RES DHC

Renewable Energy Sources for District Heating and Cooling

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

Renewable Energy Sources in District Heating and Cooling

Baseline surveys in the 6 participating regions

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Document Information:

Authors:	Riccardo Battisti, Ambiente Italia S.r.l.
Contact:	Ambiente Italia S.r.l. riccardo.battisti@ambienteitalia.it

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1. MORE RENEWABLES IN DISTRICT HEATING & COOLING: A REGIONAL APPROACH

In the RES-DHC EU-funded project, the key objective is to stimulate the market uptake of renewables in district heating and cooling networks in 6 pilot cases in Europe, represented by either regional territories or utilities. As first step on this path, all the pilot areas carried out a specific survey on the current status of the market, also highlighting the available support schemes and incentives, as well as an analysis of the main stakeholders and of both the barriers and the opportunities for renewables in district heating.

This summary document was developed starting from the complete surveys for the 6 pilot areas of the RES-DHC project, which are available in the corresponding national languages. Please refer to the original documents for more details and for the references, i.e. the sources of information.

The main abbreviations used in this document are:

CHP: Combined Heat and Power (cogeneration)

DH: District Heating

DHC: District Heating and Cooling

HP: Heat Pumps

RES: Renewable Energy Sources

2. AUSTRIA – CITY OF GRAZ

Source: Energie Graz GmbH & Co KG

2.1. Current status of district heating and cooling

The city of Graz (331,000 inhabitants, 127.58 km², of which 40 percent is green space) is located in the southeast of Austria in the federal state of Styria. The main share of heat for DH is provided by high-efficiency cogeneration plants, gas-fired peak-load boilers as well as industrial waste heat and biomass boilers and large-scale solar thermal plants. In 2018, an average annual heat demand of 1,100 GWh/a, with a peak load of about 450 MW_{th}, was provided in the district heating supply area of the city of Graz along a route length of 412 km.

Starting in 2018 with a share of around 25% of RES in the heat supply mix, further measures are to be introduced in the next 10 years to achieve a share of 50% RES in the total DH supply. By 2050, the framework conditions are to be created to supply the whole DH network from RES.

Currently, a share of about 50 % of the heat demand of the city of Graz is supplied by DH.

Due to the basin location and special climatic conditions, particularly high value is placed on the ecological aspects. Three pollutants are to be considered for local air pollution:

- Particulate matter (PM): relevant for all solid fuel furnaces.
- Nitrogen oxides (NOx): relevant also for gas firing systems.
- Benzo(a)pyrene (BaP): relevant for solid fuel furnaces.

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 DH network through the integration of waste heat from commerce and industry, heat based on renewable and regionally available energy sources such as biomass and solar energy supplemented by environmentally friendly technologies such as heat pumps powered by electricity from RES, power-to-heat and geothermal energy.

The vision of the city of Graz is to provide a sustainable energetically balanced DH supply by the year 2050 under three key principles:

1. Highest possible share of RES.
2. Additional increase of energy efficiency in buildings, customer plants and in the overall system.
3. Ensuring security of supply.

A study says that technologies already available might allow that at least 73 %of DH will be provided from RES. In order to achieve the vision of 100% RES-DHC 2040-2050, the implementation of seasonal storage technologies is necessary to cover the electricity demand for heat pumps in winter and the input (driving energy) for absorption heat pumps from RES. In addition to the provision of energy from 100% RES, the energy-efficient and conscious actions of the citizens are very important.

2.2. Subsidies and incentive systems

In Austria, subsidies are available at the federal, state and municipal levels.

At the state level, there are subsidies for waste heat utilization in DH, innovative (cold) DH systems, biomass CHPs, solar thermal plants, district heating customers, connections to a DH network and heat pumps >100 kW.

At the federal level, Styria offers subsidies for building and expanding DH on the basis of RES as well as solar thermal plants and the connection to an existing DH network.

Finally, the city of Graz offers subsidies for solar thermal plants, the conversion of heating systems to DH (for apartments, subsidies are given according to social criteria) as well as DH systems.

2.3. Barriers and opportunities for RES DHC

An obstacle to expansion of DH in low-density settlements is the fact that network expansion needs high investment costs and is hardly economically feasible due to the very low heat demand of the customers.

Increasing the share of RES in DHC is possible but challenging. Of course, biomass heating or CHP plants could also be integrated. However, this seems to be problematic due to associated emissions of classical pollutants (especially PM), at least in the urban area. Furthermore, there are not enough resources of biomass in the Styrian region for a high number of biomass plants. Another option is the use of heat pumps, which use waste heat or ambient heat (e.g. river, ground or wastewater) and are powered by electricity from RES (e.g.: hydropower, wind and photovoltaic). The market segment for DH is densely built-up urban areas with a building stock that does not meet the highest thermal standards. DH is hardly competitive if density is too low or if the thermal standard is too high. Additional market disadvantages exist for DH if customers also require air conditioning and build their own plants for this purpose, which can be operated in heating and cooling mode.

Although the Styrian building law includes an obligation for connecting to DH, there is a significant number of exceptional cases.

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

The current model of a few (large) producers and many consumers will change to a multitude of actors who are simultaneously consumers and producers and increasingly use RES and waste heat on-site.

Other barriers to RES are the steadily increasing consumption by customers, the limited peak output of solar thermal power, and the question of whether winter power generation can be truly renewable.

On the other hand, regarding the opportunities for RES DHC, technical measures include the integration of renewables such as biomass and solar thermal energy, use of waste heat, e.g. from wastewater for cooling and heating, and appropriate energy storage. Both potential studies and implementations are planned. In the field of energy storage, potential areas/sites are to be identified and legal framework conditions for their use should be improved (e.g. the creation of priority areas and reserves). Furthermore, evaluations of the technical feasibility of different storage concepts in the environment of heat generation plants will be carried out with the help of different simulation methods and tools (e.g. Modelica/Dymola). Based on the developed concepts and their economic evaluation, the realization and implementation of an appropriate storage concept is considered.

