Advancing District Heating & Cooling Solutions and Uptake in European Cities

Overview of Support Activities and Projects of the European Commission on District Heating & Cooling

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Foreword

An overview of support activities and projects of the European Commission on District Heating & Cooling (DHC) was initially published by the Celsius Initiative in 2020, and subsequently updated in 2021 and 2022. In the meantime, geopolitical developments have made it apparent that the current energy security crisis is a heating crisis. Indeed, today in Europe, heating accounts for 50% of the energy demand and 70% still comes from fossil fuels. In this difficult context, local governments just as states are looking for solutions to substitute natural gas for heating. District energy, which is about connecting local resources to local needs, can be one of them. Expanding and modernising DHC systems in EU cities is a concrete way to drastically reduce natural gas consumption and make Europe climate-neutral by 2050. Hence, I find the publication of this brochure highly relevant today!

District energy is on a constant journey towards greater efficiency, greater flexibility and increased use of renewable energy and waste energy sources. It is playing an increasingly important role in a more integrated energy system, exploring new business models and applying new digital solutions. DHC has the potential to be at the centre of the decarbonisation of the heating and cooling sector and contribute to strengthening Europe's energy resilience and security. By reading this brochure, one will find inspiring examples of rolling-out local renewable/waste heat sources and upgrading heat networks, as well as policy support and market uptake measures that can be replicated elsewhere.

The EU funded projects and support activities featured in this publication have been leading the way towards sustainable solutions at local level in cities and communities all over the European Union. All partners involved are very grateful to the European Commission and its agencies for their support in getting these projects off the ground and their continued help throughout their lifetime. In the future, adequate funding through dedicated and specific calls and topics for renewable heating and cooling projects is essential to develop future-proof district heating and cooling technologies. I do believe that the DHC sector can convert the current crisis into a unique opportunity to accelerate Europe's heat transition and sincerely hope that the required political support and dedicated funding is forthcoming.

Aksana Krasatsenka, Director of Knowledge Transfer at Euroheat & Power

1 Why District Heating & Cooling for Cities?

Heating and cooling consume half of the EU's energy. Today, the majority of heating and cooling is still generated from fossil fuels and almost all of the waste heat produced in the EU is currently not used. The IEA finds in its 2020 report on heating that the decarbonisation of the sector is not on track (https://www.iea.org/reports/heating). In order to fulfil the EU's climate and energy goals, the heating and cooling sector must not only urgently become more efficient, but carbon-neutral by using 100% renewable sources and waste heat.

District Heating and Cooling (DHC) is a proven solution for delivering heating, hot water and cooling services through a network of insulated pipes, from a central point of generation to the end user. They are suited to feed in locally available, renewable and low-carbon energy sources, such as solar thermal and geothermal heat, waste heat from industry and commercial buildings, heat from combined heat and power plants. The ability to integrate diverse energy sources means customers are not dependent upon a single source of supply. District energy networks are inherently diverse and variable in terms of size and load; while employing similar operating principles, each network develops according to specific local circumstances and adapts to continuous innovation. Heat networks are based on economies of scale, as the generation of heat in one large plant can often be more efficient than production in multiple smaller ones.

District energy is a community-based solution that plays a key role in the sustainable cities we want to live in.

A growing number of cities worldwide are adopting modern district energy solutions, as the best way to bring sustainable heating and cooling to these dense urban areas. The refurbishment, construction and expansion of district energy network, combining district heating and district cooling, integrating and balancing a large share of renewable power, serving as thermal storage, are prerequisites for the smart energy systems of the future. The constant evolution of district heating and cooling mirrors that of the broader energy transition. More efficiency, more renewables and more flexibility lead to a better energy system. District heating currently accounts for around 12% of heating in Europe. With the right investments, this share could grow to 50% by 2050. In the face of rising energy prices and reduced energy security due to geopolitical developments, modern district heating and cooling networks offer a solution that can be fuelled by a wide range of locally available resources.

The European Commission has been funding projects in the sector of district heating and cooling that are innovative and advancing the state of the art of district energy networks to drive the energy transition. These projects have already been presented in the European Commission's publication "Overview of support activities and projects of the European Commission on energy efficiency and renewable energy in the heating and cooling sector" which gathers all EU-funded projects in the heating and cooling sector, with one chapter focusing on DHC.

The present brochure builds on the 2016 document and provides an overview of the EU-funded projects in the area of district heating and cooling. It focuses on the Horizon 2020 Programme for Research and Innovation (2016-2020), including projects funded under the LIFE programme and adds the latest Green Deal projects. The projects have been identified through desk-based research on CORDIS, examining also the sister projects of the identified projects, as well as triangulating the results with the identified projects of the RHC Platform's project database and projects listed by the DHC+ Platform c/o Euroheat & Power.

1.1 About the Celsius Initiative

The Celsius Initiative is a demand driven collaboration hub for efficient, integrated district heating and cooling solutions supporting cities in their energy transition to carbon-neutral systems. More information about the Celsius Initiative, see Annex 3.4.

The partners are RISE Research Institutes of Sweden, IMCG, Euroheat & Power and Johanneberg Science Park (JSP) as lead partner. This brochure has been drafted in the framework of the co-fund by the European Commission.

1.2 How to Read “Advancing District Heating & Cooling Solutions and Uptake in European Cities”

The developed DHC solutions are there to be replicated elsewhere! This brochure is meant to foster the uptake of DHC solutions in cities and is therefore structured in a way that makes the solutions easy to find.

Chapter 2.1 gives an overview of all projects that are part of the brochure in a concise way, including Key Performance Indicators and summary tables. Each solution is rated with its replication potential (from one to five stars 1*-5*****), so you can see immediately if this solution can potentially be implemented in your city.

In Chapters 2.2-2.10 you can browse projects by category. If you are interested in a particular topic, this is the place to find all projects focussing on a specific area. It provides a high-level overview and analysis of the current state of the art in research.

Finally, for more in-depth content, consult Chapter 3 - Annex that gathers all project fiches in alphabetical order. The project fiches have been designed with cities and their needs in mind and go well beyond generic information provided on the project websites. They not only provide a summary of the projects, the demonstration sites, and relevant contact details, but also give answers to the most pressing questions concerning the replication of these solutions: “what is the solution”, “why should I use it”, “what is the environmental impact of the solution”, etc.

The brochure is also accessible in design version here.

2 EU-Supported Activities in District Heating and Cooling

2.1 Overview

Between 2016 and 2022, the European Union has supported a plethora of R&I activities to advance the state of the art of district heating and cooling. These projects have undertaken R&I activities for renewable thermal generation and waste heat recuperation to be used in heat networks, but also established enabling frameworks such as policy support and market uptake measures. In addition, many of the Smart City and Communities Lighthouse projects funded under Horizon 2020 have included DHC technologies in their scope. One project on district heating and cooling has also been funded under the LIFE Programme. All these projects are described in the following chapters, providing an overview of the different innovations and research activities that have been achieved thanks to European Union support.

In total, 268 mio EUR have been spent out of the EU contribution on the Smart Cities and Communities Lighthouse projects that include DHC technologies. Under these funding amounts other technologies outside of DHC are also supported, as SCC projects obviously tackle a wide spectrum of city infrastructure and technologies. This is why looking at total numbers would not give a clear picture of DHC projects funded and the SCC projects are presented separately in the following tables. 180 mio EUR have been spent on the other H2020 funded projects, and the budget of the LIFE project amounts to 3 mio EUR in EU funding. Tables 1, 2 and 4 provide an overview of the funding amounts per project.

For the non-SCC projects, the EU funding amounts are mostly in the range of 1 to 4 mio EUR, see table 1. This means that two thirds of the projects are rather small-scale. About one third of the projects (12) surpass this funding range. REWARDHeat and WEDISTRICT are the projects with the highest funding amount of just under 15 mio EUR, both of which include a big number of demonstrators in the project.

For the SCC projects, the EU contribution is between 17 and 27 mio EUR, see table 4. All SCC projects’ funding ranges are, hence, surpassing the other H2020 fundings. The SCC projects with the biggest EU contributions are from the 2014 and 2015 calls. The other projects all have EU contributions to their budget of just under 20 mio EUR.

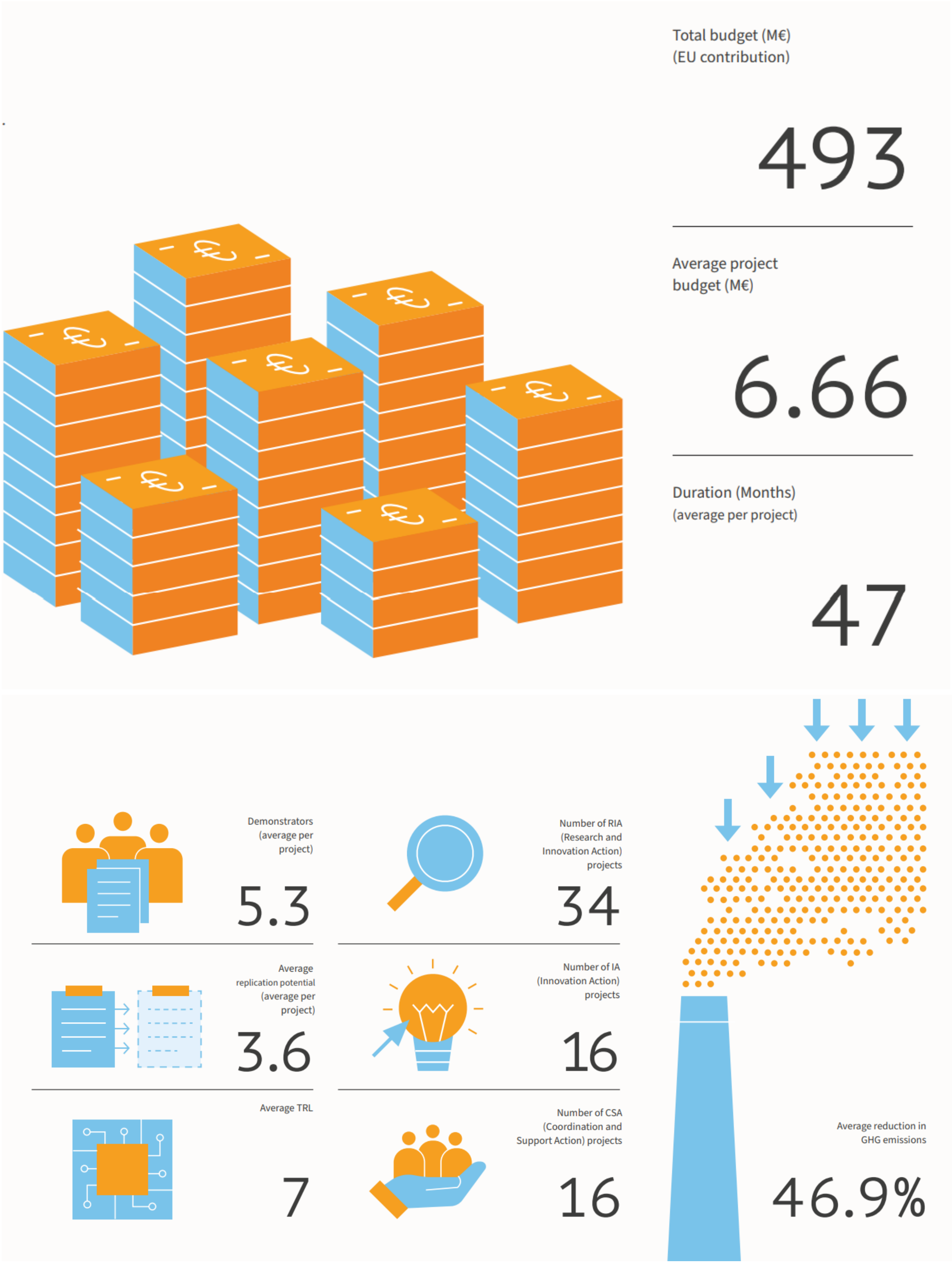
Three FP7 Smart City projects have also been included, namely the CELSIUS, PITAGORAS and READY projects which have received around 14 mio EUR, 6 mio EUR and 19 mio EUR of EU funding, respectively.

The Life4HeatRecovery project funded under the LIFE programme receives an EU contribution of 3.3 mio EUR, see table 2.

DG Energy has also financed four tenders in the field of DHC that are as well described in the following.

2.1.1 Key Performance Indicators

Figures based on factsheets submitted by each project partner. Different methodologies were used for certain KPIs and all projects were not always concerned by each KPI: therefore, the average values do not necessarily represent the whole set of 69 projects featured in this document.



Call topic	Project ID	Project Acronym	Start date	End date	Total Budget (in EUR)	EU contribution (in EUR)	Replication potential[1]
H2020-LC-GD-2-1-2020	101037085	Bio-FlexGen	01/09/2021	31/08/2024	5,984,697.50	5,984,697.50	1*
H2020-EE-2017-RIA-IA	767799	COOL DH	01/10/2017	30/09/2022	5,291,186.25	3,958,349.10	3***
H2020-LCE-2015-3	691679	CoolHeating	01/01/2016	31/12/2018	1,644,340.00	1,644,340.00	N/A
H2020-LC-SC3-2019-RES-IA-CSA	857830	CROWDTHERMAL	01/09/2019	31/08/2022	2,305,801.25	2,305,801.25	4****
H2020-LC-SC3-2018-2020	893509	Decarb City Pipes 2050	01/07/2020	31/08/2023	1,894,032.50	1,894,032.50	4****
H2020-EE-13-2015	696009	E2District	01/02/2016	31/07/2019	1,999,849.50	1,999,849.50	N/A
H2020-LC-SC3-EE-2018	847121	EMB3RS	02/09/2019	01/09/2022	4,245,118.57	3,984,671.32	3***
H2020-LCE-2017-RES-RIA-TwoStage	763919	FLEXCHX	01/03/2018	20/02/2021	4,489,545.00	4,489,545.00	3***
H2020-EE-13-2014	649820	FLEXYNETS	01/07/2015	31/12/2018	1,999,363.75	1,999,363.75	4****
H2020-LCE-2016-RES-CCS-RIA	727583	GEOCOND	01/05/2017	31/10/2020	3,955,740.00	3,955,740.00	4****
H2020-LC-SC3-2018-RES-SingleStage	818242	GEOENVI	01/11/2018	30/04/2021	2,495,871.50	2,495,871.50	5*****
H2020-LC-SC3-2019-RES-TwoStages	851917	GeoHex	01/11/2019	31/10/2022	4,989,401.25	4,989,401.25	2**
H2020-LC-SC3-2018-RES	818232	GEORISK	01/10/2018	30/09/2021	2,184,118.38	2,184,118.38	5*****
H2020-EE-13-2015	695780	H-DisNet	01/06/2016	31/12/2019	2,699,895.00	2,009,697.50	N/A
H2020-EE-2015-3	695989	Heat Roadmap Europe	01/03/2016	28/02/2019	2,113,482.50	1,946,042.50	N/A
H2020-EEB-2016	723925	Heat4Cool	03/10/2016	02/10/2020	7,934,577.50	5,703,012.88	5*****
H2020-EE-2016-RIA-IA	723677	HotMaps	01/10/2016	30/09/2020	2,996,870.00	2,332,803.75	3***

[1] Replication potentials are classified according to this scale:
*5***** = market-ready solution can be implemented immediately*
*4**** = solution can be implemented in other replication sites in the very near future (max. 6 months after project end)*
*3*** stars = solution has high replication potential but needs further minor testing and/or technological modifications for other markets (max. 1 year after project end)*
*2** = solution may be implemented in other replication sites in the future with feasibility analysis/ technological modifications/further testing still necessary (max. 2 years after project end)*
1 = solution has replication potential but cannot be exploited in the near future*

H2020-LC-SC3-EE-2019	891775	HP4ALL	01/09/2020	28/02/2023	996,286.25	996,286.25	5*****
H2020-LC-GD-2-1-2020	101036656	HYPERGRYD	01/10/2021	31/03/2025	5,987,875	5,987,874.50	1*
H2020-EE-13-2015	696174	InDeal	01/06/2016	28/03/2019	1,992,726.25	1,992,726.25	N/A
H2020-LC-SC3-EE-2019	894800	INCUBIS	01/05/2020	30/04/2023	2,049,875.00	1,999,875.00	5*****
H2020-EE-13-2015	696098	INDIGO	01/03/2016	30/09/2020	2,792,766.56	2,229,321.25	3***
H2020-EE-2017-CSA-PPI	784966	KeepWarm	01/04/2018	30/09/2020	2,098,497.50	2,098,497.50	5*****
H2020-LCE-2017-SGS	774309	Magnitude	01/10/2017	31/03/2021	3,999,057.50	3,999,057.50	2**
H2020-LC-SC3-2018-ES-SCC	824441	MUSE GRIDS	01/11/2018	31/10/2022	7,430,784.50	5,877,577.26	4****
H2020-EE-13-2014	649796	OPTi	01/03/2015	30/04/2018	2,100,130.00	2,100,130.00	3***
H2020-LCE-2017-SGS	773839	PLANET	01/11/2017	31/01/2021	3,999,695.00	3,999,695.00	3***
H2020-EE-2016-RIA-IA	723757	PLANHEAT	01/10/2016	31/01/2020	2,977,212.50	2,977,212.50	3***
H2020-LCE-2017-RES-CCS-RIA	764706	PUMP-HEAT	01/09/2017	31/08/2021	5,904,426.25	5,904,426.25	3***
H2020-LC-SC3-EE-2019	892429	R-ACES	01/06/2020	30/11/2022	1,980,376.25	1,980,376.25	4****
H2020-LCE-2015-2	691739	REEEM	01/02/2016	31/07/2019	3,997,458.75	3,997,458.75	3***
H2020-EE-2017-RIA-IA	768567	RELaTED	01/11/2017	31/10/2021	4,755,475.00	3,943,251.26	5*****
H2020-LC-SC3-EE-2018	847087	REPLACE	01/11/2019	31/10/2022	1,999,878.75	1,999,878.75	3***
H2020-LC-GD-2-1-2020	101036766	RESTORE	01/10/2021	30/09/2025	5,667,736.25	5,667,736.25	2**
H2020-LC-SC3-2018-2019-2020	952873	RES-DHC	01/09/2020	31/08/2023	2,582,946.25	2,582,946.25	2**
H2020-EE-2017-RIA-IA	767429	ReUseHeat	01/10/2017	30/09/2022	4,894,330.46	3,998,061.38	3***
H2020-LC-SC3-2019-RES-IA-CSA	857811	REWARDHeat	01/10/2019	30/09/2023	19,023,298.75	14,999,481.63	4****
H2020-LCE-2015-3	691624	SDHp2m	01/01/2016	31/12/2018	1,919,297.75	2,087,297.25	N/A
H2020-LC-SC3-2018-Joint-Actions-3	825998	SecRHC-ETIP	01/12/2018	31/05/2022	984,200.00	984,200.00	5*****
H2020-EE-2015-2-RIA	695965	Sim4Blocks	01/04/2016	30/09/2020	5,523,043.75	3,729,055.76	3***
H2020-LCE-2016-SGS	731249	SMILE	01/05/2017	30/04/2021	14,074,383.81	12,106,046.95	3***
H2020-LC-SC3-EE-2018	847097	SO WHAT	01/09/2019	31/05/2022	4,195,357.50	3,397,497.38	4****
H2020 EE-13-2014	649743	STORM	01/03/2015	31/03/2019	1,972,125.94	1,972,125.94	N/A
H2020-EE-2017-RIA-IA	768936	TEMPO	01/10/2017	31/03/2022	3,691,657.75	3,130,868.43	3***

H2020-EE-2016-RIA-IA	723636	THERMOS	01/10/2016	31/03/2021	2,902,480.00	2,902,480.00	3***
H2020-EE-2017-CSA-PPI	785014	Upgrade DH	01/05/2018	30/09/2021	1,999,667.50	1,999,667.50	4****
H2020-LC-SC3-2019-RES-IA-CSA	857801	WEDISTRICT	01/10/2019	31/03/2023	19,146,753.48	14,972,852.64	4****
				TOTAL	**201 mio**	**180 mio**	

Table 1: Horizon 2020 Projects on District Heating and Cooling (excl. Smart City projects)

Call topic	Project ID	Project Acronym	Start date	End date	Total Budget (in EUR)	EU contribution (in EUR)	Replication potential[2]
LIFE Program - Call for proposals CLIMA 2017	LIFE17 CCM/IT/000085	Life4HeatRecovery	15/06/2018	14/06/2023	5,819,377.00	3,360,079.00	5*****

Table 2: DHC project funded under the LIFE Programme

[2] Replication potentials are classified according to this scale:
*5***** = market-ready solution can be implemented immediately*
*4**** = solution can be implemented in other replication sites in the very near future (max. 6 months after project end)*
*3*** stars = solution has high replication potential but needs further minor testing and/or technological modifications for other markets (max. 1 year after project end)*
*2** = solution may be implemented in other replication sites in the future with feasibility analysis/ technological modifications/further testing still necessary (max. 2 years after project end)*
1 = solution has replication potential but cannot be exploited in the near future*

Tender ID #	Name	Results expected	Replication potential[3]
#ENER/C2/2018-459	Celsius Initiative	September 2022	5*****
ENER/C1/2018-496	DHC TREND - Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive	June 2022	5*****
#ENER/C1/2018-495	Policy Support for Heating and Cooling Decarbonisation	June 2022	1*
#ENER/C1/2018-493	Renewable Cooling under the Revised Renewable Energy Directive	June 2022	5*****

Table 3: Tenders under European Commission's DG Energy

[3] Replication potentials are classified according to this scale:
*5***** = market-ready solution can be implemented immediately*
*4**** = solution can be implemented in other replication sites in the very near future (max. 6 months after project end)*
*3*** stars = solution has high replication potential but needs further minor testing and/or technological modifications for other markets (max. 1 year after project end)*
*2** = solution may be implemented in other replication sites in the future with feasibility analysis/ technological modifications/further testing still necessary (max. 2 years after project end)*
1 = solution has replication potential but cannot be exploited in the near future*

Call topic	Project ID	Project Acronym	Start date	End date	Total Budget (in EUR)	EU contribution (in EUR)	Replication potential[4]
H2020-LC-SC3-2019-ES-SCC	864374	ATELIER	01/11/2019	31/10/2024	21,895,040.11	19,607,835.58	3***
H2020-LC-SC3-2019-ES-SCC	864242	SPARCS	01/10/2019	30/09/2024	23,853,178.75	19,701,216.00	5*****
H2020-LC-SC3-2019-ES-SCC	864400	POCITYF	01/10/2019	30/09/2024	22,494,291.76	19,998,275.34	3***
H2020-LC-SC3-2018-ES-SCC	824418	MAKING-CITY	01/12/2018	30/11/2023	20,107,183.68	18,089,582.76	4****
H2020-LC-SC3-2018-ES-SCC	824260	+CityXChange	01/11/2018	31/10/2023	24,174,347.50	19,999,996.38	3***
H2020-SCC-2017	774094	STARDUST	01/10/2017	30/09/2022	20,988,954.18	17,939,998.85	5*****
H2020-SCC-2016-2017	774477	MAtchUP	01/10/2017	30/09/2022	19,435,801.88	17,418,339	2**
H2020-SCC-2016	731297	mySMARTLife	01/12/2016	30/11/2021	21,191,771.50	18,656,102.41	4****
H2020-SCC-2016	731198	RUGGEDISED	01/11/2016	31/10/2021	19,508,671.37	17,692,858.41	4****
H2020-SCC-2015	691883	SmartEnCity	01/02/2016	31/07/2021	31,874,538.52	27,890,138.75	5*****
H2020-SCC-2015	691735	REPLICATE	01/02/2016	31/01/2021	29,268,376.03	24,965,263.09	3***-5*****
H2020-SCC-2014	646511	REMOURBAN	01/01/2015	30/06/2020	24,754,878.10	21,541,949.13	4****
H2020-SCC-2014	646456	GrowSmarter	01/01/2015	31/12/2019	35,801,867.83	24,820,974.38	5*****
				TOTAL	**315 mio**	**268 mio**	

Table 4: Horizon 2020 Smart Cities and Communities Lighthouse Projects with DHC Solutions, sorted by call topic

[4] Replication potentials are classified according to this scale:
*5***** = market-ready solution can be implemented immediately*
*4**** = solution can be implemented in other replication sites in the very near future (max. 6 months after project end)*
*3*** stars = solution has high replication potential but needs further minor testing and/or technological modifications for other markets (max. 1 year after project end)*
*2** = solution may be implemented in other replication sites in the future with feasibility analysis/ technological modifications/further testing still necessary (max. 2 years after project end)*
1 = solution has replication potential but cannot be exploited in the near future*

Call topic	Project ID	Project Acronym	Start date	End date	Total Budget (in EUR)	EU contribution (in EUR)	Replication potential[5]
FP7-ENERGY-SMARTCITIES-2012	314441	CELSIUS	01/03/2013	31/03/2017	26,009,670.20	14,074,931	5*****
FP7-ENERGY-SMARTCITIES-2012	186981	PITAGORAS	01/11/2013	31/10/2017	9.145.179,13	5.871.454,67	4****
FP7-ENERGY-SMARTCITIES-2013	197826	READY	01/12/2014	30/11/2019	33,340,202.60	19,213,448.35	4****

Table 5: FP7 Smart Cities Projects focusing on DHC Solutions

[5] Replication potentials are classified according to this scale:
*5***** = market-ready solution can be implemented immediately*
*4**** = solution can be implemented in other replication sites in the very near future (max. 6 months after project end)*
*3*** stars = solution has high replication potential but needs further minor testing and/or technological modifications for other markets (max. 1 year after project end)*
*2** = solution may be implemented in other replication sites in the future with feasibility analysis/ technological modifications/further testing still necessary (max. 2 years after project end)*
1 = solution has replication potential but cannot be exploited in the near future*

In the following subchapters, all selected projects will be shortly presented with their main district heating and cooling solutions and innovations. For more details, discover the project fiches in the Annex.

