

Integration of Renewables in DHC for Sustainable Living Workshop

María Victoria Cambronero Vázquez ^{1,*}, Jack Corscadden ², Antonio Garrido Marijuan ³, Giulia Barbagelata ⁴, Georg Hamann ⁵, Matthieu Grosjean ⁶ and Nora Mendoza ⁷

¹ Acciona, Engineering Department, Anabel Segura, 8, 28108 Alcobendas, Spain; mvcambronero@acciona.com

² Euroheat & Power, DHC+ Technology Platform, Cours Saint Michel 30a—Box E, 1040 Brussels, Belgium; jc@euroheat.org

³ Building Technologies Division, Tecnalía, Basque Research and Technology Alliance (BRTA), 48160 Derio, Spain; antonio.garridomarijuan@tecnalia.com

⁴ STAM Srl, Via Pareto 8 a R, 16129 Genoa, Italy; g.barbagelata@stamtech.com

⁵ SachsenEnergie AG, Friedrich-List-Platz 2, 01069 Dresden, Germany; georg.hamann@sachsenenergie.de

⁶ STEINBEIS, Steinbeis-Europa-Zentrum, Kienestraße 35., 70174 Stuttgart, Germany; Matthieu.Grosjean@steinbeis-europa.de

⁷ Fomento de San Sebastián, Municipality Economic Development Department—Smart Strategy and Sector Specialisation, c/San Roque 120, 20.009 Donostia-San Sebastián, Spain; nora_mendoza@donostia.eus

* Correspondence: mvcambronero@acciona.com

† Presented at the Sustainable Places 2020, Online, 28–30 October; Available online: <https://www.sustainableplaces.eu/>.

Published: 18 January 2021

Abstract: There is a large potential to integrate substantial shares of renewable energy and waste heat sources in district heating and/or cooling networks (DHC), reducing dependency of DHC on fossil fuels and ultimately leading to a more efficient and sustainable energy system. Several EU funded projects are currently working on this topic. The objective of the workshop aimed to share the WEDISTRIC project concept with other sister projects and interested stakeholders in order to exchange new ideas, lessons learnt from implementation and proposals about the successful integration of renewable technologies in DHC and urban regeneration.

Keywords: district heating and cooling; renewable energy; urban regeneration; smart cities

1. Workshop Introduction

The workshop was organized firstly into a number of individual presentations in two different blocks (district heat and cooling network, renewable energy sources, thermal storage and waste heat recovery at low temperatures and sustainable urban regeneration model development, demonstration of Smart City technologies in energy, transport and Information and Communication Technologies, ICT), followed by a timeslot for generating debate among the different attendants, answering a number of questions risen. The workshop was chaired by ACCIONA (Ms. Carolina Ferrandis) with the participation of a representative person from the European Commission (Mr. Daniel Maraver) who exposed the importance of the renewable energies and urban regeneration in order to meet the European climatic challenges justifying the support from the European Commission by providing funding for this kind of aligned projects. Mr. Daniel Maraver stressed that the European Commission has already started with a plan at policy level (heating and cooling strategy, clean energy for all Europeans package or SET Plan, as examples) which are high level guidelines that could be the starting point of more ambitious goals.

2. WEDISTRIC PROJECT—Smart and Local Renewable Energy DISTRICT Heating and Cooling Solutions for Sustainable Living (www.wedistrict.eu)

The WEDISTRIC project proposes the development of clean, smart and flexible DHC systems as a tool for reaching the EU climate goals. The target of the WEDISTRIC is to demonstrate 100% fossil free heating and cooling solutions by optimally integrating multiple sources of renewable energies and excess heat in new and existing DHC systems. For this, integration of 10 upgraded solutions for DHC systems into 4 real DHC sites in Spain, Romania, Poland and Sweden will be performed within the project. All of this, in a holistic context, smartly managed by ICT-integration, sustainable business models and engagement of citizens.