As systemic measures in the field of DH, investigations are being carried out into cascading heat supply. One possibility is the supply of buildings from the existing network return (no reversal of the flow direction, sufficient mass flow, all-year, etc.).

Regarding district cooling, evaluations of the competitiveness of district cooling as well as the development of innovative/ecological cooling concepts (local cooling networks, district solutions, micro-grids, etc.) for urban areas with possible applications of absorption chillers in the DH network of Graz are planned. Regarding undeveloped areas outside the existing Graz DH network, the development of micro-grids as supply concepts will be considered in detail. The development of economically viable heat supply concepts for individual buildings, multi-storey residential buildings and residential areas (based on biomass / central HP solutions) will be investigated. Possibilities of digitalization in energy supply are to be applied in order to control the complexity of the system and enable renewables to develop their full potential.

Based on planner data (type of use, occupancy, areas, energy certificate, heating system, etc.), it should be possible to estimate and/or simulate the expected heat demand. Performance/quantity specifications are to be used as a basis for an application/operating strategy.Scenarios for DH supply in 2025, 2030, 2040, alternative assessment of climate-friendly heat supply options and roadmaps for comprehensive refurbishment and DH expansion strategy as well as zoning for DH expansion areas and for areas with preferential decentralized (renewable) heat supply shall be developed.

As non-technical measures, the already existing communication basis of a regional stakeholder advisory group (RSAG) with the province of Styria is to be used for stakeholder integration. For user integration, the aim is to sustainably strengthen awareness through various communication modules and thus to inform existing and potential heating customers and to show them alternatives. For this purpose, a one-stop-shop will be set up as a contact point for DH. Under the slogan "Get out of oil", funding, communication and marketing strategies are being considered. Awareness raising has to take place on different topics e.g. "What is waste heat?", “What is the benefit for the customer of lowering the room temperature (e.g. CO_2 savings)?” or "Bonus system for low return temperatures". As innovative business models, citizen participation models, a flat rate for heat from RES and, among other things, a bonus/penalty system for high return temperatures are to be developed.

3. FRANCE – REGION OF AUVERGNE RHÔNE-ALPES

Source: Mediatheque Terra – Ministère de la Transition Ecologique

3.1. Current status of district heating and cooling

Auvergne Rhône-Alpes (AURA) is a large region with a population of 8 million people, mostly concentrated in urban centers (Lyon, Grenoble, Valence, Saint-Etienne, Chambéry, Annecy).

The region has nearly 230 DHC networks which represent about 6% of heat consumption.

Their total length is estimated to 932 km, of which Grenoble and Lyon represent nearly 50%.

RES production within AURA DHC is 65% higher than the national average.

This proportion is greater within smallest networks, often supplied with biomass up to 100%, and within the largest which had historically benefitted of heat recovery from incineration of household waste.

The number of biomass boilers to supply heating networks significantly increased over the last 10 years and the installed power is now around 500 MW.

However, other RES (solar, geothermal, heat recovery) are scarcely used because of the seasonal running or because of too high return temperatures for this type of source.

European, national, and regional goals aim at multiplying by a factor of 5 the RES heat production until 2030, particularly with the creation and renovation of heating networks.

However, main urban centers already have heating networks and, consequently, it is not very easy to find new projects.

3.2. Subsidies and incentive systems

Subsidies just allow compensation of investment costs compared to gas, whose current market price is very low.

Several types of incentive systems are in place:

- Fiscal, with a 5.5% VAT for DH sales mainly powered by RES and a 10% VAT for wood fuel;
- Grant to compensate the investment extra costs, allowing a well-balanced project compared to fossil energies, thanks to the “Fonds Chaleur” (Heat funds) created in 2009 and administered by ADEME. AURA region also helps smallest DH networks.
- Market device, with Energy saving certificates and carbon tax.

Other support schemes refer to the regulatory framework, stimulating the connections of buildings to DH networks, thanks to thermal regulations of buildings or networks ranking.

3.3. Barriers and opportunities for RES DHC

Research and innovation in heating and cooling networks is not a well-structured domain, differently from other RES or energy efficiency sub-sectors.

A working group driven by the Ministry of Environment in France gave, in 2019, encouraging advices for improvement.

Only few examples of DH networks with integrated low-temperature RES are in operation: Ugine for industrial heat recovery, Voreppe for solar thermal and, finally, Annecy for hydrothermics on the lake.

Therefore, actors in the field of heating and cooling networks have only a few references to learn from and there is a lack of knowledge on economic models, operation and available resources.

The key stakeholders (local administrations, heat network operators, professionals, planners, research organisations, suppliers, etc.) generally do not interact with each other outside contractual scope, which significantly inhibits innovation possibilities. Planners have thus a key role in the development of innovation because of their direct involvement in the development of eco-districts.

Public service delegations lead to contracts between a local administration and an operator who is going to invest and make it profitable through the sale of heat for a very long period of time (from 25 to 30 years). This results in rigidity in decision-making, since the operator is not pushed to develop innovative solutions.

Appeared a few years ago in solar thermal and under in full development, the third-party investment business model can be a very interesting lever for the different parties, since the financial and operating risk can be transferred to a third party which can also be a group of citizens whose ambitions in terms of return on investment is more modest.

It emerges from the survey of the key stakeholders that they mainly seek for a better understanding of the economic models and technical implications of using RES in DHC, possibly through specific workshops and site visits.