2.2 Smart Cities & Communities Lighthouse Projects with District Heating & Cooling Solutions

The selected SCC projects include demonstration sites with district heating and cooling networks in their scope, most of them developing district energy networks with renewable sources and waste heat recuperation. It becomes apparent that most of the recent SCC projects (ATELIER, SPARCS, POCITY, MAKING-CITY) refer to the concept of Positive Energy Districts, meaning that in certain city districts the projects aim to generate more energy than will be consumed within the district boundaries. This goes beyond the concept of Positive Energy Blocks that has been used in SCC projects such as +CityXChange.

	SCC Project Summaries and their DHC Solutions
	ATELIER is a smart city project that demonstrate Positive Energy Districts (PED) within 8 European cities with sustainability and carbon neutrality as guiding ambitions. In the PED in Bilbao, an innovative, 5th generation, very Low Temperature District Heating and Cooling System will be installed, together with thermal energy storage, that will heat and cool the buildings in the area.
	CELSIUS promoted district heating and cooling (DHC) in European Cities. It developed innovative demonstrators for sustainable production, distribution and consumption of DHC, disseminated knowledge to a network of over 72 cities and contributed with position papers for policymakers at the European Commission.
	+CityxChange brings the two aspiring Lighthouse Cities Trondheim (NO) and Limerick (IE) together with their distinguished Follower Cities Alba Iulia (RO), Pisek (CZ), Võru (EST), Smolyan (BG) and Sestao (ES), to underline their ambition to achieve sustainable urban ecosystems that have zero emissions and establish a 100% renewable energy city-region by 2050; through the development of Positive Energy Blocks. While seven cities are part of the project, the Lighthouse City Trondheim, Norway, currently addresses the issue of district heating in their demonstrator.
	Within the GrowSmarter project, a technology that recovers surplus heat and integrate it into existing district heating (DH) networks to meet local heating demands by citizens in an urban environment. An innovative business model has been developed for a yet unexplored potential, where installation of plug and play

	heat pumps at the waste heat producer facilities the ability to recover the energy into the DH network.
Making City	MAKING-CITY is a large-scale demonstration project aiming at the development of new integrated strategies to address the urban energy system transformation towards low carbon cities, with the positive energy district (PED) approach as the core of the urban energy transition pathway. District heating and cooling networks help the energy exchange that makes a district positive.
MATCHUP	MAtchUP project aims to transform cities by deploying novel solutions and technologies, focusing on the energy, mobility and ICT sectors. The project also develops very rigorous upscaling and replication plans. Ultimately, the outcomes should lead to greener, more liveable and more efficient cities that are more attractive for citizens as well as businesses.
my SMART Life	mySMARTLife project aims at the development of an Urban Transformation Strategy to support cities in the definition of transition models, as a suitable path to reach high level of excellence in its development process, addressing the main city challenges and progressing to the smart people and smart economy concepts. The main instrument to achieve this very ambitious strategy will be the definition of the Advanced Urban Planning. Multiple DHC demonstrators are part of the project: in Nantes, the DHC system was optimised, while in Helsinki, the share of renewables in the existing heating grid was increased. In Hamburg district heating with high shares of hydrogen in the conventional gas network is tested.
PITAGORAS Sustainable urban planning with innovative and low energy thermal and power generation from residual and renewable sources	PITAGORAS project demonstrates the waste heat recovery at a steel foundry in Brescia. The Organic Rankine Cycle (ORC) system in demonstration has the potential to be replicated in other heat intensive industries allowing the recovery of the waste energy either by the industry itself or - if in the proximity of a city (here Brescia) - producing useful heat for the city heat network.
POCITYF	In the Smart City project POCITYF waste heat from the ice rink at Sportcomplex De Meent will be connected to heat buffer and to an heat/cold storage system Aquifer Thermal Energy Storage (ATES), which will be the source to a local, collective, low temperature transport grid for heat or cold supply to several customers in the vicinity of the ice rink.

READY	Based on thorough integrated climate planning the READY project demonstrates a Whole City Approach including the development and demo of new solutions for low-temperature district heating, components and management ICT systems and the development and demo of flexible combined grid balancing /energy storage solutions for buildings and RES systems including combined heat pumps for heating and cooling, electrical vehicles charging, new PVT systems and 2nd life reuse of EV batteries in buildings. The concept of the project was demonstrated in the cities of Aarhus (Denmark) and Växjö (Sweden).
REMO URBAN REgeneration MOdel for smart URBAN transformation	REMOURBAN (Regeneration Model for accelerating the Smart Urban Transformation) is a large-scale demonstration European project (Grant Agreement No 646511), the purpose of which is to accelerate the urban transformation towards the smart city concept taking into account all aspects of sustainability. In Nottingham, within the first a Zero Energy retrofitting project (Gold Standard) has been implemented with an energy centre testing fifth generation heat networks with ground source heat pumps fed by bore holes. The second (the Cours) include the retrofitting under a Silver Standard and deploying a Low Temperature District Heating using the return temperatures of a pre-existing heating network.
REPLICATE	In the REPLICATE project three different lighthouse cities implement innovative DHC solutions: In San Sebastian the District Heating (DH) provides a system for distributing heat for Domestic Hot Water and heating generated in a centralized location through a system of insulated pipes for the new residential area Txomin Enea in Donostia - San Sebastian. The DH is promoted and coordinated by Fomento San Sebastian. The heat is obtained burning biomass from local forests and with the support of two gas boilers for peak needs. The district heating scheme has been sized to meet the needs of 1500 dwellings of a district including the connection of new and 156 retrofitted houses. The Bristol district heating intervention is to enable the linking of two Energy Centres to provide lower carbon heat to the businesses and residents of the Redliffe Area of Bristol. The eventual operation of the network will be able to balance improvement between local air quality, carbon emissions and cost of the heat production. In Florence a micro district heating network equipped with a seasonal thermal storage connected to a solar thermal plant is implemented.

RUGGEDISED Designing smart, resilient cities for all	In the Smart City project RUGGEDISED, smart thermal grids are implemented in various ways, in Umeå (SE), Glasgow (UK) and Rotterdam (NL). The work covers everything from aquifer well deep underground in Rotterdam to contractual models for others to exploit. In Glasgow, the City has developed a business model that enables public sector buildings in Glasgow to sell excess-heat from/to one another and for private industry to sell heat to local customers. Umea has developed a full circle business model for their DHC grid to support the city in becoming CO_2 neutral.
SPARCS	SPARCS demonstrates and validates technically and socio-economically viable and replicable, innovative solutions for rolling out smart, integrated positive energy systems for the transition to a citizen centred zero carbon & resource efficient economy. Seven cities will demonstrate 100+ actions turning buildings, blocks, and districts into energy prosumers, creating VirtualPositiveEnergy communities as energy democratic playground (positive energy districts can exchange energy with energy entities located outside the district).
STARDUST	STARDUST serves as smart connector bringing together advanced European cities and citizens of Pamplona (ES), Tampere (FI) and Trento (IT) - with the associated follower cities of Cluj-Napola (RU), Derry (UK), Kozani (GR) and Litomerice (CZ). A partnership composed of public bodies and relevant industrial partners, supported by academia and research organisations, will demonstrate three lighthouse cities, deploy intelligent integration measures, test and validate technical solutions and innovative business models, and deliver blueprints for replication throughout Europe and abroad. In Tampere, a smart DHC system based on demand response is realised, while in Pamplona heat networks based on waste heat recovery (data centres, waste water) and biomass will be developed.
smart en. city	SmartEnCity's main objective is to develop a highly adaptable and replicable systemic approach for transforming European cities into sustainable, smart and resource-efficient urban environments. This is achieved though integrated urban demonstrators in three diverse EU cities. The district heating and district cooling solutions are already existing solutions in the market , the innovation of the project is achieved by the integration of these solutions with other ones like energy efficient retrofitting, mobility measures , ICT integration…

2.3 Low Temperature District Heating & Cooling

The tendency of the evolution of district heating so far has been towards lower distribution temperatures, reducing heat losses and allowing for the integration of sustainable heat sources. These systems operate at temperatures at or just above the limit set by domestic hot water temperature requirements, i.e. the network supply temperature is reduced down to approximately 50°C or even less. These systems are still novel and need further research activities, including innovative business models and regulatory frameworks. The development of low-temperature networks will promote a cost efficient and technically viable decarbonisation of the European DHC sector. There are currently six EU-funded projects focussing on these solutions.

	Low Temperature District Heating & Cooling Projects
COOL DH	The COOL DH project will innovate, demonstrate, evaluate and disseminate technological solutions needed to exploit and utilise sources of very low-grade waste heat for heating of energy efficient buildings via Low Temperature District Heating (LTDH) and show how the District Heating systems can be more resource efficient and more energy efficient.
FLEXYNETS	FLEXYNETS developed a new generation of intelligent district heating and cooling networks that work at "neutral" temperature levels. Reversible heat pumps are used to exchange heat with the DHC network. In this way, the same network can provide contemporary heating and cooling.
H-DisNet	The overarching objective of the project is to establish Hybrid District energy Networks (H-DisNet). The Innovative thermochemical (TC) network technology to be developed would contribute to next-generation district energy networks. The main innovation is the use of thermo-chemical carrier fluids (TCF) that allow loss-free storage and transport of energy potential. The technology will exploit high chemical potential of absorption processes for loss-free transport and storage of energy potential.
RELaTED	Within the RELaTED project, concepts and technologies for the reduction of temperature levels in district heating, with the integration of renewables at district and building scale are developed. Heat Pumps and Solar Systems are connected to the district heating at building scale through purpose-specific building substations. Industrial Waste Heat is integrated as energy source to the districts.
TEMPO	TEMPO demonstrates the applicability of low temperature district heating through a comprehensive solution package including technological innovations on the network and building side, consumer empowerment enabled by digital solutions and innovative business models for EU replication.
REWARDHeat	REWARDHeat will 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. REWARDHeat will promote punctual metering, thermal storage management, network smart control as means to enable and optimise the exploitation of renewable and waste

	heat in DHC networks. At the same time, this approach permits a change of paradigm with respect to the business models devised: thermal energy will not be seen as a commodity anymore, rather it will be sold as a service to the customers.

2.4 Renewables for District Heating & Cooling

District heating and cooling networks enable the integration of renewable sources, such as geothermal, solar thermal and biomass into the system. The projects funded on renewables for district heating and cooling, focus on the one hand on advancing geothermal technologies and their market uptake and on combining different renewable sources for a sustainable energy system.

	Renewables for District Heating and Cooling
	FLEXCHX presents an economical way to utilize combined heat and power plants and district heating networks as part of the future European energy system. Tri-generation of power, heat and intermediate product (FT wax) for the transport sector is used to address the challenge of the poor match between the availability of solar energy and the demand for heating. The vision is to realise a process for optimal use of the seasonal solar energy supply and available biomass resources and satisfy the seasonal demand for heat and power, and to produce low-GHG fuels for the transport sector.
	GEOCOND, with a unique consortium of Companies and leading Research Institutions in the area of shallow geothermal energy systems and materials, focuses on four key development areas in a synergetic and system-wide approach: development of new pipe materials, advanced grouting additives and concepts, advanced Phase Change Materials and system-wide simulation and optimization.
	GeoDH is an EU funded project that aims to accelerate the uptake of geothermal district heating systems in Europe GeoDH is a technologically mature solution with a significant market uptake. In order to support its full market deployment, tailored regulatory and financial conditions should be established and a series of barriers should be resolved (i.e. risk mitigation schemes, permission procedures etc.)
	GeoHex will develop advanced materials with anti-scaling and anti-corrosion properties for cost-efficient and enhanced heat exchange performance, allowing the energy of the earth to be harnessed more effectively in geothermal applications.
	GEORISK is an EU funded project that aims to accelerate the uptake of geothermal derisking schemes in Europe and in key third countries Geothermal risk mitigation schemes, or derisking, is a proven mean to support the market uptake of geothermal energy projects, mitigating the financial risk linked to the project.
	RESTORE develops a solution based on thermo-chemical energy storage (TCES) and organic Rankine cycle (ORC) technology. TCES allows the enormous amount of energy that is wasted to be stored and harnessed, and ORC technology adapts the energy provided by different renewable energy sources to feed the storage and supply systems. By combining TCES and ORC, the project will develop a solution that can tackle the main

	barriers to the wide deployment of renewable energy and waste heat in DHC.
W.E. DISTRICT Heating & cooling solutions	WEDISTRICT proposes solutions for the District Heating and Cooling decarbonisation with smart and local renewable sources. The wide range of proposed technologies, covering a broad set of potential RES and consumer combinations, enables a significant reduction in the dependency on fossil fuels almost in any district heating and cooling scenario.

2.5 Waste Heat Recuperation for District Heating & Cooling

Waste heat recuperation and use in heat networks is vital to decarbonise heating and cooling systems and make use of otherwise wasted thermal energy. Four H2020 projects and one LIFE-funded project are focusing on waste heat recuperation and use, two of them focusing on industrial waste heat (EMB3Rs and INCUBIS) and two on unconventional urban sources (ReUseHeat and Heat4Cool). Interestingly, besides the technical innovations, the projects also deal with business models, market uptake measures and supporting stakeholders, especially waste heat owners, in bringing projects to live, which is a key barrier for waste heat recuperation projects. The LIFE-funded project LIFE4HeatRecovery deals with waste heat recovery for low-temperature district heating & cooling networks. The replication potential in other European cities is high, given that it is meant to be a plug and play solution.

	Waste Heat Recuperation for District Heating & Cooling
	ReUseHeat intends to overcome both technical and non technical barriers towards the unlocking of urban waste heat recovery investments across Europe. The project aims to reduce the need for primary energy and reduce emissions of greenhouse gases. Attention is also given to urban waste heat potential (mapping the low temperature heat sources in EU27 and assessing the implications in the energy systems from using them at national and city level) and to the business models linked to the solutions. Risks, contracts, business models and stakeholder perceptions are captured within the project's scope.
	Heat4Cool develops, integrates and demonstrates easy to install and highly energy efficient heating and cooling solutions at building and district scale, including solar PV, electrically and thermally driven heat pumps, modular PCM thermal storages, and self-adaptive building energy management. The different retrofit solutions at building scale are demonstrated in Valencia, Chorzow and Sofia, whereas district power-to-heat/cool complemented by energy recovery from sewage water is demonstrated in Budapest.
	EMB3Rs develops an excess Heat/Cold (re)use matching platform for industry and end users. A novel tool will allow energy-intensive industries and other excess heat and cold (HC) sources to explore ways of reusing their excess thermal energy. This will improve their energy performance and contribute to a healthier environment for everyone. Users, like industries that produce excess heat, will provide the essential parameters, such as their location and the available excess thermal energy. The EMB3Rs platform will then autonomously and intuitively assess the feasibility of new business scenarios and identify the technical solutions.
	Energy Symbiosis is the capture of excess heat/cold produced by industrial activities and its utilization as a source of energy (thermal or electrical) for other industrial and/or urban activities. INCUBIS will unlock the potential of Energy Symbiosis in Europe

	by deploying a consultancy service specialized in incubating Energy Symbiosis projects. This is achieved by supporting key stakeholders throughout the project´s life cycle and by building their capacity to overcome non-technical barriers and see projects through to their completion.
LIFE 4 HEAT RECOVERY	The projects aims to recover low temperature waste heat sources and integrate them in a new generation of smart district heating and cooling networks and redistribute heating & cooling to the customers with the use of heat pump powered substations. prefabricated skids will be developed to become “Plug & Play” solutions. LIFE4HeatRecovery will demonstrate the concept with four district heating and cooling pilot networks.

2.6 Heat Pumps for District Heating & Cooling

Large heat pumps are a vital part of many district heating and cooling networks, e.g. for waste heat recovery and low temperature networks. Heat pump technology developments are therefore an integral part of many projects that are described in this brochure. They are also a means to couple the thermal and the power sector. Two projects in particular focus on heat pump technology developments only: PUMP-HEAT and HP4ALL.

	Energy System Integration with District Heating & Cooling
	PUMP-HEAT integrates heat pumps, thermal energy storage and advanced controls to take advantage of the unexploited flexibility in power plants, in particular those in co-generative layout, with high temperature heat that can be taken up in DHC networks. PUMP-HEAT will allow to tap into existing flexibility opportunities in power plants, acting as technology enabler for further renewable penetration, with solutions applicable both to existing and new gas turbine combined cycles.
	HP4ALL will enhance, develop and promote the skills required for high quality, optimised Heat Pump installations within residential/non-residential buildings bringing Europe to the forefront of the climatization sector. In some demonstrators, the project will have a specific focus on larger HP solutions which could include district heating and cooling and networks of buildings.

2.7 Digitalisation of District Heating & Cooling Networks and Smart Energy System Integration

Digital technologies are believed to make the whole energy system smarter, more efficient, and reliable and to boost the integration of more renewables into the system. In the future, digital energy systems will enable district energy systems to fully optimise their plant and network operation while empowering the end consumer. All ten projects deal with the smart connection and/or optimisation of different energy networks, namely electricity, gas, heating and cooling.

Energy system integration is a concept where various energy carriers and storage solutions are linked with each other and with the end-use sectors for a robust, reliable, efficient energy system. This includes local carriers and storage solutions (heating, cooling, and local transport) as well as cross-border infrastructures (e.g. electricity, gas and transport). When taking the whole energy system into account, thermal networks can enable more flexibility and storage capacity in a future energy system. The roll-out of existing technologies and solutions; such as thermal storage, heat pumps and district heating and cooling (DHC); can play an important role in the wider energy transition, linking together parts of the system that have traditionally been isolated from each other.

	Digitalisation of District Heating & Cooling Networks and Smart Energy System Integration
Bio-FlexGen	Bio-FlexGen increases the efficiency and flexibility of renewable energy-based combined heat and power. A unique combination of gasification and gas turbine technology allows the plant to utilise hydrogen for fast dispatch and biomass for low operating costs over time. The project proposes the use of two renewable energy sources: green hydrogen from variable renewables and biomass. The results will play a key role in the integration and decarbonisation of the energy system.
E2District Community Energy, Optimisation & Control	E2District aims to develop, deploy, and demonstrate a novel cloud enabled management framework for district heating and cooling (DHC) systems. This would be done by developing a District Simulation Platform to optimise DHC asset configuration, development of intelligent adaptive DHC control and optimisation methods including flexible production, storage and demand assets, and system-level fault detection and diagnostics, development of behaviour analytics and prosumer engagement tools to keep the end user in the loop.
HYPERGRYD	HYPERGRYD develops a set of replicable and scalable cost-effective technical solutions for thermal grids allowing the integration of renewable energy sources and their coupling with electrical grids. The project demonstrates that smart energy networks are the future of efficient energy management in district heating and cooling (DHC) in synergy with the electrical grids in local energy communities/smart cities. The project’s solutions are tested across four live-in-labs cases in three representative climates.

The InDeal project aims at improving the efficiency of district heating and cooling networks by improving analysis of heating and cooling demand, fore and now casting weather prediction, development of innovative insulation material for pipes and means to actively involve the end consumers.

INDIGO contributes to the developments of a more efficient, intelligent and cheaper generation of district cooling (DC) systems by improving system planning, control, and management at all system levels. This is achieved through the development of two open-source tools for planning and simulation, and the design of a ground-breaking DC system management strategy.

The MAGNITUDE project brings flexibility provided by multi energy carrier integration to a new MAGNITUDE. MAGNITUDE addresses the challenge to rise flexibility in electricity systems, by increasing the synergies between electricity, heating/cooling and gas networks and associated systems. The project brings technical solutions, market design and business models, to be integrated on ongoing policy discussions.

MUSE GRIDS aims to demonstrate, in two weakly connected areas (a town on a top of a hill in Italy, Osimo and a rural neighbourhood in Belgium, Oud Heverlee), a set of both technological and non-technological solutions targeting the interaction of local energy grids (electricity grids, district heating and cooling networks, water networks, gas grids, electrical mobility etc.) to enable maximization of local energy independency through optimized management of the production via end user driven control strategies, smart grid functionality, storage, CHP and RES integration.

OPTi has developed a methodology for efficient engineering of a Digital Twin of a DHC system for demand forecasting, predictive optimization of production and thermal comfort assessment of consumers.

The PLANET project aims to deliver a holistic and integrated ICT framework, the PLANET Decision Support System (DSS), that will incorporate models of electricity, gas and district heating networks in a joint exploration framework in order to properly account for all their interconnection aspects and specificities. The project investigate the possible economic impact of conversion/storage technology mass scale deployment (such as Power to Gas - P2G, Power to Heat – P2H, etc.), new business opportunities and models in electricity, natural gas and district heating markets as well as the necessary adaptations of the regulatory and standardization landscape to facilitate technology adoption.

Sim4Blocks	Sim4Blocks develops Demand Response and Demand Side management at three pilot sites in Germany, Spain and Switzerland, in Germany and Switzerland in the context of decentral heat pumps combined with cold district heating grids. The aim is to raise the energy flexibility of blocks of buildings to increase the utilisation of fluctuating renewable energy sources. This is archived by advanced prediction driven energy management systems (model based building demand calculation, model predictive control (MPC) and data driven approaches) as well as by measures to increase the user engagement and awareness in energy use at home by enabling energy cost savings for end users (e.g. by app based notifications).
SMILE	The overall scope of SMILE project is to demonstrate, in real-life operational conditions a set of both technological and non-technological solutions adapted to local circumstances targeting distribution grids to enable demand response schemes, smart grid functionalities, storage and energy system integration. In the Samsø demonstrator, special attention has been paid on the business and socioeconomic assessment of introducing heat pumps with heat storage in district heating systems.
SoWHat	SO WHAT's main objective is to develop and demonstrate an integrated software which will support industries and energy utilities in selecting, simulating and comparing alternative Waste Heat and Waste Cold (WH/C) exploitation technologies that could cost-effectively balance the local forecasted H&C demand also via renewable energy sources (RES) integration, including the surrounding communities.
STORM DISTRICT ENERGY CONTROLLER	The STORM project developed, demonstrate and deploy an advanced self-learning controller for district heating and cooling (DHC) networks. The controller has been demonstrated in two sites: Mijnwater in Heerlen (the Netherlands) and Växjö (Sweden).

2.8 Heat Planning Studies and Tools

Local authorities, in both cities and regions, use regional urban planning methodologies to analyse their future energy needs and decide on projects. Adequate data on heat demand and supply as well as reliable models to analyse future scenarios are needed in order to make this happen. Until now, there were no free and open-source tools available to realise the heating and cooling mapping and planning. Therefore, the European Commission co-funded three projects that developed planning tools and toolboxes for local authorities to support them with energy master planning, focussing on heating and cooling. In addition, in the framework of the REEEM project, a study on the expansion potential and decarbonisation of DHC schemes in three cities was carried out.

