making more areas available for solar thermal plants.

7. A webinar on the topic of surface water heat pumps in DH systems is developed, organized and carried out. Relevant information on technical, financial and regulatory aspects are provided for DH suppliers, planners and interested stakeholders to initiate such projects and to raise the potential of heat from lakes and rivers in Baden-Württemberg.

6. AUVERGNE-RHÔNE-ALPES, FRANCE

The regional strategy of the RES-DHC project has been developed in consultation with stakeholders in the Auvergne Rhône Alpes region, particularly during the regional day "Decarbonated heating and cooling networks" which took place on October 13, 2021 during the Pollutec exhibition in Lyon Eurexpo with nearly 60 participants.



6.1. Regional strategy and action plans – Summary

6.1.1. Context

The Auvergne Rhône Alpes region is the second largest region in France in terms of population and the 10th largest in Europe. This territory represents 70,000 km² and a population of 8 million inhabitants, 10% of France's surface area and 13% of its population. It is the most industrialized region.

In 2019, the Auvergne Rhône Alpes region has about 230 heating and cooling networks, of very different sizes, since some of them are only a few dozen meters long and the largest one has 168 km of network. The total length of networks in the region is 932 linear km.

6.1.2. Removing the obstacles

The main barriers to the development of thermal renewable energies are of several kinds:

- Economic

RES and heat storage are more expensive than gas powered heat. Subsidies can't always permit an acceptable economic model.

- Technical

The most important heating networks are often at high temperature and pressure. The temperature level of these networks makes it difficult to integrate low temperature thermal renewable energies such as solar or geothermal energy.

- Organizational

Public service delegation contracts for heating networks are concluded for very long periods (25 to 30 years) between the local authority and the network operator. The operator deploys an economic model over the duration of the contract that is difficult for the community to question.

- Lack of knowledge

With the exception of wood and waste to energy, the thermal renewable energy sectors are not well known to local authorities and operators.

- Access to land ownership and landscape integration

Specifically for solar thermal and thermal storage, the access to land ownership is quite difficult in the region, because of a higher urban density and concurrence toward building. The landscape integration is also a big issue for these projects.

6.1.3. Defining priorities

The definition of the priority axes was carried out based on the main barriers identified in the assessment carried out in February 2021.

Priority 1: Establish a regional coordination structure

Priority 2: Promote planning at all levels

Priority 3: Support the rise in competence of the actors

Priority 4: Improve the economic performance of thermal renewable energies and storage

6.1.4. Defining effective and accessible measures

The strategy of the Auvergne Rhône Alpes region in the development of renewable energies in heating and cooling networks in the framework of the RES-DHC project must lead to concrete results. To do this, meetings were held to provide feedback and benchmark actions taken in other contexts and to analyze the reproducibility and appropriateness of these various measures, and their response to the different axes developed in consultation with the stakeholders.

Measures:

1. **Dissemination of numeric tools of identification and design of RES in DHC:** There are several planning or design tools available in France for integrating thermal renewable energies into heating networks. These tools are not sufficiently known by local authorities, planners and operators who may use them. The objective of this action is to make these tools

known to regional heating and cooling network stakeholders, to help them improve them continuously and to train users in the use of these tools.