Large agglomerations and urban planners are already engaged in a new paradigm concerning the renewal and creation of heating and cooling networks. However, a large majority of actors involved in this sector are still attracted by low gas prices and will not easily change their current model without compulsory or, at least, supporting public action.

4. GERMANY – REGIONAL STATE OF BADEN-WÜRTTEMBERG

Source: inetz GmbH Chemnitz

4.1. Current status of district heating and cooling

The federal state of Baden-Württemberg has to meet climate goals set out by the Climate Protection law and implemented through the Integrated Energy and Climate Protection Plan. In order to meet these goals measures such as the transformation of the energy and heating sectors to higher shares of RES are needed. This includes the transformation of existing urban DHC networks.

The transformation of the heating sector is supported by the implementation of compulsory heat planning by the amendment of the climate protection law in October of 2020. Therefore, heat planning becomes compulsory for the 103 biggest cities which are housing more than half of Baden-Württemberg's 11.1 million inhabitants. A study conducted in 2015 states that 587 out of 1101 municipalities have district heating networks. District heating provides 11.3 TWh out of 138 TWh end-use energy for heat. RES have a share of 15.9 % in the heating sector.

This analysis shows the importance of an interdisciplinary, participatory approach in order to transform district heating towards higher shares of RES. In addition to the market potential and the available technologies, national and European climate targets must be achieved through the participation of all stakeholders up to the end user, and existing public funding programmes must be used for implementation.

The main source of information for the market status of DHC is the Hauptbericht 2019 by the DH association AGFW, where 24 out of 32 AGFW members in the district heating sector took part. According to the AGFW members district heating provides 10 TWh of end energy use for heat. The suppliers of the cities Heidelberg, Mannheim and Karlsruhe account for 84 % of heat network input. 42 % of district heating are provided as external supply. For both external supply and self-production combined heat and power generation is the main source, accounting for more than 80 %. For external supply, industrial excess heat from Mineralölraffinerie Oberrhein (MiRO) accounts for 11 %. Heating plants account for 14 % of self-production. For CHP plants hard coal, waste and gas account for 90 % of fuels. For heating plants, 2/3 of fuel is provided by gas. This, mainly fossil, fuel composition resulted in CO_2 emissions of around 2.79 million tonnes for the total DH generation in Baden-Württemberg in 2019. The share of renewable energies in district heating generation is relatively low, at 6 %.

In principle, the smaller heat suppliers have so far used more RES than the larger heat suppliers; only two big suppliers are responsible for 99 % of coal usage.

Based on this, the following measures are possible for Baden-Württemberg in order to realise the transformation path to a CO_2 neutral heat supply by 2050:

1. Further expansion of DH in cities where it is already available.
2. Expansion of renewable energies in all heating networks.
3. Interconnection of heating networks in cities where several networks exist, in order to achieve further CO_2 savings by increasing the network simultaneity factor.
4. Development of heating networks in cities where district heating is not yet available.

Key political actors for DHC are the federal republic of Germany and the federal state of Baden-Württemberg, as they provide the legal and regulatory framework for RES DHC. As crucial stakeholders for the transformation process municipalities, energy suppliers and consumers are identified.

Municipalities also play a key role as they provide a local regulatory framework and act as suppliers and consumers themselves. In Baden-Württemberg, municipalities are organized in the „Städetag Baden-Württemberg“.

Both the private and municipal suppliers operating the district heating networks produce heat and invest in infrastructures. Alongside energy and heat suppliers, water utilities, waste management companies as well as industrial excess heat producers are possible heat suppliers for DH. Important associations in this sector are e.g. AGFW or the Association of Municipal Enterprises (VKU).

In the consumer sector the most important actors are the housing sector and private consumers, which are organized for example in the “Verband Baden-Württembergischer Wohnungs- und Immobilienunternehmen e. V (vbw)”. Since the integration of RES in DHC networks might require actions on the consumer side due to lower return temperatures, involvement of several owners is necessary.

Networks, research institutions and experts provide know-how for authorities and policy-makers and can act as multipliers for the strategies and know-how gained within the project.

4.2. Subsidies and incentive systems

At federal level relevant laws for the DHC sector are the following:

- Renewable Energies Act.
- Combined Heat and Power Act.
- Market Incentive Programme (MAP).
- Starting 2021: Federal Funding for Efficient Heating Networks (BEW).
- Federal Funding for Efficient Buildings (BEG).

Additionally, Baden-Württemberg provides several regional funding programs concerning RES DHC and compulsory heat planning.

The legislative levels considered for this survey are the EU, the federal government of Germany and the federal state of Baden-Württemberg. It is important to note that EU-legislations are mirrored in national regulations. Instruments like the European Climate Change Law are implemented by the national energy and climate plan and directives like the Renewable Energy Directive, Energy Efficiency Directive, Energy Performance of Buildings Directive and others play a role as well.

On the national level, the Federal Climate Change Act, the Climate Action Plan 2050 and Climate Protection Programme 2030 are important. Furthermore, there are different specific laws which are relevant for DHC: The Climate Protection Law Baden-Württemberg, the Integrated Energy and Climate Protection Plan, the Renewable heat Law and compulsory heat planning.

4.3. Barriers and opportunities for RES DHC

Two SWOT analysis were conducted for assessing barriers and opportunities for RES DHC in the sector: One for the transformation process of urban DH grids, and a second one for RES technologies in DH.

The main strengths of decarbonising district heating are: Sustainable contribution to climate protection, the facilitation of regional value creation and a fast track to climate-neutral heating in buildings.

On the other hand, weaknesses are the need for the involvement of a broad spectrum of actors and know-how and high costs of investment.