	Heat Planning Studies and Tools
HOTMAPS	Hotmaps developed, demonstrated and disseminated an open-source toolbox to support public authorities, energy agencies and planners in strategic heating and cooling planning on local, regional and national levels, and in-line with EU policies.
PLANHEAT	The PLANHEAT project developed the PLANHEAT Open Source tool, which is a Q-GIS plug-in. It is composed of three modules: mapping, planning and simulation of heating and cooling scenarios. In order to be operated by as many cities as possible in the EU (in accordance to the different level of availability of data), two parallel approaches have been designed: a bottom-up one (district) and a top-down one (city). Part of the PLANHEAT tool is also a district heating and cooling route optimiser to facilitate the planning of heat networks.
THERMOS	THERMOS developed a web-based software designed to optimise local district energy network planning processes and support sustainable energy master planning. In offering instant high-resolution address-level mapping, built-in energy demand estimations and network optimisation online, the software provides the methods, data, and tools to enable public authorities and other stakeholders to undertake more sophisticated thermal energy system planning far more rapidly and cheaply.
REEEM	In the framework of the REEEM project, a study of the expansion potential of DH systems in Kaunas municipality, Warsaw municipality and Helsinki region through to 2030 and 2050, through optimization modelling tools, was realised.

2.9 Support Activities for District Heating & Cooling

Besides Innovation Actions (IA) and Research & Innovation Actions (RIA), the European Commission also funds Cooperation & Support Actions (CSA) which encompass primarily accompanying measures such as standardisation, awareness-raising and communication, market uptake measures or policy dialogues. In the framework of district heating and cooling, currently nine projects are and have been active in this area. Heat Roadmap Europe provides new capacity and skills for lead-users in the heating and cooling sector through the PAN European thermal atlas and a comprehensive study on how to decarbonise the heating and cooling sector. Both KeepWarm and Upgrade DH support the retrofitting of DHC networks, and GEOENVI and CROWDTHERMAL work on support measures for geothermal energy. The European Technology and Innovation Platform on Renewable Heating and Cooling is active in defining and implementing innovation strategies, with workstreams focussing on district heating and cooling. R-ACES deals with eco-regions and their locally available energy sources, including waste heat and cold recuperation. The REPLACE project aims to carry out targeted campaigns to replace inefficient and fossil fuel based heating systems and CoolHeating supported knowledge transfer for market uptake of small-scale DHC systems. RES-DHC and Decarb City Pipes 2050 focus on decarbonising existing networks, at regional and city scale, respectively.

	Support Activities for District Heating and Cooling
CoolHeating.eu	The objective of CoolHeating is to support the implementation of small modular renewable district heating and cooling grids for communities in South-Eastern Europe. The objective of the project is achieved through knowledge transfer and mutual activities of partners in countries where renewable district heating and cooling examples exist (Austria, Denmark, Germany) and in countries which have less development (Croatia, Slovenia, Macedonia, Serbia, Bosnia-Herzegovina).
CROWDTHERMAL	CROWDTHERMAL empowers citizens and local communities to participate in the development of geothermal projects with the help of alternative financing schemes (crowdfunding) and social engagement tools. In order to support the participation in geothermal projects, CROWDTHERMAL is analysing the perception of geothermal energy and will develop a public engagement approach making extensive use of social media. In addition, CROWDTHERMAL will formulate new financial models for crowdsourcing, promoting alternative financing of geothermal projects in close collaboration with existing structures and conventional players.
DECARB CITY PIPES 2050	Decarb City Pipes 2050 showcases how local authorities can build up capacity to meet the challenge of phasing out fossil fuels for heating and cooling till 2050 the latest. Six cities – Bilbao, Dublin, Munich, Rotterdam, Vienna and Winterthur join forces to learn from each other, explore pathways and options suitable for their local challenges and build up skills and internal know-how regarding process and transition management.
GEOENVI	The GEOENVI project engages with all geothermal stakeholders to ensure the exchange of best practices and the test of

	harmonized methods in selected areas and then, to facilitate its replication across Europe. One of the main results of the project is the development of a simplified Life Cycle Assessment methodology, which can calculate the environmental impacts and benefits of geothermal projects within one day only.
Heat Roadmap Europe 2050 A low-carbon heating and cooling strategy	The overall objective of the project is to provide new capacity and skills for lead-users in the heating and cooling sector, including policymakers, industry, and researchers at local, national, and EU level, by developing the data, tools, methodologies, and results necessary to quantify the impact of implementing more energy efficiency measures on both the demand and supply side of the sector. Building on the results of former studies (including the IEE supported STRATEGO project) this project will refine an already existing pan European thermal atlas and will among other things include the industrial sector in the calculations. In addition the project foresees to undertake comprehensive study of the heating and cooling sectors in the 14 largest EU countries. HRE4 plans to cover the 14 countries in the EU ranked largest by heat demand covering around 85-90% of the heating and cooling demands in Europe BE, CZ, DE, ES, FR, IT, HU, NL, AT, PL, RO, FI, Sweden SE and UK.
KeepWarm Renewing district heating	KeepWarm supports the modernisation of District Heating Systems (DHS) in Central and Eastern Europe and the reduction of greenhouse gas emissions by improving system operations and promoting a switch to less-polluting sources, like renewables. The project partners strive to ensure that best practices for environmental-friendlier heating and cooling will be taken up across Europe, replicating KeepWarm's approach in other countries and regions, even beyond the end of the project.
R-ACES Energy Cooperation Platform	Creation of ecoregions where multiple stakeholders engage in energy cooperation by exchanging heat/cold streams, investing together in renewable energy solutions, or managing energy streams through smart energy management platforms for reducing CO2 emissions by at least 10%.
replace	With over 80 million inefficient heating & cooling (HC) systems still installed across Europe, motivating consumers to replace those units with more efficient, greener alternatives will be key for a decarbonised Energy Union fuelled by renewable energy. REPLACE therefore aims to improve coordination in local networks to implement replacement campaigns targeting households in ten target regions by means of action plans fortified with policy and business-related improvements.
RES DHC	RES-DHC will develop the solutions and instruments needed to implement the EU Renewable Energy Directive II (2018/2001), which requires a yearly increase of RES in DHC by 1%. The aim is to transform existing DHC systems into a high share of RES-DHC technologies. The project will assist in the transformation of existing systems in six countries: Germany, Austria, Italy, Poland, France and Switzerland.

RHC Renewable Heating & Cooling European Technology and Innovation Platform	SecRHC ETIP supports the work of the European Technology and Innovation Platform on Renewable Heating and Cooling since 2011. The role of the secretariat is to assist the stakeholders of the RHC-ETIP in coordinating activities related to the definition and implementation of an innovation strategy to increase the use of renewable energy sources for heating and cooling, and to foster the growth and the market uptake of the relevant industries. The RHC Platform encompasses a Horizontal Working Group on Districts for 100% Renewable Heating & Cooling as well as a Technology Panel focussing on District Heating and Cooling.
SDH solar district heating **SDHp2m**	The project aims at developing and implementing advanced policies and support measures for the use of large-scale solar thermal plants combined with other RES in district heating and cooling systems. By involving 9 EU regions, the project aims at a direct mobilization of investments in Solar District Heating and a significant market rollout due to an improved policy, regulation and financing framework backed with embedded efficient market support and capacity building measures.
upgrade DH	The overall objective of the Upgrade DH project is to improve the performance of inefficient district heating networks in Europe by supporting selected demonstration cases for upgrading, which can be replicated in Europe.

2.10 Tenders

Similarly to other support activities, the European Commission DG Energy offers public procurement procedures in the form of tenders to generate offers from companies competing for service and support contracts. The following tenders have been offered to analyse, assess and support DHC markets across Europe.

	Tenders on District Heating & Cooling
Celsius Initiative	The Celsius Initiative supports cities in their endeavour to plan and deploy modern and efficient DHC systems or extend and refurbish existing ones to higher standards, allowing greater uptake of renewables, recovering of excess heat or cold while improving the overall efficiency of the systems. Using the tools and expertise already developed and available, the goal is to improve market uptake of DHC solutions.
DHC TREND	DHC TREND is a study analysing DHC markets and regulatory frameworks across Europe and providing operational guidelines for the implementation of renewable energy and waste energy sources in DHC networks. The various topics and best practices are illustrated by more than 20 case studies selected over the continent.
Renewable Cooling under the Revised Renewable Energy Directive	In order for EU member states to count renewable cooling according to the renewable energy directive II, a methodology for calculating renewable energy utilized for cooling and district cooling is developed and its impact is assessed. In order to substantiate this step, a thorough analysis of cooling technologies and current cooling consumption is being done.
Policy Support for Heating and Cooling Decarbonisation	The Policy Support for Heating and Cooling Decarbonisation tender aims to develop a roadmap that will illustrate the various decarbonsation routes that can be taken to decarbonise H&C systems, across different sectors and different local circumstances. It will identify different types of barriers that prevent or hinder the decarbonisation of the H&C system and come up with measures to overcome these barriers.

3 Annex: Project Fiches[6]

The following Annex gathers all projects that have been included in the previous chapters of this brochure. The projects are presented in the form of "project fiches", which gather all the relevant information in order to replicate the developed solutions.

The fiches also include the replication potential categorization (see also 2.1 Overview), which is classified according to this scheme:

*5***** = market-ready solution can be implemented immediately*
*4**** = solution can be implemented in other replication sites in the very near future (max. 6 months after project end)*
*3*** stars = solution has high replication potential but needs further minor testing and/or technological modifications for other markets (max. 1 year after project end)*
*2** = solution may be implemented in other replication sites in the future with feasibility analysis/ technological modifications/further testing still necessary (max. 2 years after project end)*
1 = solution has replication potential but cannot be exploited in the near future*

Some projects are presented in a shortened form of the project fiche and do not include all information; this is due to the fact that some projects have already been finalised at the time of the creation of the brochure. The information has been taken from the 2016 "Overview of support activities and projects of the European Commission on energy efficiency and renewable energy in the heating and cooling sector".

[6] The project information has been provided by the respective projects themselves and has been edited by the author.

3.1 ATELIER

Project name	ATELIER
Call identifier	H2020-LC-SC3-2019-ES-SCC
Type of action	Innovation Action (IA)
Project logo	atelier Positive Energy Districts
Project website	https://smartcity-atelier.eu
Amount of EU funding (in EUR)	19,607,835
Other public or private project funding sources (if applicable)	Estimation of 150 million additional investments related to Positive Energy Districts in the 2 Lighthouse Cities
Replication/implementation potential	3***
What is it?	ATELIER is a smart city project that demonstrate Positive Energy Districts within 8 European cities with sustainability and carbon neutrality as guiding ambitions
When can I use it?	ATELIER will showcase different innovative solutions that integrate buildings with smart mobility and energy technologies to create a surplus of energy and balance the local energy system.
Where can I use it?	Variety of applied / tested innovative solutions can be used in a broad range – no explicit restrictions, but logically adaptation needed to local conditions (technical, financial, legal, social).
Why should I use it?	The fundamental objectives underlying the ATELIER project require that realised energy systems should be sustainable, secure and affordable for all citizens. The PEDs support these objectives and improve the quality of the urban surroundings of citizens living in and using the district, but also through smart systems contributing to the security and affordability of the system as a whole. ATELIER will demonstrate PEDs in Lighthouse cities through the use of renewable energy, storage, and digitalisation, including integration of electro- mobility for future storage and balancing capacity. The demonstrated PEDs in Amsterdam and Bilbao will generate a total surplus of primary energy of 1340 MWh annually. Both new-build and refurbished buildings have applied highly energy efficient materials in their façades (optimal insulation), glazing (triple windows) and green roofs, that ultimately will meet energy performance levels and go beyond the existing building codes. In each Lighthouse and Fellow city, a bold City Vision 2050 is developed by city authorities and relevant stakeholders that guides city-wide deployment of Positive Energy Districts by 2050.
Project size	ATELIER is implemented in 8 lighthouse cities from all over Europe.
Summary	Amsterdam and Bilbao are the Lighthouse cities to realise their PEDs. Together with district users, ATELIER will showcase innovative solutions that integrate buildings with smart mobility and energy technologies to create a surplus of energy and balance the local energy system. Bratislava, Budapest, Copenhagen, Krakow, Matosinhos, and Riga are

	the Fellow cities that will replicate and adapt successful solutions. All cities will establish a local PED Innovation Atelier to co-produce locally embedded, smart urban solutions. In the ateliers, the local innovation ecosystem (authorities, industries, knowledge institutes, citizens) is strengthened, enhancing embeddedness and removing any obstacles (legal, financial, social, etc.) for implementation of the smart solutions. The Innovation Ateliers are designed to be self-sustaining and to live on after the project has ended. The ateliers are engines for upscaling solutions within the ATELIER-cities and replication to other EU-cities. ATELIER integrates a high degree of citizen engagement throughout the project, by actively involving local residents (>9000), local initiatives, and energy communities in activities to align technical solutions with citizens' objectives and behaviour. Each of the cities will develop a City Vision 2050 that creates the roadmap for upscaling the solutions in the long term. ATELIER has the ambition to pave the way for "energy positive cities" in Europe. All ATELIER activities will be monitored (socially and technically), and lessons learned are systematically drawn and disseminated to relevant SET- plan groups, city networks, and innovation forums.
Project details	In Amsterdam the PED will deliver an energy surplus of 249 MWh (primary energy) that saves 1.2 kton CO2. In Bilbao these figures are 1091 MWh and 0.5 kton CO2 emission, respectively. Amsterdam and Bilbao are both transforming former industrial neighbourhoods into low-carbon, smart, Positive Energy Districts with mixed uses. In these districts new energy efficient buildings are being built, old buildings are being retrofitted, a high share of RES generating solutions are installed and smart technology is deployed for optimising local energy balance and sharing between different users. In Amsterdam far-reaching smart urban solutions are facilitated through a special derogation from Dutch energy laws, exempting the PED from a number of potential legal obstacles that could otherwise hamper or even forbid the development of an innovative efficient energy system. This derogation enables those to whom it is granted to experiment with highly innovative solutions, such as the 'Local Energy Market Platform', that enables energy communities to efficiently exchange electricity and balance the local energy system. In the PED in Bilbao, an innovative, 5th generation, Very Low Temperature District Heating and Cooling System will be installed, together with thermal energy storage, that will heat and cool the buildings in the area. The Lighthouse and Fellow cities develop a Bold City Vision for 2050, which includes a pathway for full decarbonisation of the city's energy system in 2050, promotes further alignment or even integration of different planning mechanisms (energy, mobility and urban planning) and integrates relevant urban, technical, social, financial, and legal perspectives. The Smart City Planning Group in each participating city develops the Bold City Vision in which all relevant stakeholders are

	cooperating. Making a City Vision also entails developing a common methodological framework for an integrated City Vision approach. The process is organised in such a way that the City Vision further guides the City representatives from planning towards implementation of the City Vision and replication and scaling up of successful solutions. 4. PED Innovation Ateliers are established in the Lighthouse and Fellow cities in which the local innovation ecosystem cooperates to support the tailoring and implementation of smart urban solutions and interventions. These Ateliers are set up and organised in such a way that they can continue their work after the project's lifetime for the further upscaling and replication of the solutions. Furthermore, the concept of the PED Innovation Atelier is developed and demonstrated to be replicable to other cities. In the PED Innovation Ateliers knowledge and policy co-creation sessions are organised along four tracks: Track i:Integrated smart energy systems and electro-mobility Track ii: Governance, integrated planning and law Track iii: New financial instruments Track iv: Data, privacy and data platforms
Demonstrator site description	In Bilbao, the following smart urban solutions will be deployed to create the Positive Energy District in Zorrotzaurre: Buildings will be equipped with smart meters in connection to integrated Smart Energy Management Systems, optimising control of demand, storage and generation of renewable thermal energy and electricity. All buildings are connected to an innovative, 5th generation low temperature network, which supplies zero emission thermal energy for heating and cooling demand. The thermal network system is further equipped with seasonal thermal energy storage capacity.
How can cities use the technology?	N/A
Environmental impact	Generate an energy surplus of 1340 MWh of primary energy and prevent 1.7 kt of CO2
Project coordinator's contact details	City of Amsterdam - ATELIER.EU@amsterdam.nl Project coordinator : f.verspeek@amsterdam.nl
Contact information for demo site or specific solutions	City of Amsterdam demo-site contact: rudy.rooth@amsterdam.nl City of Bilbao demo-site contact: jguardo@bilbao.eus

3.2 Bio-FlexGen

Project name	Bio-FlexGen
Call identifier	H2020-LC-GD-2-1-2020
Type of action	Research and Innovation Action (RIA)
Project logo	Bio-FlexGen
Project website	https://bioflexgen.eu/
Amount of funding from EU	EUR 5 984 697.50
Other public or private project funding sources	NA
Replication/implementation potential	3***
What is it?	Bio-FlexGen will develop Phoenix Biopower's Biomass-fired Top Cycle (BTC) to increase the efficiency and flexibility of renewable energy-based combined heat and power combined with flexible production of green H2 and CO2, playing a key role in energy system integration, and making a significant contribution to the decarbonisation of the energy system and industry.
When can I use it?	2030, TRL3
Where can I use it?	The BTC can preferably be used in energy systems where there is demand for flexible power and heat, and biomass or biomass waste is available. This includes cities, municipalities and industrial areas. In a certain design it can even produce hydrogen which adds to the flexibility.
Why should I use it?	The BTC is flexible and efficient. It aims at a future energy system where fuels are expensive and intermittent power constitutes a substantial part of the total power production. This calls for efficient and flexible CHP.
Project size	N/A, technology is in pre-sales phase.
Summary	Climate change is the most significant challenge for humanity today. For this reason, fossil fuels must be replaced utilising renewables, improved energy efficiency and more flexible energy systems. An optimal combination of several renewable sources is needed to satisfy human energy needs. Bioenergy, in combination with hydrogen, can take the role as secure and plannable source for power and heat complementing intermittent renewable sources such as wind and sun. BIO-FlexGen will increase the efficiency and flexibility of renewable energy-based combined heat and power (CHP), playing a key role in energy system integration, and make a significant contribution to the decarbonisation of the energy system. In particular, to overcome these challenges, Bio-FlexGen brings to the table a unique combination of gasification and gas turbine technology that allows the plant to utilise hydrogen for fast dispatch and biomass for low operating costs over time. Due to the high efficiency, three times more

	power can be generated from biomass for the same heat load, and the plant can quickly achieve full load by starting and operating on 100% hydrogen. To meet fluctuations in seasonal demands and prices, a variant of the plant can provide climate-positive hydrogen production during long periods of low electricity prices or heat demand. To do so, Bio-FlexGen consortium gathers the necessary experience, knowledge and resources through a multistakeholder approach that covers the whole value chain of the project. It consists of a multidisciplinary team of 14 entities from 5 different EU countries (Spain, Finland, Sweden, Germany, Hungary), among which, 4 universities, 2 RTD organisations, 1 NGO, and 4 SMEs to ensure market exploitation (2 industrial companies and 1 District heat company).
Project details	The BTC technology will be developed regarding high-pressure oxygen-blown gasification in hybrid fluidised-bed gasification for renewable H2 production, and, in addition, H2 combustion technology for power production. The performance of the BTC will studied in different operation modes in order to ensure correct input data to the energy system models. Four operation modes of the BTC technology will be examined: 1. High Efficiency Bio-CHP, 2. Fast response H2-fired Electricity, 3. Hydrogen production, 4. Hydrogen and Power Production. The integration of the BTC in certain energy systems will be modelled.
Demonstrator site description	A scaled demonstration unit is to be erected at a closed down coal-fired power plant at KTH Campus in central Stockholm, Sweden. The demonstration unit will have a fuel capacity of up to 500 kW and will demonstrate both air-blown and oxygen-blown operation. The gasifier will also be integrated with an atmospheric combustion rig currently installed at the site. The demonstration unit will feature the new HFB hybrid fluidized bed gasifier designed for high pressure gasification (+20 Bar) with dual bed particles and turbulent fludization. Reformation of tars from produced syngas will also be demonstrated at pressure. The full scale BTC technology will be demonstrated at a 25 Mwe CHP plant with planned commissioning in 2028-2029. The plant will utilize forest residues as fuel and provide plannable power and renewable district heating.
How can cities use the technology?	One of the outcomes of Bio-FlexGen is the performance of the BTC in use cases, which include cities. Depending on the cities' demand for heat and power, the BTC can prove an important supplier to meed the needs for power 24/7/365 in an energy system with large share of intermittent production. Providing stable renewable power supply all year round at competitive prices will be key to the cities of the future to maintain, and attract new, industries and jobs.

Environmental impact	The BTC is up to twice as efficient as conventional CHP as for power production, which implies less emitted CO_2 per MWh of power. The BTC may even out intermittent power production and thus allow for a larger fraction of wind and solar in the system.
Project coordinator's contact details	Susanne.paulrud@ri.se
Contact information for demo site or specific solutions	Michael Bartlett <michael.bartlett@phoenixbiopower.com>

3.3 CELSIUS

Project name	**CELSIUS**
Call identifier	FP7-ENERGY-SMARTCITIES-2012
Type of action	CP - Collaborative project
Project logo	celsius smart cities
Project website	https://project.celsiuscity.eu/
Amount of EU funding (in EUR)	14,000,000
Other public or private project funding sources	Co-funded by the 20 partner organisations
Replication/implementation potential	3***
What is it?	CELSIUS promoted district heating and cooling (DHC) in European Cities. It developed innovative demonstrators for sustainable production, distribution and consumption of DHC, disseminated knowledge to a network of over 72 cities and contributed with position papers for policymakers at the European Commission.
When can I use it?	At the centre of the project were 30 demonstrators, 20 existing ones and 10 which were built during the project. Many of the existing solutions are commonly used and easily replicated. Of the demonstrators built during the project, some are being replicated by other projects, for example recuperating waste heat from the London underground is being replicated by the ReUseHeat project. Others have high replicability potential but have not yet been replicated, for example connecting the stenaLine ferry to the local district heating network in Gothenburg while it is docked. An lastly, some were not as successful as it was originally expected.
Where can I use it?	The CELSIUS Project demonstrators provide tested energy efficiency solutions for the production, distribution and consumption of heating and cooling, particularly in densely populated urban areas favorable for district heating. The diversity of the CELSIUS demonstrators provides a wide range of possible solutions. Some will be more relevant for cities with heavy industry in the vicinity, others with underground metro systems and others for cities with energy storage problems, for example. People living in London's Islington Borough, Rotterdam, Cologne, Genoa and Gothenburg have been benefitting from the installation of these demonstrators since at least 2015.
Why should I use it?	These DHC solutions provide sustainable and energy efficient heating and cooling solutions. It allows cities to reduce their dependency on fossil fuels and energy poverty. Many of these solutions facilitate the use of secondary energy sources making the energy system more robust and less polluting.
Project size	The project partners were spread across the following five countries: United Kingdom, The Netherlands, Germany, Italy

	and Sweden. The dissemination and outreach efforts engaged 72 cities from across Europe, representing about 30 million citizens.
Summary	Based on the premise that cities and districts are in a position to take the lead in the energy transition, the European Project CELSIUS, funded under the 7th Framework Programme assembled a network of 72 cities and 68 City Supporters between 2014 and 2017. They joined the project partners (20 organisations from public, private and research institutions) to help cities plan, develop and optimise their district heating and cooling networks. The Project partners gathered around the five leading cities: Islington Borough and the Greater London Authority in the UK, Rotterdam in The Netherlands, Cologne in Germany, Genova in Italy and Gothenburg in Sweden. At its centre was the innovative technology development; 30 demonstrators that showcased technologies, systems and practices for the production, distribution and utilisation of heating and cooling through district energy networks. The demonstrators were closely monitored to determine the energy savings and impact they could have if replicated. The project had a strong focus on knowledge sharing, so that the information gathered by CELSIUS and other members of the CELSIUS network would not to be wasted or lost. The data and expertise were then transferred to the member cities and city supporters via the CELSIUS wiki, webinars and various workshops and conferences. This network of knowledge transfer and collaboration has become one of CELSIUS' strongest assets. Thirdly, to combine a bottom-up with a top-down approach, the CELSIUS project also endeavoured to be a communication channel between the cities and the European Commission. Project partners participated in various of the European Commission's consultations regarding energy efficiency and housing directives.
Project details	The CELSIUS demonstrators constitute a package of innovative state-of-the-art energy efficient technologies, systems and practices. To cover the whole CELSIUS City concept within this demonstration project, 10 new demonstrators were built. The demonstrators already in operation secured a full range of innovations and solutions covering the five categories necessary to display and demonstrate the CELSIUS City commitment: system integration, sustainable production, storage, infrastructure and end-user engagement. Below you will find the description of the most innovative demonstrator in each partner city. For additional information about the other demonstrators, please visit: https://project.celsiuscity.eu/demonstrator/.
Islington Borough Demonstrator site description	**Waste heat recuperation from the London Underground** The London Underground's mid-tunnel ventilation shaft and UK Power Network's electricity substation were identified as sources of waste heat that can utilised within the local Bunhill