2. **Reinforcing engineer capacity in local authorities and operators on RES in DHC:** With the objective to decarbonize heating networks, it is necessary to develop energy sources that are still not widely exploited in Auvergne Rhône Alpes: Geothermal energy, solar thermal energy, waste heat, storage, fine regulation of networks... These subjects are not yet well mastered by all the players in the value chain and by decision-makers. The objective of this sheet is to strengthen the technical means of the actors.
3. **Financing DHC monitoring and thermal storage by Energy Efficiency Certificates:** Energy savings certificates are a financing mechanism for actions that reduce fossil energy consumption through a market mechanism. Energy operators have volumes of certificates to recover from project owners, in exchange for their participation in the financing. Since 2019, activities subject to CO₂ emission quotas (including combustion for a power of 20 MW or more) are eligible for certificates. This makes it possible to consider financing actions that were not previously financed by this scheme, in particular the storage and monitoring of heating and cooling networks. The action aims at sending to the ministry a request for a CEE program or a standardized action sheet to propose a way to calculate the number of certificates generated by these actions.
4. **Development of local DHC planning:** In France, the government requires local authorities with a heating network prior to 2019 to carry out a master plan for the heating network. In practice, if the communities that have delegated the operation of their network to a private company have all carried out this type of plan, it remains that the majority of communities that operate their network themselves do not have this study. The action aims on the one hand to mobilize the communities that do not yet have a plan to carry one out and to include more systematically thermal ENR and storage in the specifications of these studies.
5. **Dissemination of documentation and analysis of best practices:** The actors of heating and cooling networks in Auvergne Rhône Alpes do not have an easy access to knowledge on the most efficient networks in terms of integration of renewable energies, reduction of network temperatures and thermal storage. This information is nevertheless essential to enable them to take ownership of the opportunity to evolve existing heating networks towards more sustainable practices. The action aims at identifying the best practices, already deployed or in the process of being deployed, and at disseminating their technical and economic characteristics through publications and project reviews.
6. **Improving the incentive framework on innovation in DHC:** The financing of heating and cooling networks has been put in place over the last ten years to massively develop heating networks in the territories. These financial tools are not necessarily dedicated to the realization of innovative and exemplary operations. A national call for projects "New Emerging Technologies" exists for the most important networks but it excludes the thermal storage called "sensitive". The objective of this sheet will be to make the regional financial systems evolve to encourage new technologies in a more obvious way, including in small-scale heating networks.
7. **Webinar on solar thermal in DH for local representatives:** Solar thermal energy is still a little-known technology among local authorities with a heating network in Auvergne Rhône Alpes. However, it appears that solar thermal energy is economically competitive with fossil

fuels, which continue to provide backup for wood-fired heating networks, especially in summer. The objective of this document is to design and produce a webinar format dedicated to solar thermal energy and its possible applications in heating networks.

8. **Guidelines on technical issues for lower temperatures in DH:** The reduction of flow and return temperatures is an essential factor to allow the valorization of low temperature renewable energies, solar, geothermal and waste heat. However, the modalities of reducing network temperatures are complex, and not necessarily only from a technical point of view, but also from a contractual point of view, because the subscribers, due to their consumption profile, generate an adapted operation and temperature regime. The purpose of this action is to explain the methodology that allows to reduce the network temperatures and to provide the numerical tools associated with a better management of the network temperatures.
9. **Solar thermal and geothermal sector animation:** In the region, companies that develop solar and geothermal solutions do not have visibility on the heating and cooling network market. Indeed, they develop their activities in the building sector. However, an animation of the solar thermal and geothermal sectors will provide them with information on the opportunities for deploying these technologies in the field of heating and cooling networks.
10. **Development of multi grid design software:** The coupling of heating networks to the electricity and gas networks is a promising way to develop the overall energy system of territories, particularly in Auvergne-Rhône-Alpes. Because of its ease of storage, in dedicated units or directly in the networks, heat is an essential complement to the electrical network, to ensure more flexibility, and to the gas network via cogeneration or green gas production. The objective of the action is to develop and deploy, for these multi-energy global energy systems, specific multi-energy planning tools, as well as associated control tools.

7. SWISS CANTONS, SWITZERLAND

In Switzerland, the entire country is concerned by the RES-DHC project. The actions focus particularly on the cantonal authorities to improve the framework but also on district heating network operators, city planners and local authorities, which are involved in concrete installations and projects. A stakeholders' advisory group was gathered to support the project team to develop the most relevant actions.