For the actors, the transformation of their heat networks provides the opportunity to meet municipal climate goals, get public funding for RES DHC projects and facilitate a sustainable transformation. The transformation process is supported by the compulsory heat planning for cities (Climate Protection Law BW).

Risks to the transformation process of urban district heating are a focus on power generation due to high power demand (the region is importing power from outside), the lack of an overarching concept for the transformation process, possible competition with gas grids and competition with refurbishing measures on buildings, lowering heat demand.

RES in DH provide climate-neutral heat, increase the use of local resources while lowering the need of imports and raise regional value creation. Constant heat prizes due to an independence from fossil fuels and decentralized heat production are further strengths of RES.

On the other hand, these technologies can have specific weaknesses such as local availability for biogenic fuels or area competition with other projects for solar thermal. The implementation of RES in DHC could also require lowering of network temperatures. Opportunities risen by RES technologies are almost identical to the decarbonisation: They help meeting climate goals and provide sustainable heat production. The use of these technologies is supported by the CO2 tax, the possibility of public funding and possible synergies with other infrastructure measures.

Risks to the integration of RES in DHC are regulatory obstacles, long approval processes and an unsteady framework for public funding.

From the two SWOT analyses, possible overarching starting points and levers emerge that could result in concrete implementation possibilities within the RES-DHC project for Baden-Württemberg:

- Networking, know-how transfer, best Practice examples, derivation of guidelines/strategies.
- Activation of investments into transformation processes.
- Involvement of the regional stakeholder advisory group, e.g. on needs and assistance.
- Improving the framework conditions for RES DHC in line with needs.

A good opportunity is also represented by the large number of best-practice examples in Baden-Württemberg for the transformation of existing heat networks to a higher share of renewable energies. In particular, the structures implemented via the energy agencies at the state or regional level (KEA-BW and rEA BW) contribute to the successful implementation of decarbonisation measures.

The city of Lörrach decided in 2010 to become a climate-neutral municipality. A yearly reduction of CO_2 emissions by 3.5 % until 2050 is key in the decarbonisation strategy. Since 2021, the three active heat suppliers in Lörrach are joined into one energy company in order to combine their grids and further improve organisational procedures.

In the city of Karlsruhe district heating goes back as far as 1904. Today 23.2 % of homes are connected to district heating. Since 2010, industrial low-temperature process heat by the Mineralölraffinerie Oberrhein (MiRO) is fed into the district heating grid of Stadtwerke Karlsruhe, saving 100.000 tons of CO_2 annually. This is going to be combined with industrial process heat by a paper factory by Stora Enso Maxau (SEM), which will save another estimated 10.000 tons of CO_2 a year.

In Ulm, the Fernwärme Ulm (FUG) lowered CO_2 emissions to 25 % compared to 1990 by substituting fossil fuels with regional, sustainable biogenic fuels and implementing technically and economically demanding measures to lower the grid temperatures.

In Tübingen, the municipal council in 2020 decided the climate protection programme 2020-2030 and aims to be climate neutral in terms of energy related CO_2 emissions by 2030. In order to implement the climate protection programme, the city, the public utility Stadtwerke Tübingen, and the urban society work together to implement measures such as creating a communal heat plan and successively increasing shares of renewable energy sources in the district heating grid.

The integration of solar thermal heat generation plants into existing district heating systems has already contributed to the decarbonisation of the heat supply in Baden-Württemberg over the last ten years. Through a series of research projects, Solites, HIR and AGFW, in collaboration with a number of other research partners, have been able to qualify large scale solar thermal plants for use in district heating systems.

5. ITALY – UTILITY IREN

Source: IREN

5.1. Current status of district heating and cooling

While in the period 2006-2010 70 new cities installed a DH network in Italy, the exhaustion of the possibility to access White Certificates, together with the lack of an alternative support system, caused a collapse of new initiatives. Indeed, in 2015, 2016 and 2018, new district heating volumes only concerned extensions of existing networks and in 2017, only one new network was installed.

In 2018, 368 networks were operating in Italy, 129 of which are small or very small, with a total length of 4,446 km, an increase of 2.5% compared to the previous year.

DH is available in 196 urban centers and supplies a total volume of almost 360 million cubic metres, saving 0.5 Mtoe/year in primary energy and avoiding 1.7 million tons of CO_2 emissions.

The energy produced is 11,250 thermal GWh per year (and 6,329 electrical GWh from co-generation) and 133 cooling GWh. Net thermal energy amounts to almost 9,300 GWh/year, covering approximately 3% of the national thermal demand.

A trend that must be underlined is the reduction over time of the linear density, i.e. the ratio between the volume of district heating and the linear extension of the networks, which shows how new developments are increasingly focused on low-density centers, such as mountain areas, leaving out medium and large urban centers.

With regard to the almost 83,000 sub-stations, it should be noted that the system solution supplying heat for space heating and the production of hot water prevails, with about 70% of the total.

The geographical distribution of DH shows a clear prevalence of the north of the country: more than 97% of this volume, in fact, is concentrated in only five regions: Lombardy, Piedmont, Emilia-Romagna, Trentino-Alto Adige and Veneto.

The production, whose total thermal power reaches almost 3.5 GW, is still mainly based on thermoelectric plants, cogeneration units and waste-to-energy systems. The current situation, therefore, leaves much room for a more widespread use of RES. These sources, in fact, currently cover only 25% of the annual energy production in DH networks and, moreover, this value also includes energy recovery from waste. It should be noted, that the coverage of renewables in 1995 was only 3%. A positive sign in this regard is that the few new initiatives registered in 2018 focus on waste heat recovery and a greater use of locally available thermal RES.