	Heat and Power Network. This demonstrator looked at how these sources of waste heat can be captured and integrated into this local district heating system. It also included a plan for how this could form the beginning of a strategically important energy hub that will allow the subsequent extension of the heating system in the area. The second part of this demonstrator was the integration of a thermal storage to help with energy balancing in the area. This demonstrator developed an understanding of how waste heat can be economically captured and utilised within a local district heating system and how a thermal store can help with the balancing of both surplus electricity and heat within their respective networks. For more information, please visit: https://celsiuscity.eu/bunhill-2-energy-centre-up-and-running/. At the end of the project, as a result of the three demonstrators developed in the Borough, Bunhill supplied heat to around 700 homes and 2 leisure centres, and with the expansion it will allow for at least 500 more homes to be connected as well as two new developments and additional existing buildings in the vicinity. The heating system is more carbon and financially efficient than London's district heating systems have traditionally been designed, specified and built.
How can cities use the technology?	Possible requirements for replicability for the demonstrator, related to heat extraction from the underground are: • Presence of a ventilation shaft or a water source from the underground system and sufficient adjacent space to install the necessary equipment; • Set-up of clear lines of responsibility between infrastructure and district heating; • High temperatures in the waste heat source (minimum 20-30°C); • Availability of a failsafe system to allow normal operation in case of district heating breakdown.- Possible requirements for the replicability of the demonstrator related to heat extraction from the electrical substation are: • Presence of oil-cooled transformers with an oil-to-water heat exchanger in addition to normal cooling systems; • Sufficient load on the transformer to require cooling systems; • Availability of sufficient space for the equipment to be installed; • Set-up of clear lines of responsibility between infrastructure and district heating; • Presence of a failsafe system to allow normal operation in the event of district heating breakdown.
Cologne Demonstrator site description	**Waste heat recovery from sewage.** In large cities such as Cologne, heat generation accounts for more than two thirds of stationary energy consumption. That's why the search for ways to make more efficient use of

	non-fossil energy sources to create sustainable heating systems in metropolitan areas is so important. The City of Cologne began to use wastewater along with geothermal energy, solar energy and wood pellets as a sustainable source of heat for large buildings – a sensible addition to an economically viable mix of energy sources including natural gas, district heating systems and local heating sources. Wastewater systems have major heat recovery potential. Studies have shown that around 20 per cent of all buildings in Germany could be heated using this technology. The CELSIUS project identified the most effective methods so as to increase the success rate of future projects. Cologne divided the four-year project into two stages. Beginning in late summer 2013, demonstration facilities were set up in three locations near six schools and gyms across the city to test a range of different heat recovery methods. From 2014 onwards the technology was rolled out and tested in other types of buildings. For more information, please visit: https://celsiuscity.eu/waste-heat-recovery-from-sewage-water-in-cologne-germany
How can cities use the technology?	Considering the replication potential at European level, more than 84% of EU population is connected to a sewage network, share which increases if focusing the analysis on urban areas only; this means that the replication potential for the Cologne demonstrator is particularly high, also due to the adaptability to different climate conditions and the use of conventional technologies that are economically viable. According to the analyses carried out within other research projects (e.g.: Stratego), 5% of total heat demand could be covered with heat recovered from sewage systems in cities and towns with more. The technology demonstrated in Cologne could be replicated in several places, within the city of Cologne and in other cities over the EU, provided that some minimal requisites are verified. To ensure the economic feasibility of heat recovery from sewage the following aspects are important: • Low supply temperature (a 40 °C temperature leads to a COP of 5 whereas a temperature of 70 °C gives a COP of 3) • High temperature of sewage (min. 12 °C) • High heat demand to pay off the higher investment (min. 150 kW) • New construction or refurbishment of the building to be heated • Short distance between building and sewage pipe (max. 200 meters) • Adequate sewage pipe (minimum diameter 800 cm; dry weather flow 15 l/s)

	For more information, please visit: https://celsiuscity.eu/wp-content/uploads/2020/02/126-Guidelines-for-the-replicability-of-the-Cologne-Wahn-Demonstrator.pdf
Rotterdam Demonstrator site description	**Cooling by river water Rotterdam.** Cold is centrally generated through three water-cooled compression chillers through a cold water inlet connected to the river New-Meuse. Cold to the homes is provided through a distribution set with a metered connection. Water from the nearby river, Maas, is used for free cooling of the De Rotterdam Vertical city. The river water that is used has a temperature that varies between approximately 3 - 27°C during one year. The river water is pumped through a coarse filtration system to prevent solids and fish in the river from getting sucked into the water pumping system. Thereafter the water is processed through an antifouling system that uses chlorine as the antifouling agent. The water continues through a second stage of filters before passing through a heat exchanger. Problems during the early stage of the project occurred with small organisms, such as clams, that passed through the filter system. When settled, the organisms grew causing problems in the system. An environmental friendly extra anti-fouling step is used to solve this: thermic shocks. This method is used to prevent small organisms and clams from growing inside the system. The small eggs of the clams can pass the filtering system and stay inside the heat exchanger system. When growing they obstruct the flow in the system. By periodically raising the temperature to a high degree in a short term, called thermic shock, the clams and other small organisms are unable to hold their grip on the inner surface of the system and are flushed out. The system is also connected to electrically driven water cooled screw compressor chillers used when the river water temperature is too warm and supplementary cooling is needed. The river water chills the cooling medium that passes through the chillers which in its turn chills the water that is distributed to the buildings. The buildings are then cooled by different heat exchange systems that cool the air. The river water is returned to the river after passing through the chillers and heat exchanger. The water supplied to the building has a temperature of approximately 8-12°C while the returning warmed water has a temperature of approximately 16°C. More information available on: https://celsiuscity.eu/the-river-provides-indoors-cooling
How can cities use the technology?	Cooling by river water: Important, of course, is that water is available close to the building. Since the water temperature is not very high, longer distances can be used because the thermal losses will still be small.

Genoa Demonstrator site description	**Expansion turbine for mechanical energy recovery** The demonstrator will be developed in the district of Genoa Gavette located in the North zone of the city. The area is chosen for its high thermal and electrical demands from different type of users as buildings and industrial processes. The main industrial activity is meant to ensure the distribution of natural gas to the city. The natural gas is taken from the national distribution network at a pressure of 25 bar(a), it is then processed in order to reduce the pressure to 6 bar(a) necessary for its distribution at the city level. The city, and in particular the area supplied by the Gavette expansion plant, is very rich in residential buildings while industry is almost absent, the use of gas is so closely linked to the building heating's demand. The process expansion of the gas can induce an excessive reduction of its temperature and this could affect the safety of the plant. The gas must be suitably heated before its expansion. The natural gas demand implies a preheating thermal demand proportional to it. The expansion take place in throttling valves, with an isenthalpic process to which corresponds to a small decrease of the temperature. Offices and mechanical workshops located in the area contribute to increasing the thermal and electrical demand. The Genoa demonstrator promotes improvements along the entire energy chain: from production, through distribution to the final users. The turboexpander is used in a natural gas distribution station, this plant has the aim of reducing the gas pressure from 24 bar(g) to 5 bar(g) for the fuel distribution at a local level. The turboexpander used in the demonstrator is capable of supplying about 550 kW of electricity at a nominal condition using only 650 kW of heat produced by a CHP. The demonstrator's upgrades (Fig.1) can be summarised in: • Recovery of waste energy from the natural gas pressure drop though a turboexpander • Efficient production of electricity and heat from a CHP • Improvements of DHN thermal users
How can cities use the technology?	The technology being tested in this demonstrator can be replicated all over the EU, provided that a few main requirements are satisfied: • Presence of a natural gas distribution network with a appropriate gas demand in terms of mass flow and daily/seasonal behaviour. • Presence of a natural gas expansion plant characterized by a medium / high pressure jump.
Gothenburg Demonstrator site description	**District heating to ships in the Gothenburg harbour.**

The Gothenburg city owned energy company Göteborg Energi ran the EU Smart Cities CELSIUS project through which the shipping company Stena Line has connected one of their regular ferries, Stena Danica, to the district heating system when at quay. The Göteborg Energi district heating system stretches for 1200 km and covers about 90% of the city's apartment blocks. 30% of the district heating origins from waste CHP plant Sävenäs. The ferry carries up to 2274 passengers and 480 passenger cars, and docks in Gothenburg Port two times per day.

The overall objective with the demonstrator was to limit emissions: both regulated emissions such as SO2, particulate emissions and NOx, as well as CO2 and noise from ships when docked at quay in Gothenburg. Efforts targeting the main emission sources heating of buildings, power generation and road traffic have been successful. Emissions from ships at quay can be reduced if heating and power generation is switched from the ships marine gas oil (MGO) fuelled engines to more sustainable energy sources. The option to connect ships to the power grid is available in Gothenburg Port. Though the need for heating and hot tap water on board remains. This pilot project shows the possibility to further reduce emissions from ships at quay in the central part of the city.

Stena Lines input was EUR 77 000 worth in working time, and the EU contribution for hard ware was EUR 52 000. The project was evaluated after the first full year of operation. The adaption of the ferry connection to district heating includes installation of a heat exchanger in a container on the quay, flexible pipes to the ferry's four heat exchangers. It was assumed that the demand for district heating would mainly occur during the cold season. However, the environmental advantages to heat the ship's main engines when at quay has led to a demand for district heating also during the summer. The ferry's consumption of district heating during 2015 was estimated to 800 MWh.

The pilot project is regarded as a successful project to improve environmental performance, even if it is not increasing profitability for the shipping company. From the Gothenburg city perspective the project is a good example to show the possibilities to improve the environment by reducing both global and local emissions through a wider system perspective, including several sectors. Reduced noise from ships at quay enables housing development in port areas. The expected reduction of CO2 emissions is estimated to more than 200 tons per year with district heating instead of marine gas oil for the ship generators and heaters at quay in Gothenburg.

More information available on: https://celsiuscity.eu/district-heating-to-ships-in-harbour-in-gothenburg/

How can cities use the technology?	Technical requirements for replicability: • Ships at quay for stops long enough to allow the connection ship-district heating network (at least five hours are required) • Ships equipped to be connected to DHN • The amount of heat supplied to the ship is enough to allow the ship to switch off the on-board oil-fired boilers On the ferry steam is used for the heating system. The steam is produced by an oil furnace, and the heat from flue gases. Steam system is designed to 7 bar and 170 ° C. These heating systems have different power and temperature requirements. On the ferry there are two hot water circuits for heating; "Pre-treatment" system and "Reheating" system. In the "Reheating" system air is heated to the desired temperature in the AC units. Two steam condensers are used in the current situation to heat the system. Pretreatment "system is part of the air conditioning system that has as a main objective to cool the air and condense water out. In the winter, the heat is transported through the circuit used for heating the air. For this purpose one-used in the current situation exchanger heated by either steam from the boiler or hot water from the engine cooling. To pressure drop and water velocities in the secondary network shall be held within the re-commanding limits required lines with DN125 from the DHC to the quayside. From the quay and on to the connection point in engine selected DN100.
Environmental impact	N/A
Project coordinator’s contact details	Katrina Folland Coordinator of the Celsius Initiative. Mob +46 70 761 23 89 katrina.folland@johannebergsciencepark.com

3.4 Celsius Initiative

Project name	**Celsius Initiative**
Call identifier	#ENER/C2/2018-459
Type of action	Tender
Project logo	celsius
Project website	https://celsiuscity.eu/
Amount of EU funding (in EUR)	N/A
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	The Celsius Initiative supports cities in their endeavour to plan and deploy modern and efficient DHC systems as well as expand and refurbish existing ones to higher standards, allowing greater uptake of renewables, recovering of excess heat or cold while improving the overall efficiency of the systems. Using the tools and expertise already developed and available, the goal is to improve market uptake of DHC solutions. It is the follow-up of the CELSIUS project (see 3.3).
When can I use it?	The Celsius Initiative support tools are available now: the Celsius Toolbox is constantly updated, the Celsius Forerunner groups are running since 2019 and the knowledge sharing programme (monthly newsletters, webinars) is also publicly available to interested stakeholders at large.
Where can I use it?	The Celsius Initiatives is for all European cities – including city utilities and local energy agencies - in the heating and cooling transition, irrespective of their development stage, be it in the early planning stages, or cities with well established district heating and cooling networks in place looking to make them future-proof. Stakeholders that work with cities are also welcome in the community.
Why should I use it?	The Celsius initiative is the go-to-point for cities looking to decarbonise their heating and cooling systems, aims to accelerate the energy transition through the deployment of smart and sustainable district heating and cooling solutions in cities and accelerating their market uptake.
Project size	The Celsius Initiative will support more than 30 cities in their heating and cooling transition.
Summary	Heating and cooling accounts for more than half of the EU's energy demand, and its decarbonisation, particularly in urban areas, is still a major challenge though it has great potential to help reduce our CO2 emissions. The Celsius initiative is a platform aiming to change this by supporting cities in their energy transition to carbon-neutral heating and cooling systems. Celsius gathers and shares technical and economic knowledge as well as social and policy expertise, and fosters innovation, leading to solutions that accelerate sustainable development in Europe and across the world.

	Cities face many difficulties in their ambition to cut carbon emissions through the implementation of efficient and renewable heating and cooling solutions, in particular district energy. The challenges differ depending on the cities' starting points and what kind of solution they would like to implement. Moreover, they are often multifaceted, not only technical, but also related to policy, funding and stakeholder engagement, to name a few. To help cities overcome these obstacles, the Celsius Initiative has established its so-called "forerunner groups" made up of cities that share the same type of challenges and interests. In addition, the Celsius Initiative promotes best practices and shares knowledge via monthly webinars and newsletters and the Toolbox. The Celsius Toolbox (https://celsiuscity.eu/toolbox/) aims to be a source of knowledge and inspiration for cities interested in developing district energy (district heating and cooling) solutions. It addresses cities which are just beginning to implement small-scale district heating and cooling networks as well as cities with large established systems endeavouring for even smarter and more efficient solutions.
Project details	At the heart of the Celsius Initiative are the "Forerunner Groups" that gather cities and experts around common challenges. Through collaboration and with help from carefully selected experts, based on a peer-to-peer approach, these groups will support a selected Spearhead City in the implementation of a solution that will help accelerate the transition to a sustainable energy system. They are based on the following principles: Knowledge sharing based on the demand and needs expressed by the cities; cities are co-creators and decide on the support they require; collaboration with experts from industry, research, projects and supportive organisations; and matchmaking with other cities facing similar challenges. Currently, the following forerunner groups have been set up: • Getting a district heating & cooling system started • Waste heat recuperation from urban infrastructure • Low temperature district heating (LTDH) • District cooling • Decarbonisation of heat networks
How can cities use the technology?	Cities can join the Forerunner Groups and receive tailor-made support from experts, as well as follow the knowledge sharing programme (newsletter, webinars) and benefit from the resources in the Celsius Toolbox.
Environmental impact	N/A
Project coordinator's contact details	Katrina Folland Coordinator of the Celsius Initiative. Mob +46 70 761 23 89 katrina.folland@johannebergsciencepark.com

3.5 +CityXChange

Project name	**+CityxChange**
Call identifier	H2020-LC-SC3-2018-ES-SCC
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	www.cityxchange.eu
Amount of EU funding (in EUR)	19,999,996.38
Other public or private project funding sources	around 10 million co-funding of infrastructure etc.
Replication/implementation potential	3***
What is it?	+CityxChange brings the two aspiring Lighthouse Cities Trondheim (NO) and Limerick (IE) together with their distinguished Follower Cities Alba Iulia (RO), Pisek (CZ), Võru (EST), Smolyan (BG) and Sestao (ES), to underline their ambition to achieve sustainable urban ecosystems that have zero emissions and establish a 100% renewable energy city-region by 2050; through the development of Positive Energy Blocks
When can I use it?	The project combines a variety of existing solutions with innovative products, services, and applications. Therefore, many of the project's elements can be already replicated elsewhere, while more specific elements such as the Decision-Support-Tool, the local energy trading platforms, etc. are ready to be replicated at the end or shortly after the project.
Where can I use it?	The project targets both interventions in historical inner city context as well as small and medium-sized cities in the European Union. No particular difference in regard to climate or geographical conditions exists. Many of the developed and implemented solutions can be replicated regardless of the geographical context.
Why should I use it?	The project and its elements are contributing to the sustainable energy transition of the European Union and provide replicable solutions in different fields of small and medium-sized local authorities across Europe, ranging from energy saving, energy generation, and alternative sustainable energy sources, to electric Mobility as a Service, Decision-Support-Tools and Local Energy Trading Platforms. All of them are strongly connected with local policies through, e.g. the Bold City Visions, as well as co-created by the community through various formats and types of citizen engagement. We believe that the combined approach can lead to sustainable and significant transformation of the local energy ecosystem.
Project size	The project covers seven small and medium-sized cities in the European Union, each with one or several demonstration

	sites. These are Trondheim (NO), Limerick (IE), Alba Iulia (RO), Pisek (CZ), Võru (EE), Smolyan (BG) and Sestao (ES). The full overview of all demonstrators is available at www.cityxchange.eu/our-cities. The project aims to connect a minimum of 60 existing or new buildings to the Positive Energy Blocks.
Summary	+CityxChange aims at enabling the co-creation of the future we want to live in by developing a framework and supporting tools to enable a common energy market supported by a connected community towards Positive Energy Blocks. This leads to recommendations for new policy intervention, market (de)regulation and business models that deliver positive energy communities integrating e-Mobility as a Service (eMaaS).This central objective shall be achieved by the secondary objectives of the categories Citizen-centred Approach, Replication, Technology, Business Models.
Project details	The project combines a variety of solutions, services, products, and technologies. The primary ones are described below and further detailed in the deliverables on the project website. For the citizen-centred approach, the project is: 1) Enabling citizen participation and ownership of solutions for the transformation towards a positive energy city; 2) developing a Bold City Vision for 2050 and Guidelines that create and trigger integrated approach to sustainable urban development, citizen/private company/NGO integrated processes, and a way ahead that ensures inclusion; 3) co-creating Distributed Positive Energy Blocks (DPEB) through citizen participation; 4) and creating a citizen participation playbook and platform. To allow for replication, +CityxChange is: 1) delivering integrated planning and design, common energy market & community exchange solutions leading to wider rollout of Positive Energy Districts that can be replicated and gradually scaled up to city level and Guidelines that create and trigger integrated approach to sustainable urban development, citizen/private company/NGO integrated processes, and a way ahead that ensures inclusion; 2) deploying innovative replicable solutions that reduce overall energy consumption, increase share of renewables, enable full-scale integration of the complete energy system - electricity, thermal/cooling, and in the future renewable liquid fuels such as biogas and hydrogen; and 3) stimulating investment and replication across 20 additional EU cities with decentralised platforms, blended finance, and risk shaving. The adapted and developed technologies: 1) integrate local distributed renewable energy sources and energy storage; 2) connect buildings and building systems to energy communities and markets, to energy and district heating systems and integrate smart metering; 3) optimise energy system operation and mobility solutions by offering eMaaS;

	and 4) encourage open innovation and digital platforms for community and stakeholder engagement supported by open data and prototyping. Lastly, the business models are: 1) Stimulating innovation and development of new products and services, stimulating company and job creation; 2) establishing Investment pipelines, build novel business models with the Follower Cities, and create interconnected markets enabling local energy trading within the Distributed Positive Energy Blocks (DPEB); 3) enabling a fair deal to all consumers through a local flexibility market and innovative financing and risk distribution models; and 4) fostering a new energy market design coupled with consumer-driven innovation developed in close working cooperation with national regulators, Distribution System Operators (DSOs), property developers, and local energy communities.
Demonstrator site description	While seven cities are part of the project, the Lighthouse City Trondheim, Norway, currently addresses the issue of district heating in their demonstrator. The project-spanning demonstration projects are explained on the website at https://cityxchange.eu/demo-projects/. The Lighthouse City of Trondheim will establish two Positive Energy Blocks; Brattøra focusing mainly on electricity, and Sluppen comprising 5 corporate buildings and one apartment building, focusing on electricity and thermal solutions and the interaction between these. PEB Sluppen is a large PEB area covering a serviceable floor area of some 45,000 m2. The Sluppen area boasts two viable sources of waste heat; a large data centre (air cooled) and 5,000 m2 of cold storage operated by 3 large cooling machines. The potential thermal output from these two sources is approximately 1.5 GWh/yr. In order to obtain useful thermal output at appropriate temperatures and energy that is usable and attractive for customers, Norwegian University of Science and Technology (NTNU) has developed a new heat pump solution based on existing CO2 pump solutions. The solution is a 2-step cascade CO2 pump based on environmentally friendly media. The solution can easily be expanded in order to obtain temperature lifts high enough to also send surplus heat out on the larger thermal grid. This makes possible local redistribution of excess thermal energy, and setting up a virtual local thermal market. The heat pump will be part of a local energy and flexibility market at Sluppen, combining both electric and thermal producers and customers. The heat pump itself will be a standalone actor in the market, including buying electricity from different providers in the local market (grid, PV, battery storage) https://cityxchange.eu/our-cities/trondheim/
How can cities use the technology?	The particular solutions developed for Trondheim can be replaced in similar contexts where several industrial heat sources are available. Further, the connected local energy

	market can be replicated in combination with other technologies, depending on the local regulatory context. For all solutions of the project, replication profiles are being developed and will be publicly available at a later stage of the project.
Environmental impact	Expected impact (https://cityxchange.eu/expected-impact/ on GHG emissions, energy efficiency, air quality).
Project coordinator's contact details	Annemie Wyckmans, NTNU annemie.wyckmans@ntnu.no
Contact information for demo site or specific solutions	Bjørn Ove Berthelsen, Trondheim Kommune bjorn-ove.berthelsen@trondheim.kommune.no

3.6 COOL DH

Project name	**COOL DH**
Call identifier	H2020-EE-2017-RIA-IA
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://www.cooldh.eu/
Amount of EU funding (in EUR)	4,289,398.88
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	The COOL DH project will innovate, demonstrate, evaluate and disseminate technological solutions needed to exploit and utilise sources of very low-grade waste heat for heating of energy efficient buildings via Low Temperature District Heating (LTDH) and show how the District Heating (DH) systems can be more resource efficient and more energy efficient
When can I use it?	The final solutions will be collected as a catalogue of LTDH solutions. After the project's end, the involved industrial companies will use the project as outset for full-scale market introduction of new products, marketing of their new solutions and adjustment of business plans and models in relevant product areas in Europe and abroad.
Where can I use it?	This project is anchored in outstanding demonstrations carried out in two leading cities with sustainable city developments namely Lund in Sweden and Høje-Taastrup in Denmark both located in the Öresund region sharing many similarities but operating on different legislative and energetic frameworks. The solutions can be used in other advanced DHC sites with energy efficient buildings in Europe. The effort will focus on large-scale replication both at local level where a number of projects are in the planning phase and on international level. The project concept and technical solutions are in no way limited to Denmark and Sweden, but as these two countries are frontrunners in energy efficiency and district heating, they will likely be first movers.
Why should I use it?	The proposed COOL DH project includes a number of innovative technology aspects, in particular the effort within the following areas should be emphasised: • Development and demonstration of new solutions for low-temperature district heating, local energy storage, new components and management ICT systems. Further, utilisation of local low-grade surplus heat from various sources will be exploited and supplemented with additional use of RES both centrally and at the consumers. • Reducing the energy and exergy need for (hot) water in buildings is interesting from both a resource and an energy perspective. Efficient and innovative water solutions will be

	developed and used in both new and retrofitting of buildings. Moreover, the project proposal contains activities and demonstrations related to the use of new innovative components of renewable energy such as PV/T and Heat Pump solutions. Finally, the project will pay much attention to the future replication of projects results on a European and global scale, in particular with focus on countries similar to the North and Central European climate zone. In line with that, COOL DH has included the neighbouring municipalities of Gladsaxe and Ballerup as observers, where the potential market of some of the developed solutions and concepts will be assessed and prepared in the local conditions and market as part of this project.
Project size	In Lund, the full development of the project for LTDH will generate 10 GWh/y of CO_2 neutral energy by 2021 – as a direct result of COOL DH project, as COOL DH is the pilot phase for the full development. The solutions developed in the project can find replicability to other major cities in Sweden like Malmö, Göteborg and Stockholm and in any European city with plans of supplying LTDH to buildings districts with high energy efficiency. The same goes for the demonstrations in Denmark where there is direct replication potential in neighbouring districts and Municipalities and a longer term replication potential in any European city with plans of supplying LTDH to buildings districts with high energy efficiency. In Høje-Taastrup, the results of COOL DH will be used for designing a new urban development of 250,000 m² with all facilities including homes for 3,000 new inhabitants. The name of this development is "Nærheden", and the LTDH system will fully serve the district. In addition, existing settlements of multifamily blocks are facing deep energy refurbishments and in connection with this, the heating systems will be converted to LTDH district by district. Furthermore, the new town hall, new residential buildings (social housing) and new and existing offices in Høje-Taastrup C (downtown) will also be connected to the LTDH system. This will accelerate the development by showing the good examples for other European cities. Therefore, the project sites both have a factor 10 direct built-in replication impact on local level and have a great market potential for similar developments in Europe and abroad.
Summary	The COOL DH project will innovate, demonstrate, evaluate and disseminate technological solutions needed to exploit and utilise sources of very low-grade "waste" heat for heating of energy efficient buildings via Low Temperature District Heating (LTDH) and show how the District Heating (DH) systems can be more resource efficient and more energy efficient. The demonstration covers both new developments and stepwise transition of existing areas with district heating and energy retrofitting of buildings. The COOL DH consortium consists of the utilities and municipalities of the two cities Lund (SE) and Høje-Taastrup (DK) and leading DH

	energy specialists as well as leading industrial manufacturers.
Project details	COOL DH will: - Innovate, design and build cooling and heat recovery process systems, enabling heat recovery to a local lowtemperature district heating grid. They will mainly be driven by renewables. Design work will start in 2017 and heat recovery will start in 2019. - Design and build a low-temperature district heating grid with non-conventional pipe materials and testing of new innovative pipe components that will become new products introduced as a result of COOL DH. - Innovate and design suitable innovative heating systems and controls inside buildings that combine LTDH with distributed integration of local produced renewable energy on the buildings. Erection of new buildings in Lund will start in 2018 and will continue throughout the time of this project, while LTDH in Høje-Taastrup mainly will be for existing buildings being refurbished including modification of the heating system. - Develop viable business models and new pricing systems, that ensures a good (low) return temperature and provide the building companies with maximum flexibility regarding the choice of heating systems. - Demonstrate a full system with all needed components suitable for ultra-low DH temperatures (40 oC) incl. demonstration of systems for heating of DHW without risk of legionella.
First demonstrator site description	Lund Municipality (MUN-SE) is located about 15 km from Malmö in the southern part of Sweden in the region Scania (Region Skåne), and has 116,834 inhabitants with high growth rate, Lund city centre has about 85,000 inhabitants (2015). Lund Municipality (MUN.SE) with City of Lund is dedicated in its work to decrease the emissions of greenhouse gases. The municipality has six overarching goal areas where one is to decrease its environmental and climate impact substantially. The specific target is to decrease the emissions of GHG from the whole municipality from 1990 to 2020 by 50% and in 2050, the GHG emissions should be nearly zero. In 2014, a decrease of 47% was obtained compared to 1990. Lund is amongst other well known for Lund University (UNI-SE), which is among the top 100 universities worldwide having 41,000 students and 7,500 researchers. Also, the city is known for housing the research facilities of MAX IV (synchrotron light) and European Spallation Source, ESS (a new joint European particle accelerator, as in Cern) and Science Village Scandinavia with 10,000 high level employees. The city is branding itself by being a Young and Smart City and a Lighthouse for demonstration of the latest solutions in many fields. One such field of demonstration will be the largest lowtemperature district heating network, established through Lund's energy and utility company Kraftringen Energi

(UTIL-SE). This large-scale LTDH network based on fossil-fuel-free waste energy is a main focus area of this project.