In the workshop, Ms. María Victoria Cambroneró (Acciona) gave an overview of the different upgraded technologies/solutions and demosites where those technologies and solutions will be deployed and demonstrated. The WEDISTRIC technologies and solutions are: 3 solar concentration technologies based on Parabolic Trough Collector (PTC), Fresnel and new tracking collector system; 2 renewable cooling technologies: based on absorption chiller and air cooling unit; 1 low-emissions biomass: adding new DeNO_x system; 1 photovoltaic (PV)–geothermal hybrid; 1 advanced thermal storage molten-salts based; 1 heat recovery system based on fuel cell; 1 advanced digitalization system.

Demonstration and validation of WEDISTRIC technologies and solutions will be performed in 4 demosites:

- New DHC system in Alcalá de Henares (Spain)
- Extension of current DH supply in Bucharest (Romania)
- Retrofitting of a current coal-based DH system in Racibórz (Poland)
- Heat recovery system in Data Center with fuel cell as heat source for a current DH in Lulea (Sweden).

Besides this, the replication potential of the solutions will be analyzed by performing the study of 12 demo-followers from different countries (Spain, Italy, Poland, Cyprus, Romania, Chile) which have joined to the project in order to assess the most cost-effective option for their DHC projects.

3. REWARDHeat PROJECT—Renewable and Waste Heat Recovery for Competitive District Heating and Cooling Networks (www.rewardheat.eu)

The REWARDHeat project is about smart networks integrating renewable and waste energy sources. The overall objective is to demonstrate a new generation of low-temperature district heating and cooling networks, which will be able to recover renewable and waste heat, available at low temperature.

During the workshop, Mr. Jack Corscadden (Euroheat & Power) outlined the need to lower the network supply temperature compared to conventional networks, in order to integrate locally-available sustainable energy sources. This need was illustrated with examples of low- and neutral-temperature networks being deployed at the Croatian, French and Swedish demonstrators.

The REWARDHeat project will deploy highly innovative solutions that are replicable in urban environments across Europe. Multiple urban renewable and waste energy sources will be integrated in modern DHC networks, allowing for the flexible use and storage of heat. Digitalisation solutions allowing for the optimisation of the DHC network management will be demonstrated and novel business models that facilitate the sale of heat 'as a service' will be developed.

4. RELaTED PROJECT—New Developments on Ultra Low Temperature District Heating Networks (www.relatedproject.eu)

RELaTED Project aims to foster the decarbonization of DHC for sustainable cities through a reduction on the working temperature of DH networks. With this objective, RELaTED develops the concepts concerning ultra-low temperature DH (ULT-DH), a temperature level that enables the use of low grade sources of thermal energy, increasing the performance of the systems associated such

as solar thermal systems or combined heating and power plants, reducing heat losses and providing cost effective solutions. These developments will be demonstrated in four locations: Tartu, in Estonia, being the DH operated by Fortum (www.fortumtartu.ee); Vinge, in Denmark, being the DH operated by Vestforbraending (www.vestfor.dk); Belgrade, in Serbia, being the DH operated by Beogradske Elektrane (www.beoelektrane.rs); and Spain.

Within the Integration of Renewables in DHC for Sustainable Living Workshop, the main ideas concerning ULT-DH and the technologies developed within RELaTED were shared by Mr. Antonio Garrido Marijuan, mainly building integrated solar systems, novel substations and District-heating connected Reversible Heat Pump systems. The main lessons learnt from the RELaTED Project were shared as following:

- In the demo site of Tartu, digitalization has demonstrated its crucial role for a proper transition to ULT networks, as it can detect suboptimal conditions as well as potentialities for further reduction of temperature.
- The case study of Belgrade shows that a public DH operator such as Beoelek, with political and social interest, can succeed on the decarbonization of the network even with a conventional business view.
- The development and transformation of DH networks faces non-technical issues, as it was learnt from the VINGE demo case, where important delays were experienced due to the real-estate sector, the macroeconomic situation as well as other aspects strictly not related to technical constrains.