7.1. Regional strategy and action plans - Summary

In Switzerland, all three levels of action are important: national, regional, local. There is no geographical limitation to the action plan as it concerns the entire country but, and in particular thanks to representatives of these three levels of action in the stakeholders' advisory group, it is possible to address the regional and local levels too.

The current situation is that many of the large cities already have a district heating network, mostly based on waste heat. The integration of further sources of renewable energies to reach higher shares of renewable heat is not very frequent. However, most cities face the challenge of reaching higher shares of CO₂-neutral heat supply or even to decarbonize the heat production (e.g., Zurich until 2040), or extending the network and delivering more heat without lowering the share of CO₂-neutral heat. With high operation temperatures and low efficiency, the existing and sometimes older networks are not the most adapted to the integration of renewable energies. Moreover, it is not always simple to identify which energies should have priority or how much flexibility should be added to the network to adapt to the energy production.

For a few years, due to political will and decarbonization strategies, more and more cities are planning very large extensions of their district heating networks to provide CO₂-neutral heating and cooling. In dense urban areas however, such projects last several years and the challenge is to offer options for temporary heating solutions to potential customers, before they implement individual renewable solutions.

There is also a great need in education and training. Currently, there are various educational activities, but the feedback shows that the needs of different interest groups (planning offices, installation companies, operating companies, authorities, etc.) are not specifically identified and coordinated with the training offer.

Finally, there is an important need for a single information point. In order to support the procedure for the realization of thermal networks, various institutions are helped by the industry and the federal government, which prepare reports, documents, papers and tools and make them available to all interested parties. However, it is impossible to have an overview and to know which offer is available from whom on which topic.

In view of this, the following priority measures will be initiated and implemented:

1. Carrying out two exemplary feasibility studies to demonstrate the technical and economic feasibility of integrating renewable energies into existing district heating networks. These examples can then be used for dissemination amongst the district heating industry and perhaps lead to the implementation of some pilot projects.
2. Based on the existing training offer and an analysis of the needs of the main stakeholders, improving the training offer. The aim is to ensure in the medium and long term that, on the one hand, specialists in thermal networks are trained and, on the other hand, that industry employees can obtain additional training on topics important for the decarbonization of networks.

3. Producing a free and publicly accessible manual with methodological guidelines on how to transform an existing district heating network by increasing its renewable energy share. The handbook will cover the technical, economic, legal and organisational aspects related to the transformation of a district heating network. It will be addressed to anyone involved in the operation and/or development of district heating network in the Swiss context: District heating network operators, engineering and consulting firms, city planners and local authorities.
4. Gathering information on possible solutions for the temporary supply of heat by the district heating operator, to deliver the heat through the network until the pipes are built, and drafting of a fact sheet. The topic should be investigated through interviews with market players on technical, economic and regulatory aspects.
5. Designing and setting up an information point so that it will be available in the long term after the conclusion of the RES-DHC project. It will be supported by an organisation that brings continuity to the cause. The Swiss District Heating Association (Verband Fernwärme Schweiz) has agreed to take on this task and, as part of the RES-DHC project, will be supported by the project team and the advisory group.

8. CONCLUSION

In total, the six regions selected 38 measures to address one of the six types of barriers identified in the first phase of the project.

As showned in the **Table 1**, lack of knowledge appears to be the most significant problem and, therefore, communication, training programs and availability of information clearly need to be improved. Organizational problems are of different natures, but demonstrate the need to develop coherent action plans. Technical and economic barriers appear to be of equal importance and highlight the need for financial schemes and know-how transfer activities. The legal and political aspects are less adressed within the regions. This is probably due to the fact that it is difficult to aim at a direct impact in these topics so that measures with higher efficiency on the short-term were prioritized.