In this way, the expansion of the city can take place without increasing the GHG emissions and the biomass presently used in the district heating system will be released to replace fossil fuels where this is used today (in the actual case in Copenhagen) Kraftringen (UTIL-SE) together with other partners develops the concepts for energy, mobility and lighting, where the low-temperature district heating LTDH infrastructure will be built from 2018 and onwards to be Europe's largest LTDH facility and test field for LTDH solutions. First district to be served will start from the southern part – the total development will over time cover 100 ha; forming a part of the Brunnshög area is the Science Village Scandinavia. Covering 18 hectares of land right between the Max IV and ESS facilities, the plan is to build approximately 250,000 m2 of gross floor area, providing space for businesses, educational facilities and research in the field of innovation and cutting edge material research. The area will also bring University campuses, guest accommodation, services, restaurants, gyms and cafés to this northern part of Lund. Local plans allow for buildings up to eight floors high, in several architectural styles.

There are now several developers in Brunnshög that aim to design the buildings for low temperature heating – a fact that makes the availability of large amounts of low-temperature heat from ESS and MAX IV even more suitable.

As in many other Swedish cities, district heating started up in the 1950’s and the district heating system now covers almost the entire city. Production and distribution systems built and operated by Kraftringen (UTIL-SE), a company owned by Lund, and three other municipalities. The main heat production unit is a large scale biofuel based CHP facility. Other important production units are a large scale geothermal system, a heat pump for recovery of heat from sewage water, district cooling heat pumps and other renewable energy sources. Kraftringen has the ambition to be completely free from fossil fuels in all heat production, and the production in Lund is fossil-fuel-free already today. Expansion of the city will call for more non-fossil energy sources to be integrated and utilised in the system such as low-grade waste heat. (Adding more biomass is not an option in the long-term as the biomass is a scarce resource that can be used better in other places). The main source of low-grade heat will be recycled fossil free waste heat from the MAX IV and later ESS research facility. The total cooling demand for ESS is 29 MW. In the preliminary design, the cooling is assumed to be split in three (3) temperature levels MW at 55/35 oC will be used for internal heating at ESS.

Another part of the waste heat will supply the LTDH system. The aim is to reach at least 5 MW within the time limit of this COOL DH project and then expand the system further as the Brunnshög area gradually will be developed. The residual

	waste heat will be delivered to the existing DH system in Lund. In order to cope with climate changes and occasionally very low temperatures it will be possible to raise the flow temperature in the LTDH to 62 oC for critical buildings during extreme winter periods. In the building's substations, shunts will reduce operation temperatures to minimum possible as well as focus on reducing the return temperature. The low-grade heat source from Cooling Water at MAX IV is 6 MW and is already available for exploitation. The total available source of low-grade heat including ESS will grow to 250 GWh/y by 2025 with a maximum capacity of 40 MW. In order to utilise the low grade surplus heat, (normally lost as cooling in a cooling tower), it is necessary to develop and install an innovative heat exchanger coupling in order to supply low temperature district heating for the LTDH net in COOL DH project.
Second demonstrator site description	Høje-Taastrup (MUN-DK) is one of the most sustainable municipalities in Denmark and is the only municipality that has received support to demonstrate the implementation of an accelerated transition to a fossil free future in a cost effective way. See more at www.htk.dk/compact. The district heating supply in Høje-Taastrup is getting greener and greener every year. In 2015, the supply consisted of 51% fossil free energy from biomasses, the renewable part of waste, solar, geothermal energy etc. The present project on utilising a larger share of low-grade surplus heat and increasing system efficiency is an important step of reducing emissions even further form the present level of 98 kg/MWh CO_2 emission (2015). The surplus heat will be harvested from various sources hereunder the city mall called CITY2, the data centres of the Danske Bank (name of a Danish bank), DSB (Danish railroads facilities), hotel facilities and from existing facilities at Copenhagen markets as described in the following text. The surplus heat derives from: • Cooling machines at the CITY2 Mall that will operate on power from more than 16,358 m² PV plant with an installed capacity of 2.07 MW (the so far largest roof mounted PV plant in the Nordic Countries of Europe). • Cooling machines and cooling of servers at the Danske Bank data centre, DSB and hotels having a high cooling demand year round. In the initial phase and as part of the COOL DH project, the collected heat from the abovementioned locations will supply the district of Østerby – the district marked with orange close to CITY2 mall. The network will be LTDH and serves an area of terraced houses with 158 dwellings. The LTDH network will eventually be expanded in the neighbouring areas with 350 houses (36,000 m²), an elderly home and since to neighbouring quarters of refurbished social housing. Moreover, new buildings are coming up in the development area of Høje-Taastrup C and will have the possibility to connect to the LTDH.

	Close to the CITY2 mall, the Copenhagen markets is situated (marked with blue in fig 4). It has a cooling demand year round with surplus heat and heat pumps that presently deliver heat 73/33oC (mean temperature 53oC). The capacity will be expanded along with the implementation of LTDH supply capacity and demand - and at the same time, the operation temperatures will be gradually lowered to improve efficiency and fit the demand of the LTDH system. The project will closely monitor this transition. Further, an ATES for seasonal storage and an energy storage for load levelling, will be connected if justified in pre-investigations of COOL DH. The capacity of low-grade surplus heat sources at Copenhagen markets is 8.7 MW, which is to be utilised via heat pumps to produce 11 MW cooling over time.
How can cities use the technology?	The project will pay much attention to the future replication of projects results on a European and global scale, in particular with focus on countries similar to the North and Central European climate zone. In line with that, COOL DH has included the neighbouring municipalities of Gladsaxe and Ballerup as observers, where the potential market of some of the developed solutions and concepts will be assessed and prepared in the local conditions and market as part of this project. The effort will focus on large-scale replication both at local level where a number of projects are in the planning phase and on international level. Moreover, the involved industrial companies will use the project as outset for full-scale market introduction of new products, marketing of their new solutions and adjustment of business plans and models in relevant product areas in Europe and abroad.
Environmental impact	The yearly energy saving based on recovery of low grade waste heat in COOL DHis estimated at 10 GWh p.a. in Lund 1) and 8.8 GWh p.a. in Høje-Taastrup Each 1 MWh utilised low grade waste heat will save 1 MWh primary energy Utilised low grade waste heat will marginally save 300 kg CO_2 /MWh The new LTDH supply will tariffed according to actual costs, but is based on experience expected to be 10-25% cheaper in variable cost depending on temperature level, but CAPEX will be higher. COOL DH will present detailed economic calculations as a project output. In Lund the share of renewables will be increased from 98% to 100%. In Høje-Taastrup the share of renewables will be increased from 51% to 90%.
Project coordinator's contact details	Reto Michael Hummelshøj RMH@cowi.com

3.7 CoolHeating

Project name	**CoolHeating**
Call identifier	H2020-LCE-2015-3
Type of action	Cooperation and Support Action (CSA)

Project logo	CooHeating.eu
Project website	http://www.coolheating.eu/
Amount of EU funding (in EUR)	1,644,340
Other public or private project funding sources	N/A
Replication/implementation potential	N/A
Summary	The objective of CoolHeating is to support the implementation of small modular renewable district heating and cooling grids for communities in South-Eastern Europe The objective of the project is achieved through knowledge transfer and mutual activities of partners in countries where renewable district heating and cooling examples exist (Austria, Denmark, Germany) and in countries which have less development (Croatia, Slovenia, Macedonia, Serbia, Bosnia-Herzegovina). Besides techno-economical assessments, core activities of the CoolHeating project include measures to stimulate the interest of communities and citizens to set-up renewable district heating and cooling systems as well as the capacity building about financing and business models. The outcome will be the initiation of new renewable heating and cooling grids in the target countries.
Project details	CoolHeating expects to mobilize about 98 GWh heat or cooling per year in the 5 target communities. This would create about 100 direct and 100 indirect jobs and stimulate 44 M€ investments.
Project coordinator's contact details	Dominik RUTZ, dominik.rutz@wip-munich.de

3.8 CROWDTHERMAL

Project name	CROWDTHERMAL
Call identifier	H2020-LC-SC3-2019-RES-IA-CSA
Type of action	Cooperation and Support Action (CSA)
Project logo	CROWDTHERMAL
Project website	https://www.crowdthermalproject.eu/
Amount of EU funding (in EUR)	2,305,801.25
Other public or private project funding sources	N/A
Replication/implementation potential	4****
What is it?	CROWDTHERMAL: Empower citizens and local communities to participate in the development of geothermal projects with the help of alternative financing schemes (crowdfunding) and social engagement tools. In order to support the participation in geothermal projects, CROWDTHERMAL is analysing the perception of geothermal energy and will develop a public engagement approach making extensive use of social media. In addition, CROWDTHERMAL will formulate new financial models for crowdsourcing, promoting alternative financing of geothermal projects in close collaboration with existing structures and conventional players.
When can I use it?	CROWDTHERMAL core services will be designed from the very beginning with a purpose of sustainability, to be operated after the EC-funded period, helping geothermal projects to tap into alternative finance during the years to come. The CROWDTHERMAL core services will be ready for deployment in January 2022. CROWDTHERMAL project has a TRL 8. A broad social-media campaign will be deployed to connect with young people, who may themselves become financiers of geothermal projects during the 2025-2030 period, giving a final assist to achieving the 2030 targets.
Where can I use it?	The scope of the CROWDTHERMAL project is European. Led by the European Federation of Geologists, CROWDTHERMAL is implemented by a consortium of 10 partners from 7 European countries, combining extensive experience in large-scale geothermal project development, alternative finance, social media engagement, innovation, education, and international networking on geothermal energy. In addition, 17 EFG Linked Third Parties support the extension of the project database and the dissemination in 18 countries. Our vision is to empower citizens and local communities for local clean energy solutions, contributing to the European Green Deal.
Why should I use it?	Would you like to participate in geothermal projects? CROWDTHERMAL will formulate new financial models for crowdsourcing, promoting alternative financing of geothermal projects in close collaboration with existing structures and

	conventional players. CROWDTHERMAL will formulate recommendations for a novel risk mitigation scheme that will be complementing the alternative financing solutions while protecting the interests of private investors. What can we do to support your project? CROWDTHERMAL will prepare a decision tree algorithm with guidelines for the developers and promoters of geothermal energy.
Project size	CROWDTHERMAL has three case studies: Hungary with the district heating system of Szeged; Spain with housing cooperatives in Madrid using shallow geothermal energy for heating and cooling, and Iceland with greenhouse heating for food production in the area of Lake Mývatn. These case studies will allow to validate the project findings and in particular its approaches in terms of social engagement, alternative finance and risk mitigation. In addition, the EFG Linked Third Parties will identify geothermal projects interested in alternative finance in 18 European countries.
Summary	CROWDTHERMAL aims to empower the European public to directly participate in the development of geothermal projects with the help of alternative financing schemes such as crowdfunding and social engagement tools. At the heart of the project is the innovative solution to tap into alternative finance for geothermal development, strengthening the European portfolio of economically feasible geothermal projects and demonstrating a stronger form of public engagement for the promotion of a geothermal energy.
Project details	In order to reach this goal, the following actions will be taken: • Study the requirements for social licencing and develop a Social Licence to Operate (SLO) model for the different geothermal technologies and installations • Review any successful case studies, as well as national/EU bottlenecks to alternative financing of geothermal energy in all EU countries • Formulate new financial models for crowdsourcing on a national and trans-national basis, covering individual member-states and Europe as a whole • Develop recommendations for a novel risk mitigation scheme that will be complementing the alternative financing solutions while also protecting private investors' interest • Develop core services for social-media based promotion and alternative financing of geothermal projects, working closely with existing structures & conventional players

Demonstrator site description	Hungary with the District Heating system of Szeged (28,000 households supplied by DH), has 23 heating circuits powered by 1-20mW boilers, around 200km pipelines and 224mW total energy output. During the project, 27 new wells will be drilled in the city to transform the system to geothermal DH. More than 1000 future end-users will be polled, relevant local and regional stake-holder groups will be interviewed, responses to our geothermal plans will be analysed, cross-border effects will be assessed based on focus-group interviews in Serbia. The methods of community-based financing will be investigated to reach new end-users at a later stage. In Spain the already existing cooperatives in Madrid can serve as an initial example of public-driven and co-financed shallow geothermal schemes: Residential complex of 80 dwellings and urbanization of 220 houses built according to the criteria of the Trias Energetica, using shallow geothermal energy as renewable energy source. The Icelandic Case Study is the Húsavík Community Greenhouse. It is surrounded by geothermal energy on all sides. The area is located near five active volcanos, Krafla being the best known. The case study includes three parts: Communal vegetable garden; Greenhouse laboratory, and Restaurant / Tourist Attraction / Community Center. The case study assessment protocol provides useful guidelines on how to assess all involved stakeholders' perception of the process, concerns and needs, public acceptance and participation issues. Document link: https://www.crowdthermalproject.eu/wp-content/uploads/2020/04/CROWDTHERMAL-D5.1-Case-study-assesment-protocol_v4.pdf
How can cities use the technology?	The project's core services will be available starting from January 2022. These will allow to connect project developers with potential financiers all across Europe.
Environmental impact	N/A
Project coordinator's contact details	Dr Isabel Manuela Fernández Fuentes European Federation of Geologists Isabel.fernandez@eurogeologists.eu

3.9 Decarb City Pipes 2050

Project name	**Decarb City Pipes 2020 – Transition roadmaps to energy efficient, zero-carbon urban heating and cooling**
Call identifier	Horizon 2020 – LC – SC3 – 2018-2020
Type of action	Cooperation and Support Action (CSA)
Project logo	
Project website	https://decarbcitypipes2050.eu/
Amount of funding from EU	1,894,032.50 €
Other public or private project funding sources	NA
Replication/implementation potential	4****
What is it?	This project showcases how local authorities can build up capacity to meet the challenge of phasing out fossil fuels for heating and cooling till 2050 the latest. Six cities – Bilbao, Dublin, Munich, Rotterdam, Vienna and Winterthur join forces to learn from each other, explore pathways and options suitable for their local challenges and build up skills and internal know-how regarding process and transition management.
When can I use it?	Since this is an exchange and capacity-building project, no technology / solution is being developed in its course.
Where can I use it?	This capacity-building project was designed to help cities (city authorities) in their transitioning process to an energy-efficient zero-carbon heating and cooling system by 2050.
Why should I use it?	Transitioning the heating and cooling system of a city requires a broad spectrum of cooperation, not least between the city, its network operators and utilities, but also between civil society, etc. Cities, however, are often still unable to adequately meet the pressure from various interest groups and lobbyists when it comes to advancing certain issues related to urban heating and cooling. They lack capacity and skills as well as legal empowerment to act. The aim of this project thus is to showcase how local public authorities can be empowered to meet these complex challenges.
Project size	Six partner cities (and Bratislava) of differing sizes, from 110,000 to 1.9 Million inhabitants.
Summary	Climate urgency calls on all political levels to act more stringent and faster. Responsible for roughly half of the EU´s final energy consumption, transitioning heating and cooling to energy efficient, renewable solutions will be critical to bring EU countries in line with their pledged climate and energy targets. Given the long-life cycles of buildings, their envelopes and their heating systems as well as of the grid infrastructures (district heating, electricity, gas) involved, there is an urgency to start the planning of this transition today. But how ? What first ? Which system ? How to govern this process ? Increasing complexity of the energy system

	and technological uncertainties require a high level of knowledge and skills to act wisely. Cities are, however, often ill-equipped for this. In this project, six cities – Bilbao, Dublin, Munich, Rotterdam, Vienna and Winterthur – explore, with the support of scientific partners, pathways and technically and economically feasible solutions suitable for their local challenges, and build up skills and internal know-how in the gathering and use of data, planning tools and instruments. In a participatory process within each city administration and in close cooperation with external stakeholders, the cities will develop tangible and actionable transition roadmaps to decarbonize heating and cooling for buildings by 2050 (or even earlier as in the case of Munich, Vienna, Winterthur), taking up the challenge of phasing out gas and oil. Together, they will also advocate for needed changes to current framework conditions on all levels.
Project details	In the beginning of this project, all six cities established local working groups to discuss in detail local visions, outlooks, and spatially differentiated heating and cooling plans. These local working groups each represent local framework conditions and include stakeholders from city government as well as utilities, grid operators, etc. A first task of these local working groups was, with the support of the project´s scientific partners, to discuss and agree upon an Outlook for the city`s future energy demand and energy supply mix in 2050. Cities then aligned this quantitative vision for future demand and supply with local spatial conditions, taking into account issues such as the availability of demand and supply, infrastructure. Guided by these urban heating and cooling plans, cities will now address the challenge of implementation by developing actional transition roadmaps. In these they will detail on e.g. the priorisation of options, instruments to be employed, actions, sub-targets and milestones to be set etc., thereby setting the framework for how to reach energy efficient, zero-carbon local H/C by 2050. To support cities in their local discussions, exchange and peer-to-peer learning sessions have been set up in the course of this project to build capacity and expertise and promote frequent exchanges between cities and (external) experts.
Demonstrator site description	In the course of this project, all six cities will perform local “Transition Experiments” in which they will test approaches or procedures so as to maximize specific learnings. These experiments can concern a planning process, procedures in the city administration, new instruments, practicing new cooperation with utilities, DSOs, energy communities, ensuring citizen participation etc. and are currently being defined and developed.
How can cities use the technology?	This project showcases how cities can meet the challenge of transitioning to an energy-efficient, zero-carbon heating and cooling systems by 2050. It is designed to help cities in this transition process.

Environmental impact	Responsible for roughly half of the EU's final energy consumption, transitioning heating and cooling to energy efficient, renewable solutions will be critical to bring EU countries in line with their pledged climate and energy targets.
Project coordinator's contact details	Viktoria Forstinger, UIV Urban Innovation Vienna GmbH forstinger@urbaninnovation.at

3.11 DHC TREND - Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive

Project name	**DHC TREND - Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive**
Call identifier	#ENER/C1/2018-496
Type of action	Tender
Project website	Link to the publication will be available in Q3-2021
Amount of EU funding (in EUR)	N/A
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	DHC TREND is a study analysing DHC markets and regulatory frameworks across Europe and providing operational guidelines for the implementation of renewable energy and waste energy sources in DHC networks. The various topics and best practices are illustrated by more than 20 case studies selected over the continent.
When can I use it?	The study will be available in Q3-2021
Where can I use it?	The study covers in detail the 27 Member States, as well as Iceland, Norway, the United Kingdom and Ukraine. The study can be used for both emerging and mature DHC markets because of the broad subjects and the wide geographical scope (allowing comparison of best practices) it covers. The technical section of the study provides food for thought for the design of new DHC networks and for existing networks aiming at phasing-out fossil fuels.
Why should I use it?	The study provides a wide and detailed market analysis and assesses the various regulatory frameworks implemented across Europe, with operational inputs extracted from public literature and experts interviews in 31 countries. The study also highlights best practices in regulation, urban planning, governance, and in the integration of renewable energy and waste energy sources with concrete examples from more than 20 cases studies.
Project size	N/A
Summary	This project aims at enhancing knowledge of European DHC systems and markets, needed to develop efficient policies, initiatives and projects that will contribute to achieve the decarbonization targets set in the European Green Deal. The study, which will be completed in June 2021, is divided into 3 main sections, covering the European Union, plus Iceland, Norway, the United Kingdom and Ukraine: • Section A provides a complete analysis of DHC markets: - H&C demand and DHC market share, technology and fuel mix

	- DHC historical developments, size and type of networks - Market actors, DHC regulatory framework overview, and customer protection and satisfaction • Section B describes and analyses in more detail the different regulatory frameworks set across Europe for DHC regarding: - Measuring, accounting and reporting - Pricing regimes and support schemes - Third Party Access (TPA) - Urban planning and building regulation, illustrated by 13 case studies • Section C provides technical and operational guidelines for the integration of renewable energy and excess heat/cold sources in DHC: - Operational details for 6 renewable energy sources and 6 excess heat/cold sources - Illustration by 10 detailed case studies selected across Europe
Project details	The first section of the study provides a detailed market overview of DHC in each European Member States, plus Iceland, Norway, the United Kingdom and Ukraine, as well as a cross-analysis of the European Union as a whole. By focusing on the technical parameters of existing DHC networks, regulatory frameworks and consumer perception, the tangible objectives of the first section can be classified in the following categories: - Quantification, description and graphical representation of the energy supply, consumption shares by sector, fuel, and technology mix of the existing DHC networks. These quantitative data are gathered and presented through a user-friendly tool (Power BI) available on-line. - Quantification, description and graphical representation of the historical developments and size of the DHC networks. Additional assessment and classification of the existing networks types based on the average specific heat demand, heat source and integration with the electricity sector. - Overview of the current regulatory framework and identification of the relevant market actors. - Additional research on the current market satisfaction based on the available literature and existing case studies. The second section provides a detailed description and assessment of the regulatory regimes applied to DHC, in particular with regard to network/system access, measurement and pricing, and contractual modalities for third party access. Additionally, the impact of the national building regulations and urban planning on the DHC systems are investigated.

While the geographical coverage is the same as in the first section, a special focus is put on 10 countries, that reflect all the different DHC markets situations in the EU. These are:
- “Advanced” Nordic DHC countries: Finland, Denmark, Sweden
- Significant DHC markets: Germany, Poland
- Eastern European countries: Slovakia, Bulgaria
- Baltic country: Lithuania
- “Emerging” DHC markets: France and the Netherlands

The analysis performed in these two sections is based on a comprehensive literature review that has been completed by a survey and interviews addressed to the main DHC stakeholders in the 31 countries entering the scope if this study.