5. TEMPO PROJECT – TEMPerature Optimisation for Low Temperature District Heating across Europe (www.tempo-dhc.eu)

The TEMPO project develops technical innovations that enables district heating networks to operate at lower temperatures. Mr. Dirk Vanhoudt, (EnergyVille/VITO) presented the first results obtained of the first temperature reduction measures in the demo sites: in Windsbachm, with one heating season a reduction of 7.2% in distribution losses has been observed as well as 5% savings in investment cost, however distribution losses should be reduced more; in Brescia, supply temperature reduction led to a lower energy demand of the network, translated into a lower significant reduction in primary energy demand (15.7% on annual basis).

6. MATCHUP PROJECT – MAXimizing the UPscaling and Replication Potential of High Level Urban Transformation Strategies (www.matchup-project.eu)

The MAtchUP project is a large-scale collaborative project with several project partners all over Europe. It investigates the transformation of urban structures into a Smart City. Three cities in Europe are therefore developing concepts in the fields of energy efficiency, digitalisation, decentralisation, renewable energies, multimodality and electromobility. The implementation of such intelligent technologies contributes to creating efficient, sustainable, clean and future-proof living spaces for citizens, which can, among other things, meet the challenges of climate change.

As a partner in the EU project “MAtchUP”, DREWAG/ENSO, the local energy and infrastructure supplier of Dresden, was a speaker at the workshop, represented by Mr. Georg Hamann. The contribution in the block “district heat and cooling (DHC) network, renewable energy sources, thermal storage and waste heat recovery at low temperatures” informed about the feasibility as well as the theoretical and practical investigations to feed-in renewable energies into the Dresden district heating network. The expertise is intended to reduce the primary energy demand in the future and to “green up” the heat supply of the city, while maintaining the flexibility of the district heating network and the quality of supply. The resulting measures serve as a model for other cities in Europe and complement to national energy and climate protection concepts.

7. DRIMPAC PROJECT—Unified DR Interoperability Framework Enabling Market Participation of Active Energy Consumers (www.drimpac-h2020.eu)

DRIMPAC project aims to enable the participation of small prosumers (building level) in implicit and explicit Demand Response programs within a future electricity market environment. It addresses the interoperability gaps along the DSO-prosumer path by developing an end-to-end solution connecting the major standards (OpenADR, OneM2M, IEC 61850...), while striking the right balance between comfort preservation and energy conservation in home dwellings via environment and preferences monitoring and intelligent algorithms. DRIMPAC scope is to provide the open, standards-based technological framework that enhances building management intelligence for enabling end-to-end communication between the building and the DSO via aggregators in order to publish building-demand flexibility information for implicit and explicit DR operations, while preserving comfortable and healthy living conditions. During the presentation the latest developments of the project were shared by Mr. Marco Barbagelata, in particular:

- The completion of the ICT backbone for the connectivity of DSO/AGR/platform/asset (DL-DER)
- The finalization of Hypertech's energy management system, Smart boxes and local IoT monitoring/control system
- The development of UCY's InEIS platform that will be used as an interface with commercial BEMS
- The successful OpenADR communication between the Aggregator and buildings assets
- Development of several data-driven value-added software components (Flexibility forecasting, Predictive maintenance, VES) and UIs for DRIMPAC stakeholders

DRIMPAC is developing and testing different innovative DR business models at four pilot sites:

- Integrated supplier and aggregator for suppliers to optimise the balance position of their portfolio by applying dynamic pricing schemes, that in addition provide flexibility for the DSO
- Independent aggregator dissociating energy supply and flexibility service, providing flexibility for the DSO
- Flexibility service company (FLESCO) service provider for load shifting behind the meter, causing maximised prosumers' benefit from dynamic/time-of-use pricing schemes