Type of barriers addressed	Number
Lack of knowledge	12
Organisational	9
Technical	7
Economical	6
Legal/Political	3
Other	1

Table 1: Distribution of measures according to the barriers

In addition to the common barriers faced in all regions, cross-cutting issues are observed:

- Needs in training, information point, best practices documentation to fill the knowledge gap
- Guidelines for transformation plans
- On the technical side, needs in tools for design and planification plus thermal storage solutions
- Development or improvement of incentives schemes to overcome economical barrier

Conversely, only one region highlighted the need to inform users about energy issues, solutions and involve them in the project.

These examples demonstrate the potential for synergies that can be developed between regions and beyond, in terms of exchanging best practices, providing mutual support, helping to implement and replicate the most promising solutions.

9. ANNEX – FACTSHEETS LISTS

ID	Title	Barrier addressed
A-1	Development DH scenarios 2025/30/35 - detailed simulations for future feed-in options regarding the implementation of demo projects	Technical
A-2	Thermal storages - hydrogeological investigations for underground storage systems	Technical
A-3	District cooling - Implementing an economic system solution based on Austria's DC status	Economical
A-4	Evaluate DH areas where customer needs and supply via return match best	Organisational
A-5	User integration and further measures	Other

Table 2: Factsheets list – Austria

ID	Title	Barrier addressed
PL-1	Increasing RES and CHP share in DH systems	Technical
PL-2	Socially responsible spatial planning for RES location	Legal/Political
PL-3	Mass using of RES solutions - scale effect	Economical
PL-4	Marketing and PR - promoting DH as ecological solution	Organisational
PL-5	Economical incentives for LTDH	Economical
PL-6	Best practice examples from other countries (deep geo, ecogrid, etc.)	Lack of knowledge

Table 3: Factsheets list – Poland

ID	Title	Barrier addressed
I-1	Simplification of the permitting process	Legal/Political
I-2	Improving the incentive framework	Organisational
I-3	Information campaign	Lack of knowledge
I-4	Thermal storages and non-programmable RES	Technical
I-5	Bankability of projects: Real data for performance and maintenance	Organisational
Priority 2	Increase of the 'Carbon Tax', which would favor the economic convenience of using RES instead of fossil fuels.	Economical
Priority 2	Promotion of RES-DHC (residential and large-scale) in territories not yet served by DHC networks	Lack of knowledge

Table 4: Factsheets list – Italy

ID	Title	Barrier addressed
D-1	Methodical approach of transformation plans	Organisational
D-2	DH companies fit for RES in DHC	Lack of knowledge
D-3	Helpdesk (direct support) for RES in DHC	Lack of knowledge
D-4	Qualitative assessment of municipal heat planning	Organisational
D-5	Practical technical issues for the integration of solar thermal systems into district heating networks	Lack of knowledge
D-6	Solar thermal sites – Screening approach to identifying plant locations	Organisational
D-7	Webinar concept on the topic surface water heat pumps in district heating systems	Lack of knowledge

Table 5: Factsheets list – Germany

ID	Title	Barrier addressed
F-1	Dissemination of numeric tools of identification and design of RES in DHC	Technical
F-2	Reinforcing engineer capacity in local authorities and operators on RES in DHC	Technical
F-3	Financing DHC monitoring and thermal storage by Energy Efficiency Certificates	Economical

F-4	Development of local DHC planning	Legal/Political
F-5	Dissemination of documentation and analysis of best practices	Lack of knowledge
F-6	Improving the incentive framework on innovation in DHC	Economical
F-7	Webinar on solar thermal in DH for local representatives	Lack of knowledge
F-8	Guidelines on technical issues for lower temperatures in DH	Lack of knowledge
F-9	Solar thermal and geothermal sector animation	Organisational
F-10	Development of multi grid design software	Technical

Table 6: Factsheets list – France

ID	Title	Barrier addressed
CH-1	Feasibility studies	Lack of knowledge
CH-2	Training activities	Lack of knowledge
CH-3	Transformation plans	Organisational
CH-4	Factsheet about temporary solutions	Organisational
CH-5	Website information point	Lack of knowledge

Table 7: Factsheets list – Switzerland