IREN Group, one of the Italian partners (together with Ambiente Italia) in the RES-DHC project, is the first Italian operator in the DH sector with 5 networks active in the North-West of the country for a total of about 95 million cubic metres in the urban areas of Turin (about 70 Mm^3), Genoa (about 4 Mm^3), Parma (about 6 Mm^3), Piacenza (about 2 Mm^3) and Reggio Emilia (about 14 Mm^3).

5.2. Subsidies and incentive systems

The implementation of new DH systems is usually financed by the investor, which is normally the same entity that managing the system and selling the produced heat to the end users.

This means, therefore, that the investment cost has to be justified, i.e. recovered, in a reasonable time, from the billing revenues. The cost of the thermal kWh to the user must be competitive with alternative solutions, such as individual boilers. In conclusion, therefore, investments in new grids, but also grid extensions or the construction of RES plants connected to an existing grid, must be economically sustainable operations, i.e. they must not produce increases in the price of heat for end users.

In some cases, especially for small networks, regional funds from European sources could be used to finance interventions but, usually, these funds address public entities.

As far as RES DHC are concerned, the following instruments should be mentioned:

- Conto Termico 2.0 for solar thermal energy
- Tax credit for biomass and geothermal
- CO_2 tax ('carbon tax')
- White Certificates for high-efficiency cogeneration

Conto Termico 2.0 provides an incentive, to be paid in five equal annual instalments, for solar thermal systems serving DH networks, with a maximum gross surface area of 2,500 m^2. By using solar thermal collectors of good performance, the amount of the incentive can easily cover a share of the initial investment between 50% and 65%.

The tax credit applied to the consumption of heat produced by biomass and geothermal DH consists in the granting of a tax credit of € 0.02194 per kWh of heat supplied, and be transferred in the price to the end user, i.e. the recipient of the tax benefit.

This benefit is accompanied by a further tax credit of €20.6582 for each kW of contracted power (tax credit for connections).

The White Certificates mechanism is available for high-efficiency cogeneration units that came into operation following new construction or refurbishment after 6 March 2007: if combined with a DH network, the incentive is given for a period of 15 years.

The application of the ETS leads to a clear market distortion, caused by the fact that individual heating plants are not subject to ETS, while DH, though optimizing the emission sum of the individual plants replaced, is subject to ETS (for installations > 20 MW).

A missed opportunity, on the other hand, is represented by the exclusion of DH from the package of measures included in the 110% tax Superbonus.

Finally, the economic competitiveness of the use of RES in DHC is closely linked to the cost of the fossil fuels that must be replaced. This issue is discussed below in the chapter on barriers and obstacles.

Following the so-called 'Renewable Energy Decree' (Legislative Decree 28/2011), thermal energy production systems, in buildings constructed or renovated on the basis of planning permission submitted from 1 January 2018, must guarantee simultaneous compliance with the coverage, through the use of RES, of 50% of the consumption for domestic hot water and 50% of the sum of the consumption for domestic hot water, heating and cooling.

As far as DHC is concerned, then, the Decree states that buildings connected to a DHC network that covers the entire heat demand for space heating and domestic hot water are not subject to the above-mentioned obligation.

5.3. Barriers and opportunities for RES DHC

A general trend in the DHC sector is a progressive shift towards more efficient technological solutions. This greater diffusion of RES in DHC seems to be closely linked to a more massive development of DHC in general. The barriers highlighted here will refer to specificities of the use of RES in DHC and also to more general characteristics of DHC.

The main barriers that today limit a more widespread use of RES in DHC are the following:

- High initial investment needed (partially mitigated by the possible availability of incentives);
- High payback time values (as for infra-structures); it is clear, however, that this consideration is also linked to the time horizon assumed by the investor;
- Scarce knowledge on DHC and sometimes 'a priori' local opposition;
- Underestimated potential for RES DHC;

- Heat recovery: need to develop an appropriate business model that also covers the risks of supply variations;
- Need of availability of areas for RES (wells for geothermal, logistic and storage platforms for biomass, areas for solar collectors, volumes for storage, etc.);
- Intermittency in the production of some RES (e.g. solar thermal);
- Presence of many superheated water networks, whose high operating temperature makes the integration of some RES, such as solar thermal, less efficient or even not implementable;
- Depending on the nature of the city, the type of building and the characteristics of the network itself (topology, size, location, demand), it might be difficult to implement efficiency upgrades;
- For RES: Low average level of knowledge of technologies on the market and little field data available for project bankability;
- For RES: competition with tax-free natural gas used in cogeneration mode;
- For non-programmable RES: Significantly lower number of equivalent hours compared to other energy sources and lower reliability and availability during the heating season may limit the environmental and economic benefits of their integration;
- For solar (thermal and photovoltaic to feed heat pumps): Need to install significant storage capacity for peak shaving;
- Biomass-based DHC currently excluded from the Conto Termico 2.0;
- Constraints on biomass combustion in some areas, due to air quality issues;
- Biomass-based DHC incentivized by Energy Efficiency Certificates only in existing networks;
- for the substitution of fossil fuels with biomass;
- DHC not included in the 110% tax Superbonus.

In parallel to the obstacles, also several opportunities should be pointed out:

- Growing interest in efficient DHC and RES deployment by grid operators, due to a more general 'green transition', the path towards efficient DHC introduced by recent European regulations and the increased sensitivity of end-users;
- Possibility of direct involvement of the end-user in new RES projects, including forms of direct economic participation such as crowdfunding;
- Availability of specific incentives; possible future increase of the 'Carbon Tax', favoring the economic convenience of RES;
- Grid extensions to connect new customers may require additional power and energy supplies, which could be partially or fully covered by RES;
- Assuming the principle of minimum cost for the end user, a recent study has shown that there is still considerable potential for using RES and waste heat in the DHC sector in Italy: A potential of 38 TWh/year, compared to about 9 TWh/year currently produced by the entire sector, including both fossil fuel and RES plants. The study also shows that a large part of this potential lies in geothermal resources and industrial waste heat, while solar thermal and high-efficiency cogeneration are expected to play a smaller role.