8. REMOURBAN PROJECT—REgeneration MOdel for Accelerating the Smart URBAN Transformation (www.remourban.eu)

REMOURBAN is a large-scale demonstration project, whose purpose is to accelerate the urban transformation towards the smart city concept considering all aspects of sustainability. One of the main achievements of this project is the development and demonstration of its Urban Regeneration Model (URM) in three cities, Valladolid (Spain), Nottingham (UK) and Tepebaşı/Eskişehir (Turkey). The URM (URM pocket guide: <http://www.remourban.eu/technical-insights/best-practices-e-book/best-practices-e-book.kl>) is an urban renovation methodology that takes into account all aspects of sustainability—energy efficiency, sustainable mobility, ICT integration and engagement of all societal players—and integrates both technical and non-technical innovations (such as citizen and stakeholder involvement, management, governance, innovative business models). The holistic methodology of the URM combined with innovative ICT-based tools supports the decision-making process of public authorities, urban planners, investors and private companies on their way to transforming cities into smarter and more sustainable environments. A detailed replicability potential analysis in European cities and a replicability framework co-designed with the follower cities of the project, Seraing (Belgium) and Miskolc (Hungary) is available for other cities willing to replicate and scale the URM in their urban eco-systems considering their own characteristics. The URM is divided into four main phases:

1. *Strategy Design*: identify the objectives and the scope of the action through the city characterization. The strategy is delivered through the Integrated Urban Plan, a city vision within a specific time frame. The Cluster Identification Tool used in this phase allows cities to pre-evaluate the key

working areas. It analyses 5 domains through a set of macro indicators characterizing the city by its similarities to other European cities in the same cluster.

2. *Action Plan*: carry out the feasibility analysis for the proposed Smart City Technology Packages (SCTPs: related to the Smart City solutions like the Low Temperature District Heating) according to the Strategy Design and the objectives identified. A decision-support tool (YOOPI!) helps cities analysing the socio-political, financial and technical features of each SCTP and suggests the most suitable set of SCTPs that can be implemented in the city to cover its needs.
3. *Implementation Plan*: a guide that helps the team to implement the interventions set by the Action Plan and focus on the needs of the interventions at each step. Political commitment and citizens' participation in the process are also key during the implementation phase.
4. *Assessment*: of the impacts achieved through the implementation of the actions, and of the effects of the regeneration strategy on the overall level of city sustainability and smartness. The results help assessing the achievement of the objectives established during the strategy design and checking the performance of the implementation compared to the action plan. The STILE tool has been created to evaluate the sustainability and smartness of the city and the impact of the implemented actions.

Thanks to the URM implementation, overall, the three pilot Lighthouse cities were able to achieve the following impacts presented by Mr. Matthieu Grosjean:

- Low energy districts: 34% energy reduction, 50% CO₂ emissions reduction
- Smart mobility: 5.1% energy reduction, 5% CO₂ emissions reduction
- ICT: 1927 variables collected in the central platform

9. REPLICATE PROJECT—Renaissance of Places with Innovative Citizenship and Technology (www.replicate-project.eu)

REPLICATE is a lighthouse large-scale collaborative demonstration project of smart implementations. REPLICATE is led by the city of San Sebastian and coordinated by Fomento de San Sebastián. The project aims to develop and validate a sustainable city business model in the lighthouse cities (pilot) of San Sebastian (Spain), Florence (Italy) and Bristol (United Kingdom), to improve the transition process towards a SmartCity in the fields of energy efficiency, sustainable mobility and ICTs/Infrastructures, accelerating the deployment of innovative technologies, increasing the quality of life of the citizens, and influencing the replication process. Furthermore, the project is contributing to the improvement of the life quality of citizens, showing the impact of the innovative technologies used to co-create Smart City services for citizens, and testing the optimum process to replicate the successes in cities and through cities. With a budget of over 29 million euros, the consortium is made up of 38 partners: three lighthouse cities, three fellow cities (Essen—Germany, Lausanne—Switzerland and Nilüfer—Turkey) public organisations, multisectorial companies and universities.

During the workshop Fomento de San Sebastian, represented by Ms. Nora Mendoza, presented the project and the implementations deployed in San Sebastian's Urumea Riverside District. An integrated planned strategy has been implemented in the district fostering its transformation into a smart district with nearly zero emissions which has become a sustainability district brand.