The last section provides technical information and operational feedback on the integration of renewable energy and waste heat/cold sources in DHC networks. This section thus analyses the technical conditions required to ensure an optimized and efficient integration of these energies, and how this integration affects the operational characteristics of the DHC system and its connected end-users. More particularly, this section addresses:
- 6 sources or carriers of renewable energies: biomass, geothermal, biogas, solar thermal, ambient energy, and renewable electricity.
- Waste energy from 5 different origins: power generation, industrial production, tertiary buildings, data centres, underground railway.
- The technical conditions for heat suppliers to connect to a DHC.

This analysis, which is based on a literature review and benchmarks, is also supported by 10 case studies across Europe in order to provide a true operational feedback on the different topics. These case studies have been selected by considering their operational excellence, but also by ensuring a wide geographical and technological coverage. More particularly, they strive to illustrate:
- Energy transition success stories (especially fuel switch)
- Upgrading inefficient DH grids into efficient ones
- DH systems having dealt with building renovation, showcasing compatibility of DHC with high energy performing buildings
- Best practices in sector integration, and common planning with electricity and gas operators
- Best practices in Central and Eastern Europe

The complete analysis of the 10 case studies tackles various dimensions of the integration of renewable energy and waste heat/cold sources in DHC: the national and local contexts, the technical features of the DHC system, the business model, and the sector integration approach.

How can cities use the technology?	The various case studies presented in this study clearly underline the central and key role that municipalities have in the implementation of efficient DHC on their respective territory, by initiating and steering their development in coordination with urban planning, by actively participating in their technical and economic monitoring or operatorship, by enhancing consumer protection and involvement… Thus, the different topics addressed in the report, which were analysed in different contexts (level of national regulation, market maturity, new/existing network…), may help cities in establishing their action plan to support the development of efficient DHC according to their local context, both at regulatory and operational levels.
Environmental impact	By focusing on the development of efficient DHC and by investigating the regulatory and operational levers for a better integration of renewable energy and waste energy sources in DHC networks, this study has clear environmental objectives, as it aims at improving the knowledge of the sector to increase the awareness of its benefits and enable more focused and adapted policies and support schemes, ultimately contributing to a higher uptake of efficient DHC. The operational case studies that were selected for section C of this report are all recognized for their environmental excellency (or under the process to achieve such excellency), with very limited CO2 content, and the best practices showcased can be replicated.
Project coordinator's contact details	Alexandre Bacquet, alexandre.bacquet@tilia.info

3.12 E2District

Project name	**E2Distric**
Call identifier	H2020 EE-13-2015
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://cordis.europa.eu/project/id/696009
Amount of EU funding (in EUR)	1,999,849
Other public or private project funding sources	N/A
Replication/implementation potential	N/A
Summary	E2District aims to develop, deploy, and demonstrate a novel cloud enabled management framework for district heating and cooling (DHC) systems. This would be done by developing a District Simulation Platform to optimise DHC asset configuration, development of intelligent adaptive DHC control and optimisation methods including flexible production, storage and demand assets, and system-level fault detection and diagnostics, development of behaviour analytics and prosumer engagement tools to keep the end user in the loop.
Project details	The work in the project would also the: • development, deployment and demonstration of a behaviour analytics tool for learning and continuously refining the demand behaviour models used in the energy demand prediction, and to develop prosumer engagement tools with specific user interfaces that keep the human end user in the loop, allow them to control equipment that is not accessible by the operator, and help influence and control actual energy demand • development of novel business models for DHC Operators, Integrators and Designers as well as validation, evaluation, and demonstration of the E2District platform The demonstration work in the project is expected to take place in a real-life district heating and cooling demonstration site at the Cork Institute of Technology Bishopstown campus in Cork, Ireland.
Project coordinator's contact details	Martin Klepal , Martin.Klepal@cit.ie

3.13 EMB3Rs

Project name	**EMB3Rs**
Call identifier	H2020-LC-SC3-EE-2018
Type of action	Innovation Action (IA)
Project logo	EMB3Rs Heat and Cold matching platform
Project website	https://www.emb3rs.eu/
Amount of EU funding (in EUR)	3,984,671.32
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	Developing an excess Heat/Cold (re)use matching platform for industry and end users.
When can I use it?	The EMB3Rs platform will be publicly available from September 2022. TRL at the moment is 5 and 6, depending on the individual components (modules), and will be at TRL7/8 by end of the project.
Where can I use it?	The EMB3Rs platform can be used by any company or other end user with excess thermal energy, DHC companies, potential final users of the thermal energy, municipalities or energy agencies, looking for local sources that can be integrated into local supply of heat/cold. The analysis is done at local level – looks for potential sinks for a given source of excess heat – so local to urban scale.
Why should I use it?	To improve energy efficiency of industries, lower energy costs, improve competitiveness and reduce environmental impacts.
Project size	The EMB3Rs platform will be initially implemented in 7 case studies, covering the following: - excess heat recovery and use from 4 industrial sectors: cement, foundry, waste treatment, food (in Portugal, UK, Greece) - options for excess heat use within 1 industrial Park (Greece) - participation of 3 DHC networks, that will analyse options to add more local excess heat to their networks (Portugal, Sweden, Denmark) - finding cost effective solutions for increased thermal energy recovery within the industrial sectors overall lead by 2 energy agencies (Portugal and Greece).
Summary	16 companies and institutes from across Europe have joined forces as part of the EU-funded project EMB3Rs to add value to waste heat and help make better use of renewable energy sources. A novel tool will allow energy-intensive industries and other excess heat and cold (HC) sources to explore ways of reusing their excess thermal energy. This will improve their energy performance and contribute to a healthier environment for everyone. Users, like industries that produce

	excess heat, will provide the essential parameters, such as their location and the available excess thermal energy. The EMB3Rs platform will then autonomously and intuitively assess the feasibility of new business scenarios and identify the technical solutions. The platform will provide costs and benefits of linking excess H/C sources to potential final users and define the technical requirements for implementing the most promising solutions. Seven case studies will deliver data to create and validate the platform including the re-use of excess heat from a cement producer, a metal casting company, an industrial park and local supermarkets in district heating networks. The project kicked off in September 2019 and will last for three years.
Project details	A bottom-up computational tool will be developed to aid industries, and other relevant stakeholders, in the assessment of the economic potential and the environmental benefits of the recovery and use of process excess HC that is otherwise lost via different streams, equipment and materials. The tool will be able to propose options for recovery and redistribution of the excess thermal energy, e.g. process HC within the same plant or in HC networks to other industries or multi-sectorial DHC networks and district heating. For industries, the platform can explore conversion of excess heat to electricity, drying of conventional or alternative fuels or raw materials, complementing and/or substituting fossil HC systems with local generation via renewable resources and integration of thermal storage. In order to match the available industrial supply of excess HC, detailed knowledge of their process characteristics regarding quality, quantity and temporal availability profiles of the recoverable thermal flows is required. These are used as the basis for the techno-economic assessment to match the supply with the existing heating and cooling demand (i.e. in other processes, other industries or other sectors).
Demonstrator site description	All seven case studies are listed and described here: https://www.emb3rs.eu/case-studies/ Case Study 1: Process resource and energy intensive industries (REII) – Cement production in Souselas, Portugal Case Study 2: Process REII – Metal casting in UK Case Study 3: Heat-exchange within an industrial park in Greece Case Study 4: REII Waste heat supply to residential and commercial DHC network of Parque das Nações in Lisbon, Portugal Case Study 5: Analysing excess heat potentials in different scenarios in Sweden Case Study 6: Innovative Business Models: Residential DH network with P2P market structure in Denmark Case Study 7: Overall Platform Functionalities in Super-User Mode
How can cities use the technology?	Users, like industries that produce waste heat, will provide the essential parameters, such as their location and the available excess thermal energy. The EMB3Rs platform will

	then autonomously and intuitively assess the feasibility of new business scenarios and identify the technical solutions. End users such as energy communities, local authorities, building owners and residents, DH network operators, will be able to determine the costs and benefits of incorporating local sources of excess HC and define the technical requirements for implementing the most promising solutions. Matching excess heat providers with end-users will enable win-win partnerships and reduction of GHG emissions.
Environmental impact	A reduction in fossil energy use (mainly Natural Gas) of up to 50% from current levels is foreseen by some of the participants (DH networks), while industries involved in the project expect up to 30% reduction in primary energy inputs and GHG emissions. For the case study with local energy community, the technical solutions to be analysed in EMB3Rs should allow for up to 20% of total heat use in buildings to be provided by local sources of excess heat /e.g. local supermarket).
Project coordinator's contact details	Zenaida Mourão Institute of Science and Innovation in Mechanical and Industrial Engineering (INEGI) Phone: + 351 229578710 Email: zmourao@inegi.up.pt
Contact information for demo site or specific solutions	Case Study 1: Process resource and energy intensive industries (REII) – Cement production in Souselas, Portugal CIMPOR - Indústria de Cimentos S. A., Paulo Rocha, procha@cimpor.com Case Study 2: **Process REII – Metal casting in UK** UoW - University of Warwick, Stuart Bradley, Stuart.Bradley@warwick.ac.uk Case Study 3: **Heat-exchange within an industrial park in Greece** CRES - Centre For Renewable Energy Sources And Saving Foundation, George Goumas, ggoumas@cres.gr Case Study 4: **REII Waste heat supply to residential and commercial DHC network of Parque das Nações in Lisbon** Climaespaço - Sociedade de Produção e Distribuição Urbana de Energia Térmica, S. A., Joao Castanheira, joao.castanheira@climaespaco.pt Case Study 5: **Analysing excess heat potentials in different scenarios in Sweden** University of Lund, Martin Andersson, martin.andersson@energy.lth.se Case Study 6: **Innovative Business Models: Residential DH network with P2P market structure** DTU - Danmarks Tekniske Universitet, Tiago Sousa, DTU - Danmarks Tekniske Universitet Case Study 7: **Overall Platform Functionalities in Super-User Mode** ADENE - Agência para a Energia, Ana Cardoso and André Santiago, ana.cardoso@adene.pt / andre.santiago@adene.pt

3.14 FLEXCHX

Project name	**FLEXCHX**
Call identifier	H2020-LCE-2017-RES-RIA-TwoStage
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	http://www.flexchx.eu/index.htm
Amount of EU funding (in EUR)	4,489,545
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	FLEXCHX - Flexible combined production of power, heat and transport fuels from renewable energy sources -presents an economical way to utilize combined heat and power plants and district heating networks as part of the future European energy system. Tri-generation of power, heat and intermediate product (FT wax) for the transport sector is used to address the challenge of the poor match between the availability of solar energy and the demand for heating.
When can I use it?	The new technologies of the project are expected to reach demonstration phase in around 2021 - 2023 and the first production plants would enter the European Heat and Power market around 2025 with full market penetration after 2030. The new key enabling technologies have been developed and validated to TRL5.
Where can I use it?	First production plants would enter the European Heat and Power market and the units will probably be integrated to existing CHP systems, while on the longer term, this technology combined with other renewable energy technologies will enable completely new production fleets to meet future needs of societies for heat, power and mobility
Why should I use it?	The key goal of the FLEXCHX project is to develop a process concept that will enable flexible co-generation of heat, power and 2nd generation biofuels in the small-to-medium size range using various low-cost feedstocks and also excess electricity during the sunny season The main benefits of the solution: - Improved economics of CHP and district heat production in the European energy transition - Increased life-time of the CHP system - Efficient and economically attractive way for utilising low-cost excess electricity - Contribution to the decarbonisation of transport sector - Assisting the European oil industry in their plans to move towards advanced biofuels - New markets for biomass supply, technology suppliers and CHP plant owners

	- Improving economics and quality of life in rural and agricultural as well as in modern cities
Project size	FLEXCHX plants can be integrated to district heating plants or indusrial CHP units with heat loads of 1-50 MW.
Summary	The FLEXCHX project is aimed at creating a method for managing the seasonal mismatch between solar energy supply and the demand of heat and power that is highly pronounced particularly in northern and central Europe. The FLEXCHX concept constitutes a complete rethinking of how combined heat and power should be produced in variable renewable energy-dominated power grids, and how the use of excess solar and wind energy can be combined with effective use of biomass residues. Tri-generation of power, heat and intermediate product (FT wax) for the transport sector is used to address the challenge of the poor match between the availability of solar energy and the demand for heating. The vision is to realise a process for optimal use of the seasonal solar energy supply and available biomass resources and satisfy the seasonal demand for heat and power, and to produce low-GHG fuels for the transport sector.
Project details	In this project, a flexible and integrated hybrid process, which combines electrolysis of water with gasification of biomass and catalytic liquefaction, has been developed. This process produces heat, power and an intermediate energy carrier (FT wax) which can be refined to transportation fuels using existing oil refining equipment. The FLEXCHX process can be integrated to various combined heat and power production systems, both industrial CHPs and communal district heating units The process development activities of the project have been focused on the following key enabling technologies: gasification, filtration, reforming, final gas cleaning, and compact FT synthesis - which essentially form the backbone of the flexible production concept. These technologies have been developed to TRL5 and the technical feasibilty of the whole production concept has been validated at pilot scale.
Demonstrator site description	Demonstration is planned as follow-on activity. Potential sites have been preliminarily assessed in the project but no final plans have been made yet. Results and information of the project can be found in: https://doi.org/10.5071/27thEUBCE2019-2BO.10.1 https://doi.org/10.5071/27thEUBCE2019-2CV.2.16
How can cities use the technology?	FLEXCHX units can be integrated to local CHP plants (industrial CHPs or district heating units). The developed hybrid production concept can be realised at smaller scale using the developed fixed-bed gasification and compact FT-synthesis technologies. Same concept can also be realised at larger scale, relevant for cities, using pressurised fluidised-bed gasification and larger-scale synthesis technologies.
Environmental impact	In the FLEXCHX process, biomass/waste-derived contaminants are effectively removed to sub-ppm level in

	order to meet the requirements set by the FT synthesis catalyst. This will also lead to extremely low emissions at the CHP plant site as ultra-clean FT off-gas is used to generate heat and power. Main part of biomass ash is recovered as bottom ash which offers good potential for nutrient recovery. Energy production is based on small distributed plants utilizing locally available residues, without impact on food production or land use and without the need for long-distance transportation. The (gradual) replacement of crude oil at oil refineries will lead to significant reduction of sulphur emissions directly at the refinery site and indirectly in applications, where high-sulphur fuel oil has traditionally been used. Biodiversity: The use of locally available feedstocks and residues for the production of renewable heat and advanced biofuels is expected to reduce the dependence on monocultural feedstocks, such as the tropical palm oil. Hence, the FLEXCHX project will have positive effects also on global scale on biodiversity. The use of a hybrid process that utilizes excess solar energy as a booster makes it possible to double or in some cases even triple the displacement of fossil fuels. This is the main contribution of FLEXCHX to the global energy challenges
Project coordinator’s contact details	Esa Kurkela, esa.kurkela@vtt.fi

3.15 FLEXYNETS

Project name	**FLEXYNETS - Fifth generation, Low temperature, high EXergY district heating and cooling NETworkS**
Call identifier	H2020-EE-13-2014
Type of action	Research and Innovation Action (RIA)
Project logo	FLEXYNETS
Project website	http://www.flexynets.eu/en/
Amount of EU funding (in EUR)	2,000,000
Other public or private project funding sources	N/A
Replication/implementation potential	**4******
What is it?	FLEXYNETS developed a new generation of intelligent district heating and cooling networks that work at "neutral" temperature levels. Reversible heat pumps are used to exchange heat with the DHC network. In this way, the same network can provide contemporary heating and cooling. FLEXYNETS solutions integrate effectively multiple generation sources (including high- and low-temperature solar thermal, biomass, PV, cogeneration and waste heat) where they are available along the DHC network, by managing energy at different temperature levels and assuring optimized exergy exploitation. Together with storages, control strategies that optimize the harvest of renewable energy sources are key from the technical and economic points of view. On the one hand, strategies are assessed that assure a thermal balance among diffused heat generation, storage and utilization. On the other, controls are elaborated to favour sector coupling, deciding when energy is to be gathered locally or exchanged (both purchased and sold) with the electricity and gas networks.
When can I use it?	The approaches and technologies developed are in advanced phase of demonstration in large scale applications over several sites in Europe.
Where can I use it?	FLEXYNETS solutions are suitable where district heating and cooling networks need to cover both heating and cooling loads and a contemporaneity of the two is present around the year. Independently of the geographical location, this includes conventional large towns and cities, where residential buildings neighbour tertiary buildings like large supermarkets, data centres, large office buildings.
Why should I use it?	The neutral temperature water supply allows effectively re-cycling waste energy from air conditioning and processes that are encountered along the district heating network. Moreover, by using electricity driven heat pumps and thanks to the digitalization of the network, a link between the thermal and electric sector is produced, which enables new

	opportunities in terms of flexibility services on the electricity market.
Project size	N/A. Laboratory tests of the control strategies elaborated have been implemented
Summary	FLEXYNETS developed a new generation of intelligent district heating and cooling networks that work at “neutral” temperature levels. Reversible heat pumps are used to exchange heat with the DHC network. In this way, the same network can provide contemporary heating and cooling.
Project details	FLEXYNETS on the one hand elaborated on how a neutral-temperature, fifth generation network should be planned and setup, and what are the consequences on the main system components sizing. On the other hand, FLEXYNETS developed technical solutions for substations and control strategies adapted to the utilization in these district heating and cooling networks.
How can cities use the technology?	Several utility companies, from small to large, operating in the district heating and electricity markets are nowadays demonstrating the technology in different sites over Europe. H2020, FESR and first commercial projects can be contacted to know more.
Environmental impact	N/A
Project coordinator’s contact details	Roberto Fedrizzi Coordinator Sustainable Heating and Cooling Systems EURAC Research Institute for Renewable Energy Roberto.fedrizzi@eurac.edu

3.16 GEOCOND

Project name	**GEOCOND**
Call identifier	H2020-LCE-2016-RES-CCS-RIA
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://geocond-project.eu/
Amount of EU funding (in EUR)	3,955,740
Other public or private project funding sources	N/A
Replication/implementation potential	4****
What is it?	GEOCOND, with a unique consortium of Companies and leading Research Institutions in the area of SGES and Materials, focuses on four key development areas in a synergetic and system-wide approach: development of new pipe materials, advanced grouting additives and concepts, advanced Phase Change Materials and system-wide simulation and optimization.
When can I use it?	The project will be ready for deployment in approximately 12-18 months after its conclusion. The current TRL of the project results is set between 5-7 depending on the products. Those products are being tested and evaluated in real environment to quantify the benefits and efficiency gains.
Where can I use it?	Project results could be applicable worldwide, especially in those regions with a vast tradition in shallow energy systems for heating and air conditioning buildings. In Europe, where the SGE was firstly implemented there is a vast potential and interest for using our project results.
Why should I use it?	The developments associated to the framework of the project will allow increasing the efficiency of the shallow geothermal systems for H&C. Furthermore, one of our main goals is the reduction of the initial investment, as one of the major barrier of the technology, by means of reduction of the total borehole length associated to the installation thanks to the use of our innovative solutions for groutings and pipes.
Project size	Amongst SGES, closed loop systems with vertical Borehole Heat Exchangers enjoy the widest deployment in the EU where the total installed number of GSHP units amounts nowadays to about 1,4 million, representing an installed capacity of about 16.500 MWth. Against this background, there is still a need to remove market barriers and gain competitiveness, but also to develop the next generation of geothermal systems with new materials for penetrating further the market of building construction and renovation. Also the area of District Heating and Cooling needs improved heating and cooling storage technologies which could largely benefit from enhanced Underground Thermal Energy Storage (UTES) technologies. By a smart combination of

	different material solutions under the umbrella of sophisticated engineering, optimization, testing and on-site validation, GEOCOND will develop solutions to increase the thermal performance of the different subsystems configuring an SGES and UTES. An overall cost reduction of about 25% is the overall aim, leading to a substantial gain in competitiveness. GEOCOND, with a unique consortium of Companies and leading Research Institutions in the area of SGES and Materials, will focus on four key development areas in a synergetic and system-wide approach: development of new pipe materials, advanced grouting additives and concepts, advanced Phase Change Materials and system-wide simulation and optimization.
Summary	GEOCOND is a European initiative for developing innovative products and materials for enhancing the performance of shallow geothermal systems. In concrete, our project is focus in the optimization of the grouting products and the pipes materials for increasing the efficiency of the heat transfer between the geothermal heat exchangers and the ground. In many theoretical studies, we have observed that the performance of those systems is limited due to the thermal characteristics of the standards materials. With our solutions, we have optimized the thermal properties of those materials keeping in mind the mechanical performance and the overall costs for triggering a significant increment on the CAPEX.
Project details	GEOCOND is formed by several European Partners with a strong background on the main topic tackled in the project related to the shallow geothermal energy. Our main objectives within the project are related to: Improved thermomechanical ageing resistance and surface properties Geothermal pipes improved (at least 15%) thermomechanical ageing resistance and surface properties (external layer good adhesion to grout and internal low flow resistance). HDPE pipes High thermal Conductive HDPE pipes and fitting elements. New pipes configuration New pipes configuration based on the use of pipes with different thermal conductivities and diameters. New additive for grouting New additive for grouting: Low cost structures based on chemical bondings of silica (quartz) and thermal conductive carbonous particles. Furthermore, Shape Stable Phase Change Materials (SS PCMs) with low transition temperatures (30-35ºC) for heat storage at DHC Tailor-made performance grouting Tailor-made performance grouting and thermal soil enhancement technologies (TSE). Material Selection Support System Material Selection Support System within an engineering methodology to optimize efficiency and minimize costs.