6. POLAND – UTILITY SEC (SZCZECIŃSKA ENERGETYKA CIEPLNA SP. Z O.O.)

Source: SEC

6.1. Current status of district heating and cooling

Polish heat market is quite complex, involving both individual producers and district heating companies and it is also a regulated market.

In case of DH, there are entities that requires concession and entities that do not need it. It depends on capacity of the installation: Up to 5 MW installed thermal power, concession is not required.

Less than 25% of heat in Poland is produced in DH networks, thus meaning that the vast majority of heat is produced individually. Therefore, individual heat producers will have the biggest influence on heat market.

The situation is also complicated, because centralised DH market is regulated. On the other hand, the regulated market is obliged to reporting, which helps to identify and track the fuel and technology of heat sources. This kind of analysis is much more difficult in case of individual heat producers.

DH systems in Poland are dominated by big networks (over 50 km). The biggest density of DH networks can be found in Śląskie Voivodship (29,5 km per 100 km^2), Małopolskie (13,3 km per 100 km^2) and Łódzkie and Pomorskie (10,3 km per 100 km^2). 63% of total heat in DH grids is produced in cogeneration mode.

DH systems produce heat mostly based on fossil fuels (over 70%) while the use of RES is limited to only 8,2% of systems. However, the share of RES in heat production is growing slowly, but systematically and DH itself grows steadily as well.

DH requires urgent technological intervention. Most of the existing DH networks are based on large (25 MW and more) heat plants which often have been operating for more than 30 years, usually operated through fossil fuels. Some of them have been upgraded, and are now using biomass. Usually the exploitation of those sources is connected to significant emission of fine particles (PM) and sulphur-nitric oxides and that should be the main area for intervention in the coming years.

The regulatory model does not incentivize implementation of innovative solutions so the DH companies are reluctant to invest in new technologies. DH systems in small cities are in the most difficult situation. Increasing CO_2 emission fees influence directly heat price for the end users and that may cause massive disconnection from DH and switching to individual heating sources.

The need for change of the technology and increasing CO_2 emission prices require significant investments. That means that the coming years will be very difficult for this sector. This issue requires an urgent intervention on the national level in terms of financial support addressed to heating sector and fiscal regulations.

6.2. Subsidies and incentive systems

Choosing the heating source for a user will always be based on economy: The smallest heat sources are not obliged to pay for CO_2 emissions, so coal-based boilers are still the most popular in individual heating sector. During last years, several support programs for natural persons were developed, where buying new, RES-based heating devices would be supported through grants and soft loans.

The National Fund for Environmental Protection and Water Management (NFEPWM) launched a regionally distributed support Programme called “Czyste Powietrze” (Clean Air). It allows to receive a financing up to 50% of investment costs (depending on the income of the applicant). This programme is very popular among the citizens, who want to exchange their heat sources to the RES-powered ones (heat pumps and PV). The need for support in this area is enormous so to receive significant efficiency, this programme should last for at least the next 10 years.

In case of large DH systems, there are financial support programmes for increasing energy efficiency (i.e. switching to pre-insulated pipes) and for mitigating the emission of sulphur and nitric oxides (installations for de-sulphurisation, etc.).

There are also support systems for CHP. Those are mostly auction systems, where the support for the installation is gained through the energy auction and it lasts for 15 years. Funds for the auction are granted on the national level (same as the funds for NFEPWM). There are also Regional Operational Programmes, where it is possible to carry out an investment on regional level.

In regulated systems, each saving must be shared with end users, while at the same time there are no incentives for heat producers to lower the heat prices by investing in innovation in DH systems. DH operators also do not have any tax reliefs for changes and innovations in the systems. The cheapest fuel, and most “traditional” heat source – coal – generates very high CO_2 emission costs. There is no consistent policy on central level in terms of regulating these aspects, which are key factors for incentivizing the operators to take innovation and intervention actions.

There is no dedicated VAT rate, which means that end user must pay this tax as well, additionally increasing heat prices and discouraging operators to make any strategic investments. This fiscal area also requires intervention from the central level.

The Polish legislation also introduced the definition of „prosumer” and it is a very well-developed solution (in both legislation and technical aspects) for RES micro-installations. Energy (electricity) producer up to 50 kW can storage not used energy in energy network and use 70% of this storage energy within a year. Those regulations are good for citizens, who want to invest their own money in RES. Unfortunately, there are no such solutions for the heating sector, where regulations require to treat small heat pump of 5 kW the same way as heat unit with capacity of 25 MW. That is the reason why innovative technologies for connecting RES with DH are not being developed in Poland.

6.3. Barriers and opportunities for RES DHC

The heating market has to face numerous challenges. Most of the individual heating systems are outdated and are powered by fossil fuels. According to the data of Forum Energii, almost 90% of heating systems with capacity of 1 MW or more are not efficient (according to the EU definition). The small district heating systems have an even more difficult situation because of the low sales volume.

Decarbonisation of the large DH networks is a challenge. The capacity of large Polish DH networks ranges between 500 and 1000 MW. Those systems are usually based on 1 or 2 sources, which means that the whole hydraulic system has been designed in a certain way, where heat production is centralised. Transformation from fossil fuels to RES will be very difficult due to this architecture. This transformation should search for small heat sources, mainly local RES and waste heat. Such systems will require deep reconstruction, not only in terms of sources and networks, but also in terms of their concept and hydraulics. It is a real challenge, then, for centralised DH networks in the next years.