The energy efficiency intervention in the main district neighborhood, Txomin, has covered the retrofitting of 156 consolidated homes and 34 commercial establishments and their connection to the new neighborhood's centralised heating and hot water system (district heating), that is owned by the City Council through Fomento San Sebastian. The connection of the district with the city center has been improved with two full electric buses that give service to this demanding line, while the municipal fleet has been improved with the inclusion of electric vehicles and e-motos for traffic agents. San Sebastian lighthouse city has developed a Smart City Platform where the different city verticals are being gradually integrated while part of this information is published in Open Data, fostering transparency in municipal management. The city's high-speed mobile wireless network, managed by Fomento de San Sebastián, has been improved, hence optimising its capacity and service.

Additionally, in the industrial area of the Urumea Riverside District, a smart public lighting system with associated IP services has been deployed.

The solutions implemented, their impacts and the business models generated have been analysed for their scalability potential within the city, as well as their replicability in other European cities. The scale up plans for the three lighthouse cities have been designed while the replication plans for the fellow cities are being currently drafted.

10. Polls Discussion

Within the workshop, 3 different polls were launched in order to interact with the attendants and know which was the main background (being industry/engineering/consultancy and scientific community representing the 83%) and their opinion related to the DHC projects development. The attendees considered that local authorities are the main actors for succeeding in the decarbonization of the DH networks (55%), while the financial is the main obstacle (90%). The speakers highlighted that, although the attendants selected the technical barrier as the second one, the regulatory and political aspects might be more problematic for a DHC project development, according to their experience. On the other hand, the outstanding actors for the development of this kind of projects are local authorities (coinciding with attendants' view) and policymakers (being in line with the main barriers encountered).

11. Conclusions and Lessons Learnt

The workshop was intended to exchange new ideas, lessons learnt from implementation and proposals about the integration of substantial shares of renewable energy sources in district heating and/or cooling (DHC) systems, in order to share commonly with external colleagues, the main concepts on reducing the dependency of DHC on fossil fuels and ultimately leading to a more efficient and sustainable energy system. During the workshop discussion few common topics came out, highlighting the following insights:

- The cruciality of user engagement in testing and developments of the solution.
- The importance of overcoming the political and technical barriers to the decarbonization of the European DHC sector was emphasized.
- Ambitious targets are needed to incentivize RES uptake and a transition to low-operating temperatures is needed to enable this integration.
- Policymakers have a key role to play in addressing these issues.
- Due to the local nature of heat supply, municipalities can have a significant impact by taking on a more active role in the energy system and pursuing their own low-carbon heat solutions.
- Services related to DH will be more important in the future than the heating product as such.
- Electrification of the networks need to be developed in parallel with the decarbonization of the electric mix.
- Several technologies are developed to decarbonize the system such as novel absorption pumps, new tariffs and ULT concepts, which needs to be supported by the public administration and well explained to the society for a large integration of these concepts.
- DHC in European countries are at very different development stages.
- Countries with a small share of DH (e.g., the Netherlands, Italy, Greece, Spain, Portugal) have a high share of individual heating with high shares of fossil fuels, mainly natural gas. There is a lack of awareness and practical knowledge on how to implement DHC systems. This is reflected in the lack of legislative and regulatory frameworks.
- Countries with a high share of DH (e.g., Denmark, Sweden, Lithuania) are more focused on networks towards increasing the overall efficiency of the networks using RES and new technologies rather than expansion of new DHs.
- Countries with old DH networks (e.g., Eastern European countries) need to renovate and optimize their networks in order to reduce heat losses (losing customers consequently).

Funding: These projects have received funding from the European Union’s Horizon 2020 research and innovation programme (WEDISTRICT—GA No 857801; REWARDHeat—GA No 857811; RELaTED—GA No 768567; TEMPO—GA No 768936; MAtchUP—GA No 774477; DRIMPAC—GA No 768559; REMOURBAN—GA No 646511; REPLICATE—GA No 691735). This publication reflects only the authors’ views and neither the Agency nor the Commission are responsible for any use that may be made of the information contained therein.

Conflicts of Interest: The authors declare no conflict of interest.

Publisher’s Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



© 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).