	The achievement of those objectives and the evaluation in real environment will allow establishing the enhancements that have been derived from our actions. The results that have been achieved and are currently under analysis indicates that our products could trigger significant reductions of the required total length for the borehole fields (up to 20 %) with a significant cut down in the initial investment.
First demonstrator site description	Valencia test site (Valencia, Spain). http://www.upv.es The geothermal laboratory of the UPV was selected to implement and evaluate the results of the project. Seven boreholes have been installed and tested here. The different properties of each BHE, the approach methodology of Thermal Response Tests (TRTs) and the results of the analysis from Thermal Response Tests were performed in order to evaluate the performance of the different solutions. Furthermore, the main conclusions that have been extracted in this test site have been presented to demonstrate that the initial hypothesis and goals of our project were mostly achieved in terms of gains in the efficiency and reduction of the total required borehole length. This work contributes to the achievement of all the main GEOCOND project objectives, because it allows to perform a real evaluation of the performance of our systems by means of TRT analysis, a widely extended method for infer the efficiency of the systems. In this sense, it is very remarkable that the achieved results have triggered substantial reductions in the Borehole thermal resistance from values around 0,15 K/(W*m) for the reference standard borehole to values around 0,06 K/(W*m) in the case of the trilobular GEOCOND configurations. Those reduction produce important reductions of the needs for drillings, and/or at the same time will increase the performance and efficiency of the SGE. The field test site is still operative and more additional test will increase the understanding of the systems as well as will permit to reinforce the theoretical models for interpreting the TRT results. Furthermore, the obtained results are translated to the partners in charge of the other test site for the analysis of results and determination of final conclusions.
Second demonstrator site description	In Boras (Sweden) a second test site has been implemented where the main objective was the evaluation of high temperature PCMS added to the grouting products in order to analysis the capacity for heat storage associated to the district heating systems. One pilot borehole (50 m depth) with a tailor-made grout with 20 % of PCM (58`C melting point) was installed. Several cycles of heating and cooling and evaluation similar to the TRT analysis are being currently conducted to evaluate the final performance. Link: http://www.ri.se/en
Third demonstrator site description	Test site in Germany. Finally it is expected to finish with real scale tests totally similar to the standards test to evaluate the performance of

	our developments in Germany. In those installations will be installed our enhanced heat exchangers and will be compared with similar boreholes performed with standard products. Those tests will allow to extract final conclusions about the real gain in efficiency supplied by our enhancements derived from the project. Link: http://ubeg.de/
How can cities use the technology?	SGE are a well-known solution for H&C in many European regions. Northern countries such as Sweden and Germany were pioneers in the use and optimization of those systems in last decades. Nowadays, with the enhancements derived from our project, we expect to increase the attractiveness of the technology by means of using more advanced materials with a better thermal performance. The translation of those benefits could be firstly related to reduction of the initial investment but also in an increment of the performance during the life span of the installations. In this context it is important to highlight that the SGE are considered as RES and with a significant impact in the reduction of the H&C energy demands. For this our project optimized products may be used by cities to promote the use of this environmentally friendly solution for covering the important amount of thermal demands from buildings.
Environmental impact	The use of SGE systems for H&C applications could trigger significant reduction of primary energy. This question has been deeply tackled in multitude of articles and publications and it is generally accepted that this could reduce between 50-60 % of the total energy derived from convectional sources (chillers, heaters, radiators, etc.). In this sense, our enhancements are focused on the increment of efficiency on the systems in such a way that the performance of the geothermal pump will be optimized and will demand lower primary energy for supplying the same amount of thermal energy. Our estimations justified and assumed in the project is that we could increase the performance up to 20 % respect to the current state of the art of the SGE systems. The reduction of the CO_2 emissions associated to those systems are qualitatively very high due to some of the alternative solutions such as chillers demand the use of fossil fuels with comparatively low values of coefficient of performance.
Project coordinator's contact details	Javier Urchueguía Schözel GEOCOND's Project Coordinator. Email : jfurchueguia@fis.upv.es Telephone : 0034963877000 School of Industrial Engineering Universitat Politècnica de València Camino de Vera s/n 460022 Valencia (Spain)

3.17 GeoDH

Project name	**GeoDH – Geothermal District Heating**
Call identifier	IEE Call 2011, RES H/C
Type of action	Cooperation and Support Action (CSA)
Project logo	
Project website	http://geodh.eu/
Amount of EU funding (in EUR)	760,920
Other public or private project funding sources	Total budget – €1,014,560.00
Replication/implementation potential	**5*******
What is it?	GeoDH is an EU funded project that aims to accelerate the uptake of geothermal district heating systems in Europe
When can I use it?	GeoDH is a technologically mature solution with a significant market uptake. In order to support its full market deployment, tailored regulatory and financial conditions should be established and a series of barriers should be resolved (i.e. risk mitigation schemes, permission procedures etc.)
Where can I use it?	There are no technical limitations to the deployment of geothermal DH in Europe. Geothermal district heating systems can be developed in all Member States. Moreover, more than 25% of the EU population lives in areas directly suitable for geothermal district heating systems.
Why should I use it?	The main benefits of geothermal district heating are the provision of local and renewable source of energy, diversification of the energy mix, reduction of fossil fuel imports and protection against volatile and rising fossil fuels prices. Geothermal DH can ensure security of supply and provide opportunities for economic growth in form of job creations.
Project size	GeoDH focused on 3 different groups of countries with juvenile, in transition and mature markets. The target countries of the project: - juvenile geothermal DH markets in NL, UK, IE, BG, RO; - in transition: HU, SI, SK, CZ, PL, DK; - mature: DE, FR, IT
Summary	GeoDH succeeded in the acceleration of approval procedures for geothermal DH, developed innovative financial solutions for supporting investments in geothermal DH systems. The project also succeded in increasing the market penetration of geothermal DH systems. As a result, a total of 16 new plants (approx. 16 MWth) become operational over the project timeline (2012 – 2014).
Project details	The work of GeoDH has been structured around the three main areas: - mapping GeoDH resources; - market barriers and regulations; - management and financing;

	GeoDH published several reports that are focused on the above-mentioned areas: 1. Map viewer of geothermal resources for DH across 14 EU Member States - http://map.mfgi.hu/geo_DH/ 2. Report on the potential for geothermal district heating - http://geodh.eu/wp-content/uploads/2014/11/GeoDH-Report-D-2.2-final.pdf 3. Report on Evaluation of Market Barriers for geothermal district heating in Europe - http://geodh.eu/wp-content/uploads/2014/11/FINALGeoDH-Report-D-3-3-Evaluation-market-barriers.pdf 4. Report on recommendations for a regulatory framework for geothermal district heating in the EU - http://geodh.eu/wp-content/uploads/2012/07/D-3.5-GEODH-Regulatory-Framework-17-02-2014.pdf 5. Report on business models for geothermal DH - http://geodh.eu/wp-content/uploads/2012/07/4.2-Business-Models.pdf 6. GeoDH manual for implementing sustainable support schemes for geothermal district heating - http://geodh.eu/wp-content/uploads/2014/11/4-1-Report-on-support-schemes-for-GeoDH.pdf
Demonstrator site description	In its final report "Developing geothermal district heating systems in Europe", the GeoDH project outlined its main conclusions and recommendations for developing successful geothermal DH projects all over Europe - http://geodh.eu/wp-content/uploads/2012/07/GeoDH-Report-2014_web.pdf Furthermore, a know-how has been achieved via the elaboration of best practices and training of national and local authorities (more than 500 trainees). An online GIS viewer showing the potential of GeoDH in 14 Member States has been elaborated and can be accessed here – http://map.mfgi.hu/geo_DH
How can cities use the technology?	Geothermal district heating systems can vary in size: small (from 0.5 to 2 MWth) to large (50MWth). This indicates that GeoDH systems are suitable in size for whole cities, large metropolitan/urban areas, and smaller villages. The GeoDH report on "Developing geothermal DH systems" provides a comprehensive overview of the main benefits of this technology, as well as recommendations for replicating this renewable solution all over Europe. The following aspects are crucial in succeeding to replicate this solution: 1. Increasing awareness amongst decision-makers and investors 2. Developing innovative financial schemes to support investments in GeoDH 3. Establishing a functional regulatory framework for establishing geothermal district heating networks Furthermore, it has also developed a Guide on project management for geothermal DH. It provides a step by step

	guidance on the project management process for GeoDH project developers - http://geodh.eu/wp-content/uploads/2012/07/WP-4.3_Guide-on-project-management_final.pdf
Environmental impact	Geothermal district heating systems are based on a renewable source of energy with no carbon emissions. The case study of the Orly Airport in Paris (outlined in the above-mentioned report) highlights that the use of geothermal energy for heating its buildings reduces its carbon emissions by 9000 tons per year.
Project coordinator's contact details	Philippe Dumas, EGEC Secretary General p.dumas@egec.org +32 2 318 40 61

3.18 GEOENVI

Project name	**GEOENVI**
Call identifier	H2020-LC-SC3-2018-RES-SingleStage
Type of action	Cooperation and Support Action (CSA)
Project logo	GEOENVI
Project website	www.geoenvi.eu
Amount of EU funding (in EUR)	2,495,871
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	The GEOENVI project engages with all geothermal stakeholders to ensure the exchange of best practices and the test of harmonized methods in selected areas and then, to facilitate its replication across Europe.
When can I use it?	One of the main results of the project is the development of a simplified Life Cycle Assessment methodology, which can calculate the environmental impacts and benefits of geothermal projects in only 1 day. It can be used as from the end of the GEOENVI project.
Where can I use it?	It can be used in any area where a geothermal project is planned.
Why should I use it?	The GEOENVI Life Cycle Assessment methodology will help the developers of deep geothermal energy projects and decision-makers to evaluate the environmental performance of their planned project, without any burden for them. Its use will help to assess what benefits will result from the development of the geothermal project and allow public acceptance.
Project size	The GEOENVI project focuses on six key countries with varying deep geothermal potential, markets maturity, and geological settings: France, Italy, Belgium, Iceland, Turkey and Hungary. These countries have been selected because they present different and complementary geological settings, as well as profiles of environmental concerns. By collecting information in these countries, knowledge gained in experienced markets can be made accessible and transferred to stakeholders in less developed markets all over Europe.
Summary	The GEOENVI project aims at answering environmental concerns in terms of both impacts and risks, by first setting an adapted methodology for assessing environment impacts to the project developers, and by assessing the environmental impacts and risks of geothermal projects operational or in development in Europe. The project will propose recommendations on harmonised European environmental regulations to the decision-makers and elaborate simplified LCA models to assess environmental impacts. Deep geothermal has a great potential for development in many European countries. However, the advantages of using

	geothermal for power production and heating & cooling are not widely known. Recently, deep geothermal energy production in some regions is confronted with a negative perception, particularly in terms of environmental performance, which could seriously hamper its market uptake. Thus, environmental impact assessment is a prerequisite to the deployment of the deep geothermal resources.
Project details	The GEOENVI project will 1. map environmental impacts and risks, as well as their perception, and define how the environmental footprint of deep geothermal plants in Europe is measured in different countries. 2. build a harmonized methodology to assess the environmental impacts of geothermal plants using a life cycle approach 3. engage decision-makers and market actors to adopt recommendations on regulations and to see the LCA methodology implemented by geothermal stakeholders.
Demonstrator site description	N/A
How can cities use the technology?	The GEOENVI methodology can help cities to plan their investment in geothermal projects and make sure they are accepted by the local communities.
Environmental impact	N/A
Project coordinator's contact details	EGEC Geothermal – Philippe Dumas: p.dumas@egec.org

3.19 GeoHex

Project name	**GeoHex**
Call identifier	H2020-LC-SC3-2019-RES-TwoStages
Type of action	Research and Innovation Action (RIA)
Project logo	GEOHEX
Project website	https://www.geohexproject.eu/
Amount of EU funding (in EUR)	4,989,401.25
Other public or private project funding sources	N/A
Replication/implementation potential	2**
What is it?	GeoHex - Advanced materials for cost-efficient and enhanced heat exchange performance for geothermal application - will develop advanced materials with anti-scaling and anti-corrosion properties for cost-efficient and enhanced heat exchange performance, allowing the energy of the earth to be harnessed more effectively in geothermal applications.
When can I use it?	Surface modifications, with a particular focus on coatings, will be used to enhance heat transfer and scaling performance in GeoHex and the current TRL for the coatings that will be developed in the project are aimed at TRL 4.
Where can I use it?	Heat exchangers are used in a variety of industries including power generation, automotive and aerospace and are utilized throughout the world. The technologies developed in GeoHex therefore have the potential to allow radical efficiency savings to be realised not only in geothermal but also other wider range of industries. Thermal management in the automotive sector is becoming ever more important with the larger role being played by electric vehicles and therefore materials developed in GeoHex might also be able to make an impact in this sector.
Why should I use it?	Cheaper and more efficient. Heat exchangers in geothermal applications are exposed to extreme conditions involving corrosive media and their heat exchange performance can degrade with time resulting from the buildup of deposit. GeoHex coatings will limit the scaling buildup, improving efficiency, but also will protect the underlying material from corrosion, so that cheaper materials can potentially be used.
Project size	GeoHex is a research project looking at improving HXs.
Summary	Geothermal is a clean and flexible energy source which can play a crucial role in stabilising the power grid against fluctuations related to the increasing utilisation of renewable energy sources, that are intermittent. Heat exchangers in geothermal organic Rankine cycle plants make up a large proportion of the total cost of the plant and therefore improvements or cost reductions in this area will have a huge impact on the overall profitability of the plant. The limitations of the current heat exchanger materials stem from their reliance on corrosion resistant alloys (CRAs) such as stainless steels, titanium etc. These alloys are : a. Expensive

	b. Have high surface energy: resulting in scale/deposit build up and degradation of performance c. Have low thermal conductivities resulting in poor heat exchange performance. The utilisation of carbon steels instead of CRAs will allow cheaper heat exchangers to be produced and will also increase the efficiency of heat exchangers because of their higher thermal conductivities. However the geothermal heat exchangers are in contact with corrosive fluids, which might cause carbon steels to corrode. Therefore the primary aim of GeoHex is to develop coatings so that carbon steel heat exchangers are protected from corrosion, whilst the coatings also act to enhance heat transfer performance. This will have the dual effect of lowering costs and improving performance.
Project details	Low temperature geothermal resources or waste heat from flash or dry steam geothermal power plants can be utilized in an organic Rankine cycle (ORC). AN ORC consists of an evaporator where the hot geothermal fluid passes on one side, heating up a low boiling point refrigerant on the other. The boiling point of the refrigerant is lower than that of water and is chosen so that boiling occurs given the temperature of the resource. The refrigerant, in the vapor phase, is then passed through a turbine to produce energy. The other primary component of the ORC plant is the condenser which allows the refrigerant to return to a liquid state before being passed into the evaporator again. The ORC also includes ancillary heat exchangers such as pre-heaters, super-heaters and various pumps. In an ORC the corrosive geothermal fluid does not come into contact with the turbine, as would be the case for flash or dry steam systems, but does come into contact with the heat exchangers. GeoHex will focus on the development of a range of different coating solutions for brine/separator water facing and working fluid facing surfaces. The coatings can broadly be categorised into two based on their function. Anti-corrosion coatings will be utilised on the brine side, and these will be electroless nickel and amorphous, Ta:Si based, coatings. Heat transfer enhancement coatings will be utilised on the working fluid side and these will include, thermal spray, carbon nanotube, sol gel and mesh coatings. These coatings will allow surface chemistry and surface structure to be optimized to result in optimal heat transfer performance. Heat transfer enhancement coatings will be utilized in the evaporator to enable conditions for sustained nucleate boiling, therefore maximising the heat transfer coefficient. Heat transfer enhancement coatings will also be utilized in the condenser to allow drop wise, rather than film wise condensation to occur, with drop wise condensation allowing more efficient heat transfer than film wise. As well as the development of coatings and testing to demonstrate their efficacy, GeoHex will also focus on numerical modelling to understand bubble/droplet dynamics

	in boiling and condensation, allowing surfaces to be further optimized for performance.
Demonstrator site description	The project is in its early stages. More information will be available at the end of the project in 2022.
How can cities use the technology?	Geothermal energy is increasingly being use for district heating and the development of more cost effective and more efficienct ORC's will allow lower temperature resources to be utilised more effectively and will mean that resources are now viable. The wide spread adoption of geothermal energy will be significant to reduction of CO_2 emissions.
Environmental impact	Reducing the HXs cost by 4-86% resulting in a decrease of specific ORC cost by more than 4.3-33% Net saving of €432,518 /MW for ORC based on air cooled condenser deployed in corrosive geothermal environment. (sec2.1) Save 12,377 kg of material per MW, 9,772 kg of CO_2/MW, 256,679 litres of water/MW For the ORC plant handling aggressive geofluid, save 13,178 kg of Ti or CRAs per MW, 590,661 kg of CO_2 per MW and 11,829,015 litre of water per MW Achieve at least 15% increased overall thermal efficiency, 10% decrease of OPEX, 20% improvement in environmental performance and resource efficiency at the lifecycle stage of geothermal ORC plant
Project coordinator's contact details	TWI Ltd., Granta Park, Great Abington, Cambridge, CB21 6AL, UK Email: info@geohexproject.eu

3.20 GEORISK

Project name	**GEORISK**
Call identifier	H2020-LC-SC3-2018-RES
Type of action	Cooperation and Support Action (CSA)
Project logo	GEORISK
Project website	https://www.georisk-project.eu/
Amount of EU funding (in EUR)	€ 2,184,118.38
Other public or private project funding sources	Total budget – € 2,184,118.38
Replication/implementation potential	5*****
What is it?	GEORISK is an EU funded project that aims to accelerate the uptake of geothermal derisking schemes in Europe and in key third countries
When can I use it?	Geothermal risk mitigation schemes, or derisking, is a proven mean to support the market uptake of geothermal energy projects, mitigating the financial risk linked to the project.
Where can I use it?	Geothermal risk mitigation schemes can take many forms and be implemented throughout Europe.
Why should I use it?	Risk mitigation schemes are proven solutions to accelerate the market uptake of geothermal technologies, and can be applied to other renewables. They reduce the cost of capital and can attract new actors to the market.
Project size	GEORISK is aiming at the establishment of a European geothermal derisking scheme. Meanwhile it is focusing on some target countries: - Hungary, Greece Poland… - Non-EU: Canada, Chile, Kenya…
Summary	GEORISK project work promotes the establishment risk insurance all over Europe and in some key target third countries to cover the exploration phase and the first drilling (test). It means activities to be funded before financial institutions and IPP funding the confirmation drilling and surface systems. It appears clear that a risk mitigation scheme must be designed according to the market maturity of the sector.
Project details	GEORISK is structured around the following tasks : - Assessment of the risks that may need to be mitigated by schemes, leading to the establishment of a GEORISK tool for risk assessment, analysis. - Analysis of risk mitigation to understand the impacts and requirements of various risk mitigation schemes, leading to a set of recommendations for the establishment of geothermal derisking schemes according to market maturity. - Promotion of geothermal derisking schemes and projects results in target European countries - Promotion of geothermal derisking schemes and projects results in target third countries

Demonstrator site description	Set up of a GEORISK tool to allow an easy access to analysis of geothermal project risks https://www.georisk-project.eu/georisk-tool/ Set up of a GEORISK helpdesk to accompany public authorities looking to establish geothermal derisking schemes https://www.georisk-project.eu/helpdesk/
How can cities use the technology?	Geothermal derisking can take many forms and be implemented in many different ways. Cities can use national geothermal derisking to accelerate and lower the cost of implementing their heating and cooling decarbonisation plan with geothermal district heating and cooling and/or cogeneration. They can also chose to establish their own derisking schemes to accelerate local developments in case national schemes are not adequate with regards to the cities' policy planning. Geothermal district heating and cooling has been identified by ADEME, the French Energy agency (and home of one of the most successful geothermal derisking scheme) as the most affordable solution for renewable heating and cooling with prices as low as 15€/MWh)
Environmental impact	Geothermal district heating systems are based on a renewable source of energy with no carbon emissions.
Project coordinator's contact details	Philippe Dumas, EGEC Secretary General p.dumas@egec.org +32 2 318 40 61

3.21 GrowSmarter

Project name	**GrowSmarter**
Call identifier	H2020-SCC-2014
Type of action	Research and Innovation Action (RIA)
Project logo	GrowSmarter Transforming cities for a smart, sustainable Europe
Project website	www.grow-smarter.eu
Amount of EU funding (in EUR)	25,000,000
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	A technology that recovers surplus heat and integrate it into existing district heating (DH) networks to meet local heating demands by citizens in an urban environment. An innovative business model has been developed for a yet unexplored potential, where installation of plug and play heat pumps at the waste heat producer facilities the ability to recover the energy into the DH network.
When can I use it?	Waste heat is abundant in cities but rarely used. Data centres and shopping malls with many freezers and coolers generate lots of excess heat which is often costly to get rid of. The technical innovation used is a heat pump model that can produce hot water at a temperature of 85°C instead of around 68ºC.
Where can I use it?	This measure is applicable to any city where there is a heating system nearby into which the waste heat can be fed. The DSO (Distribution System Operator) needs to allow, and pay, for third-party feed-in into the network. Therefore, the upscaling possibility of this measure is good when there is a DH-network in place and a DSO who are willing to apply a waste heat business model towards third parties.
Why should I use it?	Technical feasibility: Since the excess energy recovered is not a high-level heat (25-40ºC), the energy can be consumed either in the return lines or in the supply line after being further heated by efficient heat pumps (using renewable electricity). Economic feasibility The business model is based on the balance between connection/pipe investment and value of avoided other own production due to purchased waste heat. The heat supplier can lower their operating expenditure due to a new income for waste heat and avoid reinvestment cooling system costs. Replication potential: If the foundation is in place, focusing on the data centre segment (a growing worldwide business where the cooling demand is the same throughout the year) is seen as a promising replication area.
Project size	What did GrowSmarter do? The potential for heat recovery in Stockholm alone is estimated at 1 TWh annually, and the district heating utility Stockholm Exergi has developed this

	innovative approach called Open District Heating (OpenDH). Within GrowSmarter, the utility company Stockholm Exergi has delivered two heat recovering projects: one local supermarket and a data centre in the city. The heat recovered in those two projects is then injected into the existing DH network of the area. The installation at the supermarket proved to be promising, and the initial results showed the heat production from the freezers and coolers to be stable and economical feasible during a larger part of the year than originally expected. Only initial results are available, as the supermarket stopped the testing after a change of ownership. The implementation at the data centre proved very successful both for Stockholm Exergi and the data centre owner Glesys. The heat reuse of the data center chosen for the GrowSmarter project is expected to increase gradually to a level of approximately 1MW heat, a heat recovery that is sufficient to heat more than 1,000 apartments while reducing annual CO2 emissions in Stockholm
Summary	This solution was one of twelve smart solutions carried out in the GrowSmarter project. The project GrowSmarter stimulated city uptake of 'smart solutions' by using the three Lighthouse cities (Stockholm, Cologne and Barcelona) as a way to showcase 12 Smart City solutions: from advanced information and communication technology and better connected urban mobility, to incorporating renewable energy sources directly into the city's supply network.
Project details	GrowSmarter: transforming cities for a smart, sustainable Europe In a rapidly urbanising world cities need to become smarter to respond to citizen needs and to reduce their environmental footprint. GrowSmarter brought together cities and industry to integrate and demonstrate '12 smart city solutions' in energy, infrastructure and transport, to provide other cities with valuable insights on how they work in practice and opportunities for replication. The idea was to create a ready market for these smart solutions to support growth and the transition to a smart, sustainable Europe.
Demonstrator site description	Sweden's capital city Stockholm has been working on climate change mitigation and adaption since the 1990s. The city is a real frontrunner, with well implemented climate action plans and pioneering policies to ensure it meets its ambitious environmental targets. For leading the GrowSmarter project, Stockholm won the World Smart City Awards 2019 Stockholm is growing rapidly and sometimes faces challenges of both keeping and developing its unique city character. A key priority is to ensure that Stockholm remains a sustainable city, while offering an attractive and inspiring living and working environment. Which smart solutions did we implement? The 12 smart solutions were demonstrated in Årsta, a fast-growing district in the South of Stockholm.