There are no good examples of such investments and each DH system has to take up the investment risk individually. Due to current regulations, DH companies were not interested in innovations or in searching for external financial support. However, CO_2 costs are growing quite fast, which means that this industry will have to change its attitude. Unfortunately, there are neither national technologies available nor best practice examples or regulations for decarbonisation of DH systems. Technologies based on the ones from Western Europe are difficult to adapt to Polish conditions due to temperature differences in the networks: DH systems in Poland are designed for temperatures over 120 °C, while DH in the West is usually operating at much lower temperatures.

All of mentioned factors are the reasons why the situation of DH sector in Poland is very complex. At the same time, inhabitants are used to existing sources and are not interested in any changes or new technologies, such as biogas or waste incineration. Also, there are no consistent incentives, which means that many owners and system operators are not taking any actions towards decarbonisation, because they are waiting for decisions made on the central level to give them those incentives and guidelines for preferred direction of transformation.

On the other hand, some opportunities are there for increasing the use of RES in DHC. For example, social awareness regarding the influence of fossil fuels on environment and human health is also growing, thus meaning that citizens are more willing to use RES solutions in individual heating sources.

During the last few years, heat pumps, photovoltaic, biomass boilers and solar collectors have become more and more popular. This is caused not only by the growth of social awareness but also by good legislative solutions and dedicated financing programmes. Introducing the term of “micro-installation” into the RES act makes it possible to, for example, produce energy from rooftop photovoltaic and storing it in energy network with loss of 30% (from each introduced 100 kW, 70 kW can be taken back).

Another good example of legislation is the relief for modernisation and available sources for financing individual RES. Citizens readily use those programmes, as can be seen in this report: 61,4% of energy produced from the sun has been used in households, and almost 20% of fuels used for individual heating comes from biomass and other RES.

At the same time there are no similar legislative incentives for DH, which means that this sector is unwilling to introduce any innovations. There is a programme called Ciepłownicto Powiatowe (Heating for Counties), which is financed from NFEPWM, but it supports only systems owned by self-government units. The problem is that less than 4% of DH systems belong to local governments, while the rest of them are owned by different types of companies.

On the other hand, the solution that introduces auction system as support of CHP proofs, that correct shaping regulations and policies can make this business more secure (in this scheme, the support is granted for 15 years) and supports its development. Selling the electricity could be a factor that improves the economical results of DH produced in CHP.

It is not a final solution and it is well- known that gas-using CHP is only an interim technology, but it is anyway a great example of changing the approach to energy and to enlighten the users about the necessity of those changes.

Also, the Energy Policy of Poland includes assumptions of increasing RES share in district heating, reducing the greenhouse gases and growth of energy efficiency. Although this document also demonstrates solutions and actions that will help to achieve those aims, like using more RES and energy from waste, or heat storages, there are no financial incentives foreseen for the implementation of such actions.

Incentives for individual heat producers influence the awareness of heat receivers. That is the reason why clients of DH systems are more and more often interested in cheap and clean heat. That gives us hope that the rising social awareness will be a motivation driver not only for heat suppliers but also for developers to use RES and waste heat. The need to decarbonise large scale systems might cause the interest in local potential, and that can help in development in local co-operation platforms and energy clusters. It is a very positive phenomenon, because it allows not only to deliver cheaper heat but also to increase its efficiency.

7. SWITZERLAND

Source: Planair

7.1. Current status of district heating and cooling

The total heat consumption represents 100 TWh per year in Switzerland and is responsible for about half of the total energy consumption. More than 60 % of this, or over 60 TWh/a, is currently generated using fossil fuels. Since fossil energies must be reduced to zero by 2050 in order to achieve the climate targets, the federal government is focusing on increasing efficiency and developing renewable energies in its "Heat strategy".

Despite energy efficiency measures, consumption for 2050 will still be around 74 TWh, of which around 45 TWh will be for buildings, 10.5 TWh for domestic hot water and 18.5 TWh for process heat. In order to replace the remaining fossil heat, the federal government plans to expand district heating networks supplied with waste heat and renewable energies, as well as thermal networks that enable the distribution of heat or cold at different temperature levels.

Practically all large cities in Switzerland have had one or more thermal networks in operation for decades. Initially, these large urban networks were mainly supplied with waste heat from waste incineration plants, later wood-fired power plants (CHP) and mostly heat pumps using water as a heat source were added. The CO_2-neutral share of heat generation in these urban networks ranges from 60 % in Lausanne and Zurich to around 80 % in Basel or Bern. Fossil fuels are often used to cover peak loads and also serve as redundancy.

Growing urban densification and a future increase in demand for cooling further ensure the potential for thermal networks. A study by the University of Geneva has analysed the impact of reduced heating demand on the potential of district heating networks in Switzerland. The results of this study show that (1) the issue must be considered in the planning of networks, (2) the potential is shifting from high-temperature networks to low-temperature networks and (3) the potential is still much higher than what is already supplied today. The expansion of district heating also enables the use of fuels in combustion plants with efficient measures to reduce emissions.

With the basis scenario towards zero emission, greenhouse gas emissions from heating and cooling can be reduced from around 46 million tonnes of CO_2 equivalents in 2018 to around 12 million tonnes in 2050. The remaining emissions are mainly generated in agriculture and industrial processes and have to be compensated by CO_2 sequestration and negative emission technologies.

7.2. Subsidies and incentive systems

The funds for the promotion of DH come from the CO_2 tax, which is distributed as global contributions to the buildings programme of the cantons. Within the framework of the buildings programme, the cantons can promote both the construction and expansion of thermal networks and pay contributions to building owners for connection to a thermal network. The prerequisite for subsidies is the use of mainly renewable energies or waste heat.

The CO_2 reduction activities can also be registered with the federal government (Federal Office for the Environment and Federal Office of Energy) as compensation projects under Article 5 of the CO_2 Ordinance (SR 641.711). In this case, a delimitation of effects is made in relation to the cantonal support programmes. The funds originate from funds for the fulfilment of the CO_2 compensation obligation on fuel imports (SR 641.71).

As part of the deliberations on the total revision of the CO_2 Act, the Council of States introduced the creation of a climate fund in 2019. This is part of the CO_2 Act adopted by Parliament in September 2020. Part of this money is to be used to finance insurance against risks for investments in the new construction and expansion of thermal grids and the associated plants for heat generation using renewable energies or waste heat. Important for the promotion of thermal grids are long-term stable framework conditions, which are defined for example in regional or communal energy plans.

In order to achieve a rapid reduction in fossil CO_2 emissions, effective use of the subsidies must be ensured. For this purpose, quality assurance with compliance with recognised quality standards is recommended for project implementation.

The Harmonised Subsidy Model 2015 lists two measures relating to district heating.

- M-07 provides support for building owners who connect to a district heating network and replace a fossil fuel heating system. A possible condition is a minimum share of renewable and/or waste heat. 7 cantons set a limit between 70 and 80 % (Jura). 9 cantons set the limit at 50 %. Four cantons set no limit or a limit of 20 %. In the canton of Obwald, the subsidy only applies to biomass heating networks.

- M-18 provides a subsidy for the heat network operator for the construction or expansion of district heating networks. Twelve cantons offer this support, Canton Bern only for biomass heating networks. Only half have set a lower limit for the renewable share.

Furthermore, feasibility studies for district heating are subsidised in eight cantons up to a share of 60 % of the study costs.

7.3. Barriers and opportunities for RES DHC

The "Heat initiative Switzerland" initiated by AEE Suisse shows in its 2020 report that a fully decarbonised heating sector is possible in Switzerland. However, to achieve this, the full potential of renewable energy sources must be used and the right framework conditions for the expansion of renewable heat must be created.

The recommendations from this report are important and in line with the objectives of the RES-DHC project. Specific recommendations on thermal grids have been considered in this work.

The table below summarises the barriers to the market development of renewable district heating identified in this analysis. Possible levers and proposals, including those of the initiative, are compared and translated into concrete measures. These concrete measures are a wish list, a selection of which will be implemented in the RES-DHC project.

Category	Barriers	Opportunities	Concrete measure
Technical aspects	- High operating temperatures - For new grids: 100% renewable solutions not yet known by all actors, especially planners - Long implementation times	- Education and information activities for DH operators and planners on the technical solutions, e.g. storage solutions, reduction of flow temperature, load management on the customer side. - Medium-deep geothermal pilot projects - Offering interim solutions	**International and national educational activities** and exchange of experiences: courses and workshops.
			Feasibility studies and factsheets on best-practice examples to achieve the goal of 100% CO_2 neutral district heating and dissemination of results
			Development of a decision tool and the 100% renewable targets.
			Factsheet for municipalities and FW operators on interim heating solutions.
Economic aspects	- High upfront investment costs, financing difficulties - No or poor business plan with budgeted balance sheet and budgeted income statement	- Education and information activities for municipalities, FW operators and planners - Fully or partially exempt large-scale heat pumps from the taxes.	**Feasibility studies of** selected heat networks that are representative of the market and whose results apply as universally as possible.
			Produce guidelines on financing options and alternative business models, incl. prosumer models.

	(basic requirement for debt financing) - Economic efficiency, especially of the 100% renewable solutions	- Promotion of long-term storage - Funding or support instruments from municipalities and cantons - New business models for investment in thermal grids and the development of renewable energy potentials	**Simple explanation** (such as video) of full cost accounting
Legal aspects and promotion	- No incentive to increase the share of renewable energies - Lack of long-term planning - Different regulations between the cantons - Lack of resources in the municipalities - Complex procedures	- Municipal energy planning and concessions with target agreements, assumption of mandatory coordination - Simplification of the procedures for the use of renewable energies - Harmonization of regulations between the cantons, increase of the statutory renewable energy share - Reduction of concession fees for lake/groundwater heat utilization - Derogation for time-delayed W connection - Promotion of feasibility studies only if **at least one 100% CO_2 neutral solution** is	**Analysis of the reasons for** the **legal minimum share of renewable energy in the** cantons and its influence on local heating networks. Factsheets and workshop on **best practice examples of communal / cantonal energy planning** or concession contracts between communes and energy service providers or other support for communes and local associations in the process, **such as an information point, information events** etc. This point should also address competition with existing gas networks. Position paper on possible policy measures.

		calculated; access to 100% RE feasibility studies must be made easier for municipalities or associations.	
Socio-economic aspects	- Lack of information among end customers: unknown solution - Acceptance issues for locations of heat centres or pipelines	- Spreading a good image of district heating as 100% CO_2-neutral and local - Information and awareness-raising measures for decision-makers and their direct advisors - Ownership strategy for energy suppliers: cantons and municipalities	**Marketing campaign**, image "100% CO_2 neutral DH" with video, or brochure, appealing arguments in favor of the cause
			Best practice examples on **citizen participation**
General	No detailed analysis of the barriers	Increase information exchange within the sector, but also with all identified stakeholders	All available resources should be easily and centrally accessible. The development of a central training / exchange / resource platform is recommended.
			Foundation of a working group For the project, we have identified and invited the stakeholders to participate in the support group.
			Deepening the analysis of barriers, e.g. by asking decision-makers.

Summary of barriers and opportunities to market development and corresponding proposals for concrete measures in Switzerland