How can cities use the technology?	This measure is applicable to any city where there is a heating system nearby into which the waste heat can be fed. The DSO (Distribution System Operator) needs to allow, and pay, for third-party feed-in into the network. Therefore, the upscaling possibility of this measure is good when there is a DH-network in place and a DSO who are willing to apply a waste heat business model towards third parties.
Environmental impact	The heat reuse of the data center chosen for the GrowSmarter project is expected to increase gradually to a level of approximately 1MW heat, a heat recovery that is sufficient to heat more than 1,000 apartments while reducing annual CO2 emissions in Stockholm
Project coordinator's contact details	Gustaf Landahl Gustaf.landahl@stockholm.se

3.22 H-DisNet

Project name	**H-DisNet**
Call identifier	H2020 EE-13-2015
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	http://www.h-disnet.eu/
Amount of EU funding (in EUR)	2,009,697
Summary	The overarching objective of the project is to establish Hybrid District energy Networks (H-DisNet). The Innovative thermochemical (TC) network technology to be developed would contribute to next-generation district energy networks. The main innovation is the use of thermo-chemical carrier fluids (TCF) that allow loss-free storage and transport of energy potential. The technology will exploit high chemical potential of absorption processes for loss-free transport and storage of energy potential. It will be applied to form an intelligent district network with thermal, electric and gas networks and is expected to: • increase energy efficiency of heat transport and storage, • increase utilization of waste heat and renewables at low temperature • contribute to a wider usage of district networks by allowing heating and cooling in one multifunctional network and by adding the additional services drying and humidity control.
Project details	The project intends to gain the required knowledge about processes, components and network applications and to demonstrate the feasibility to allow the industrial R&D to pick up the technology and to bring it to the market • The partners would develop the TC components and intelligent network technology and demonstrate it in a residential area and in an industry environment to proof the technology's feasibility. • Modelling of TC components serves to carry out simulation of networks. On this basis, smart control strategies and a network identification tool are developed. • Based on simulation, an economic and environmental assessment determines the potential of the technology and allows defining the path to market.
Project coordinator's contact details	Philipp Geyer, philipp.geyer@kuleuven.be

3.23 Heat Roadmap Europe

Project name	**HRE Heat Roadmap Europe**
Call identifier	H2020-EE-2015-3
Type of action	Cooperation and Support Action (CSA)
Project logo	Heat Roadmap Europe 2050 – A low-carbon heating and cooling strategy
Project website	http://www.heatroadmap.eu/
Amount of EU funding (in EUR)	2,113,482.50
Other public or private project funding sources	N/A
Replication/implementation potential	N/A
Summary	The overall objective of the project is to provide new capacity and skills for lead-users in the heating and cooling sector, including policymakers, industry, and researchers at local, national, and EU level, by developing the data, tools, methodologies, and results necessary to quantify the impact of implementing more energy efficiency measures on both the demand and supply side of the sector. Building on the results of former studies (including the IEE supported STRATEGO project) this project will refine an already existing pan European thermal atlas and will among other things include the industrial sector in the calculations. In addition the project foresees to undertake comprehensive study of the heating and cooling sectors in the 14 largest EU countries. HRE4 plans to cover the 14 countries in the EU ranked largest by heat demand covering around 85-90% of the heating and cooling demands in Europe BE, CZ, DE, ES, FR, IT, HU, NL, AT, PL, RO, FI, Sweden SE and UK.
Project details	The project is expected to develop the following: • high resolution thermal maps of 14 EU countries. • energy models and scenarios looking towards 2050 of 14 EU countries. • business strategies identifying current barriers and proposing solutions looking forward. • local and a European Heat Roadmap to help countries identify next steps and optimal solutions to decarbonise the heating sector
Project coordinator's contact details	Brian Vad Mathiesen, bvm@plan.aau.dk

3.24 Heat4Cool

Project name	**Heat4Cool**
Call identifier	H2020-EEB-2016
Type of action	Innovation Action (IA)
Project logo	HEAT4COOL
Project website	www.heat4cool.eu
Amount of EU funding (in EUR)	5,703,012.88
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	Heat4Cool - smart building retrofitting complemented by solar assisted heat pumps integrated within a self-correcting intelligent building energy management system. - develops, integrates and demonstrates easy to install and highly energy efficient heating and cooling solutions at building and district scale, including solar PV, electrically and thermally driven heat pumps, modular PCM thermal storages, and self-adaptive building energy management. The different retrofit solutions at building scale are demonstrated in Valencia, Chorzow and Sofia, whereas district power-to-heat/cool complemented by energy recovery from sewage water is demonstrated in Budapest.
When can I use it?	For what concerns district heating and cooling, the sewage heat utilizing technology with innovative heat exchangers and improved maintenance methods are expected to be ready for deployment by the end of the project.
Where can I use it?	Implementation of sewage heat utilizing solution is possible anywhere provided the necessary communal sewage flows are available – larger, busy-built city areas or in closer proximity to WWTPs. The produced heating/cooling energy is transferrable via DHC pipelines, ideal end users are large energy consumer buildings, building complex or districts.
Why should I use it?	With zero emission on spot and based on a rarely utilized but widely available renewable energy source, large heating and cooling needs can be satisfied, especially in district like solutions. The same energy efficient system construction provides both heating and cooling via electrical heat pumps, also simultaneously. Low maintenance costs couple with flexible implementation (even completely underground).
Project size	Within the four demonstration sites, the site in Budapest is introducing a district-like system construction: the sewage utilization system is supplying three different large buildings from an underground engine house through a small district supply setting.
Summary	At the Budapest demo site an innovative heat exchangers (HEX) and connecting fine screen were developed, manufactured and implemented with the aim of reducing dirt

	accumulation in the system thus enhancing better flow rates, higher energy performance and operation safety. Different HEX cleaning methods have also been researched, trialled and implemented at the demonstration site.
Project details	Focusing on district level and district heating and cooling supply, the Budapest demonstration site presents a sewage heat utilizing technology comprising waste water screening station, sewage water heat exchangers with automatic cleaning, externally reversible heat pump where sewage as a renewable medium is exploited to provide utility heating and cooling for large energy users.
Demonstrator site description	The Heat4Cool project's demonstration site in Budapest District 4, Hungary is showcasing a small DHC supply construction with new innovative heat exchangers and relating fine screen implemented as part of the sewage heat utilizing technological solution. There are two separate circuits supplying different temperature heating/cooling water according to the need of the consumer buildings however their medium originates from one underground engine house where the sewage water – clear water heat exchangers are located. The district supply system connects three buildings for a total heated area of 12,500 m2 to the system: a Mayors Office, a Government Window and a newly constructed Market Hall.
How can cities use the technology?	Through the course of the Heat4Cool project implementation and design guidelines as well as training material have been drawn up to aid future implementation and replication. The sewage heat utilizing DHC solution is replicable where the energy source is available in appropriate flows and energy user consumers are identified in the vicinity. The bigger the system the more sewage source is required but the greater the energy and CO2 emission reduction potentials are.
Environmental impact	In Budapest a unique renewable energy source, the communal sewage, is harnessed to feed a heat pump based technological solution that provides utility heating and cooling (even simultaneously) via DHC network. There is zero emission on spot and due to the outstanding system efficiency reachable with this ideal medium there is high energy saving potential for the end user.
Project coordinator's contact details	Marcello Aprile (Politecnico di Milano) – marcello.aprile@polimi.it
Contact information for demo site or specific solutions	Pal Kiss (Thermowatt) – kiss.pal@thermowatt.hu

3.25 HotMaps

Project name	**Hotmaps**
Call identifier	H2020-EE-2016-RIA-IA
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://www.hotmaps-project.eu/
Amount of EU funding (in EUR)	2,332,803.75
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	Hotmaps developed, demonstrated and disseminated an open-source toolbox to support public authorities, energy agencies and planners in strategic heating and cooling planning on local, regional and national levels, and in-line with EU policies.
When can I use it?	The project ends in September 2020. The toolbox is currently in TRL 7.
Where can I use it?	Heating and cooling strategy development, in particular for municipalities; data for EU-27 + UK; comprehensive assessment of heating and cooling sector on national level
Why should I use it?	Hotmaps toolbox is: - User-driven: developed in close collaboration with 7 European pilot areas - Open source: the developed tool and all related modules run without requiring any other commercial tool or software. Use of and access to Source Code is subject to Open Source License - EU-28 compatible and adaptable: the tool is applicable for cities in all 28 EU Member States by default and users can upload their own data
Project size	The toolbox can be applied to the whole EU-28 countries.
Summary	Main objectives : 1) Develop an open source toolbox (HotMaps toolbox) that will effectively and comprehensively support local, regional and national heating and cooling planning processes. 2) Provide a default open data set to lower the initial barrier in applying the tool for regions across EU-27 member states (+UK) and include the ability that the

	users can adapt and provide more accurate, large and complex data for data for a specific area. 3) Provide a tested and user-friendly open source software tool which is based on user needs. Guarantee wide usability, flexible adjustability and concrete application of the tool within and beyond the project duration
Project details	The Hotmaps toolbox is available online. The toolbox addresses wide range of users from scientific community and consultancies to policy makers. The Hotmaps toolbox is user-driven; meaning that it is developed in close collaboration with 7 European pilot areas. In other words, final users participated in the project and their needs have been reflected into the tool development.
Demonstrator site description	N/A
How can cities use the technology?	A comprehensive Wiki and a manual have been provided besides the toolbox. Additionally, a train-the-trainer concept was followed during the project life in order to disseminate the knowledge of using the toolbox. The heating and cooling strategies developed by Hotmaps pilot cities can inspire future Hotmaps users.
Environmental impact	N/A
Project coordinator's contact details	info@hotmaps-project.eu, kranzl@eeg.tuwien.ac.at

3.26 HP4ALL

Project name	**HP4ALL**
Call identifier	H2020-LC-SC3-EE-2019
Type of action	Cooperation and Support Action (CSA)
Project logo	HP4ALL
Project website	www.hp4all.eu
Amount of EU funding (in EUR)	996,286.25
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	HP4ALL will enhance, develop and promote the skills required for high quality, optimised Heat Pump installations within residential/non-residential buildings bringing Europe to the forefront of the climatization sector.
When can I use it?	Seven partners from five European countries will work for 30 months to ensure that the energy efficiency gains afforded by heat pumps are realised.
Where can I use it?	HP4All will validate its package through three pilot regions in Austria, Ireland, and Spain, with the aim of driving market change, influencing end-user decisions and planning for new innovations. Moreover, the impact of the project will be maximised through the role of three observer countries (Croatia, Portugal and Romania) as they will follow closely the development and validation of the HP4All package, being early adopters even before the project ends.
Why should I use it?	- The HP4ALL package includes: - a HP Competency Framework to facilitate mutual recognition of HP Skills across Europe and the construction sector, - from an end user perspective, a digital HP Knowledge Hub will be created to provide guidance, support and tools e.g. technical information, case studies, procurement guidance to increase the demand for HP skills and knowledge. - A HP Benchmarking Tool enabling end users to consider options and performance of HP technologies within different building types
Project size	- 400 people will receive Capacity Building and guidance interventions at regional/national level to build skills/knowledge on new innovations and HP solutions e.g. smart grid integration, hybrid technologies etc. Large promotional campaigns for end users will be held, - >20 Case Studies/Best Practices showcasing impact of skills on HP performance created,

	- >10 workshops with policy makers, manufacturers and supply chains held, - 10 Campaigns held in DYI Stores and recommendations regarding policy and procurement development. - 20 Leading experts in the HP and Energy sector will support the regional actors to prepare the market for new innovations related to HP technology, procurement and contracting services.
Summary	HP4All brings together leading experts across Europe to enable capacity and skills development within the Heat Pump sector and to ensure that the energy efficiency gains afforded by heat pumps are realised. HP4All, following a holistic, systemic point of view, will work both with the supply side (manufacturers, SMEs, installers etc) and demand side (building owners, public sector etc.). This way, the project will enhance, develop and promote the skills required for high quality, optimised Heat Pump (HP) installations within residential/non-residential buildings bringing Europe to the forefront of the climatization sector. Over 1.1m heat pumps were installed in 2017 across Europe, with the sector seeing a 100% growth since 2006. As the transition to electrification of heat speeds up this growth rate is set to increase further. HP4All will develop the HP4All package, a set of innovative tools and resources to be used by the different related stakeholders. Moreover, a replication plan will be developed, including train-the-trainer actions, roadmap for HP4All package use and an outreach awareness campaign that includes the organisation of a pan-European event targeting public bodies. Thus HP4All will ultimately address HP Skills in all Countries, for all HP Building Types and also all HP Types and Innovations.
Project details	HP4ALL will address the project scope through three different stages: Stage 1: Analysis The first 6 months, the project will be focused on a thorough desktop analysis of the value chain and HP market perceptions and considerations of the impact of skills and knowledge of HPs in the Nearly-Zero-Enerby Buildings (nZEB) market will be reviewed. This will help to identify critical barriers and opportunities for future actions and also enable recommendations in relation to policy and legislation measures. Surveys and data gathering will occur to feed into the development phase: • WP2 Survey of HP experts to gather State of the Art information in 12 EU Countries (Consortium Countries, plus 3 Observer Countries plus other selected regions). • WP3: Survey of educators, trainers and capacity building agencies on competencies and needs for HPs in EU.

	• WP4: Data gathered from building owners, end users and others (using surveys or interviews or events) on their needs and knowledge of skills and capacity relevant to HPs in buildings • WP2 & 5: Engagement with Policy Makers Stage 2: Design & Development At this stage, the development and creation of tools, resources and measures which can affect change in the market will take place. Likewise, competency frameworks need to be identified to specific and highlight critical skills and knowledge along the value chain and resources for end-users created to enable the market to demand highly skilled and knowledge workers in the market. This stage of the project will result in the HP4All Package being developed and available to testing. Stage 3: Piloting & Evaluation Through the application of measures in 3 pilot regions, addressing different market sectors, applications and technology solutions a comprehensive consideration of the change effect of the various measures can be gained. A range of measures will be applied in Austria, Ireland and Spain with 3 other Observer Regions (Croatia, Portugal and Romania) tracking progress and considering the early adoption of HP4All in their countries. Stage 4: Exploitation, Replication and Sustainability HP4All has the ambition to spread the outcomes and lessons learned from its activities across Europe. The critical components of the HP4All Package (Competency Framework, Knowledge Hub, Performance Tool and Awareness Campaign) have the potential for development and exploitation across Europe. By engaging 3 Observer Regions (Croatia, Portugal and Romania) in the project from the outset a framework for replication will be developed already within the project timeframe. HP4All has the ambition to transfer the HP4All Package to 10 more countries by 2025. This will be driven by the project partners but in particular by European Heat Pump Association through its Education and Training Committees.
Demonstrator site description	In Austria HP4ALL will have a specific focus on larger HP solutions which could include DH and networks of buildings. The expertise gathered will be later shared with the rest of the pilot regions and observer regions. In Ireland HP4ALL will consider HPs for networks of buildings, as part of the effort to upgrade all public buildings to B energy rating by 2030, and the project will identify as well skills and competencies needed to enable such installations. Finally, in HP4ALL's State of the Art assessments (on best practice initiatives and training provision) knowledge, data

	and information relevant to HP in heating networks and networks of buildings will be also included.
How can cities use the technology?	In Ireland the project will follow the following regional plan. Austria and Spain will address their stakeholders in a similar way, adapted to each country need. End Users • HP Skills Leaflet for End Users • Promotional Campaigns for End Users in DIY Stores • Case Studies of Exemplar Installations/Knowledge Hub Resources • Workshops for Building Owners/Facility Managers Supply Chain • Capacity Training for HP Installers and SMES on Innovations • 3 Webinars on Technical Innovations • Workshop with Training and Education Providers on Competency Framework • Training Programme for Designers/Specification/Procurement of HPs Policymakers • Meetings with CIF, Engineers Ireland on Competency Framework • Meeting with NSAI, SEAI, DCCAE and HPA on Standards and Best Practice From their part, Austria will have a specific look at larger scale HP installations in particular and hybrid solutions and strong industry (manufacturer) engagement.
Environmental impact	• Primary energy savings 2 GWh/year • Renewables production 1.95 GWh/year • Reduction of 628 tCO_2 /year
Project coordinator’s contact details	Seamus Hoyne seamus.hoyne@lit.ie

3.27 HYPERGRYD

Project name	**HYPERGRYD – Hybrid coupled networks for thermal-electric integrated smart energy districts**
Call identifier	H2020-LC-GD-2020
Type of action	Research and Innovation Action (RIA)
Project logo	HYPERGRYD
Project website	https://hypergryd.eu/
Amount of funding from EU	5.987.875 €
Other public or private project funding sources	n/a
Replication/implementation potential	1*
What is it?	A 3,5-year Horizon 2020 project that aims to provide a set of replicable and scalable-cost effective technical solutions for the integration of renewables-based technologies with different dispatchability and intrinsic variability inside thermal grids and their link with the electrical grids.
When can I use it?	Solutions will be validated at TRL5 in 4 demo sites (Live-in-Labs) under realistic operating conditions. Technologies will be commissioned in March 2024 (Project's month 30), while tools and services will be running from September 2023 or March 2024, depending on the specific solution. Currently, included technologies and tools are at TRL4-5.
Where can I use it?	Technologies and tools are designed to be implemented in DHC networks, with the aim of enabling high-RES DHC networks (4th and 5th generation) where thermal and electric grids are fully integrated. Solutions can enable the exploitation of excess heat and electricity from prosumers and industrial processes, targeting residential, commercial and industrial sectors. Most suitable for application are cold and temperate areas (levels C and D of Koppen-Geiger system).
Why should I use it?	Results from HYPERGRYD can be used to demonstrate how to plan and operate a Smart Hybrid Network based on 4th and 5th generation DHC models, and to prove its environmental sustainability. RES penetration and waste heat recovery in DHC networks will be maximized by integrating renewable technologies, power to heat (P2H) technologies, innovative storage systems and ICT technologies. The project will also demonstrate how end-users can become part of the flexibility energy trading systems, enabling the pathways from a centralized to a distributed smart energy network, where consumers become prosumers.
Project size	Sizes of the Live-in-Labs: - KEZO: 3 buildings, (2 labs, 1 buildig with labs, conferences rooms and guest rooms) - SONNENPLATZ: 8 residential buildings (28 households), 4 commercial/industrial buildings (offices, hotels, commercial, industrial), 6 public buildings. - ENVIPARK: 10 buildings (4 labs, 5 offices, 1 canteen/restaurant) - EURAC: no buildings, only a laboratory.
Summary	HYPERGRYD is a new platform serving as an integrator for the efficient cooperation of renewable energy sources technologies

	towards the IoT ecosystem of DHC network, delivering a compatible and holistic solution for a network of systems and end-users. HYPERGRYD includes the development of RES-based enabling technologies and ICT tools, all integrated in a unique platform allowing to: - Deliver complex event processing and dynamic data analytics and optimization, especially for the intermittent RES operations in DHC networks - Serve as the single service hub for all hardware, end users and stakeholders - Exploit the extensive flexibilities of edge computing - Ease the user engagement through easy set-up and operation - Offer great improvements of connectivity with existing and new systems, sensors, end users and data sources of the 4th and 5th generation of thermal energy networks HYPERGRYD impacts are : - 60% RES penetration in the 4th generation and 80% in the 5th generation DHC, reducing environmental emissions for H/C sectors - Temperature level reduction at 50º-60ºC in the 4th generaiton and at 25ºC in the 5th generation DHC, minimizing grid losses and increasing the integration of heat recovery from industrial sectors and electricity production - Adaptability and scalability of DHC networks connected to local RES, CHP and energy storage - Engagement of users in the energy transition - Primary energy saving increase respect to current scenario
Project details	HYPERGYRD has six main objectives: #1 Development of RES-based enabling technologies for DHC and integration with electrical grids for cost- and energy- efficient decentralized production, improved demand RES share at building and district levels and increased share of variable RES in Smart Hybrid Grids (SHG). #2 Development of innovative tools for RES-enabled District Heating and Cooling (DHC) planning and optimization for the effective improvement of planning solutions and increased RES share in 4th and 5th generations DHC. #3 Development of an integrated ICT platform for coupled networks and interfacing with existing grids, offering seamless transition between different specialized platforms to monitor, analyse and operate the whole system from different aspects and different lifecycle stages. #4 Validation of HYPERGRYD's technical solutions, ICT platform and tools in 4 representative Live-in-Labs (LiL) able to simulate 3rd to 5th generation DHC networks in three different climates (cooling dominated, mid H/C and heating dominated). #5 Engagement of all types of DHC and grid users to ensure a long-lasting appeal of the HYPERGRYD solutions and platforms. #6 Creation of an exploitation and capacity building plan for wide scalability and replication of HYPERGRYD through user engagement.

	TECHNOLOGY SOLUTIONS: - Modular reversible heat pumps with short-term PCM storage - Sorption storage - Reversible CHP with steam engine ICT TOOLS SOLUTIONS: - Interoperable Digital Twin for DHC asset and monitoring data management - GIS-BIM compatible DHC network piping and configuration planning - Exergoeconomic models for 4^{th}-5^{th} generation of DHC - Full-scale dynamic simulation tool for multiple energy carrier coupled network complex - Open-source marketplace tool for energy exchange and trading in Local Energy Communities (LEC) PLATFORM & SERVICES: - Novel Machine Learning (ML) methods for facilitating coupled electric and thermal load forecasting - Anomaly detection and predictive maintenance - Demand Response management and predictive control - Market-aware Demand Response management with self-adapting trading strategies - Enhanced smart edge computing techniques, leveraging IoT and distributed learning - Advanced visualization and easy-to-use functionalities with end-user engagement
Demonstrator site description	HYPERGRYD will perform a wide demonstration campaign relying on 4 demonstration actions with the aim of reproducing the multi-faceted context of DHC, in terms of operating conditions, technological aspects and use cases. The 4 Live-in-Labs are: EURAC (BOZEN, ITALY) - Research Lab - Technologies/tools: CHP steam buffer - Use case applications: - DHC with coordinated operation of heat pumps, storage and PV production; - RES-based CHP for electricity and heat generation and heat pump mode for grid services. ENVIPARK (TURIN, ITALY) - Office district (grid utilities) - Technologies/tools: dynamic simulation tool; Digital Twin. - Use case applications: - Islanded mode for electric and heat demand; - 4^{th} generation DHC high-RES share; - DHC with other energy carriers. KEZO RESEARCH CENTER (JABLONNA, POLAND) - Laboratory and office buildings (academia, public and utilities users)

	- Technologies/tools: heat pump with PCM storage; sorption storage; novel algorithms for heat pump; DHC management. - Use case applications: - Simulation of building, hotel and tertiary loads in small districts; - DHC with coordinated operation of heat pumps, sorption cooling, storage and PV production. SONNENPLATZ (GROßSCHÖNAU, AUSTRIA) - Biomass-based distant heating system - Technologies/tools: GIS-BIM tool; exergoeconomic model; dynamic simulation tool; tool for the local energy marketplace. - Use case applications: - Local energy market for heat and power; - DHC network planning including spatial constraints; - Real data-driven simulation of multi-carrier DHC.
How can cities use the technology?	Cities can use the solutions to retrofit or design new Smart Hybrid Networks based on the 4th and 5th generation DHC networks, where thermal and electric grids synergically operate to maximise the potential of RES and offer flexibility to the grid. Implementation steps (hardware) RES-based enabling technologies for coupled smart energy networks will be integrated in KEZO demo site (Modular heat pump with short-term PCM, RES-based sorption storage for H&C provision and high dispatchability of RES) and EURAC demo site (RES-based small-scale CHP with steam engine and steam buffer). Implementation steps (software) The dynamic simulation tool will be mainly applied to ENVIPARK and SONNENPLATZ demo sites, the exergoeconomic optimization tool, the local energy market exchange tool and the GIS-BIM based Digital Twin platform will be manily applied in SONNENPLATZ. Machine learning models for load predictions and demand response in coupled energy networks will be applied in KEZO, ENVIPARK and SONNENPLATZ demosites, while only in KEZO site the project will implement the edge-computing optimizer and IoT architecture for RES-based DHC, and the high-level control strategies of interacting RES with grid. An HYPERGRYD platform will be developed to be used as an overall umbrella which can be used by end users to monitor data and manage the single tools. Replication potential: - EURAC. The laboratory offers realistic test conditions, with the possibility of imposing properly designed source/load profiles and interfacing with building simulation models to provide H&C profiles. - ENVIPARK. Envipark use cases can be easily replicated when planning a retrofit from 2nd-3rd gen DHC to a Smart Hybrid Network based on 4th gen DHC.

	- KEZO. Proposed demo could be replicated in small district heating systems with a couple of different small tertiary buildings to test applied technologies with developed and optimized algorithms. - SONNENPLATZ. Small-to-medium scale DH networks within Europe. Demo's end users represent very well an average example of available buildings in rural areas in Central Europe.
Environmental impact	A low temperature heating system (4th gen DHC) could achieve a 11% reduction in primary energy supply (120 TWh savings) for heating in HRE4 countries (14 european countries with highest heat demand) according to the Heat Roadmap Europe by Aalbord University https://vbn.aau.dk/ws/portalfiles/portal/288075507/Heat_Roadmap_Europe_4_Quantifying_the_Impact_of_Low_Carbon_Heating_and_Cooling_Roadmaps..pdf. Transition to 4th gen DHC guarantees an avoidance of about 160 Mt CO2eq, 58% of the baseline emissions (where heating is produced at building level by boilers (fueld by NG and LPG). A transition to the 5th gen DHC avoids about 200 Mt CO2eq, 73% of the baseline emissions.
Project coordinator's contact details	Francesco Milani (f.milani@arcbcn.cat) Àngel Font (a.font@arcbcn.cat)
Contact information for demo site or specific solutions	For hardware solutions: Valeria Palomba (valeria.palomba@itae.cnr.it) For software solutions and ICT tools (qianwang@kth.se)

3.29 InDeal

Project name	**InDeal**
Call identifier	H2020 EE-13-2015
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	http://www.indeal-project.eu/
Amount of EU funding (in EUR)	1,992,726
Other public or private project funding sources	N/A
Replication/implementation potential	N/A
Summary	The project aims at improving the efficiency of district heating and cooling networks by improving analysis of heating and cooling demand, fore and now casting weather prediction, development of innovative insulation material for pipes and means to actively involve the end consumers. Two case studies are foreseen in order to test the sub-systems and the final system of InDeal in operational conditions: • Real Case Study A in an area with District Heating System in Vransko municipality, Slovenia • Real Case Study B in area with District Heating and Cooling System in France
Project details	The project expects to • develop of innovative insulating materials, innovative pipe design and intelligent piping system • develop a weather forecast tool for forecasting weather parameters • develop an energy demand prediction tool • develop a storage management and monitoring tool • develop an automated decision Support System for DHCS • develop a central monitoring and control platform for DHCS using a web based platform accessible for mobile devices permitting the users to monitor the network's operation and its properties. • undertake life cycle analysis of the system during the lab tests and the real case studies for life cycle cost assessment and quantification of the economic and environmental impact
Project coordinator’s contact details	Kostas Chrysagis, kostas.chrysagis.1@city.ac.uk

3.30 INCUBIS

Project name	**INCUBIS**
Call identifier	H2020-LC-SC3-EE-2019
Type of action	Cooperation and Support Action (CSA)
Project logo	INCUBIS ENERGY SYMBIOSIS INCUBATOR
Project website	www.incub-is.eu
Amount of EU funding (in EUR)	1,999,875
Other public or private project funding sources	50,000 EUR private funding
Replication/implementation potential	5*****
What is it?	Energy Symbiosis is the capture of excess heat/cold produced by industrial activities and its utilization as a source of energy (thermal or electrical) for other industrial and/or urban activities. INCUBIS will unlock the potential of Energy Symbiosis in Europe by deploying a consultancy service specialized in incubating Energy Symbiosis projects. This is achieved by supporting key stakeholders throughout the project´s life cycle and by building their capacity to overcome non-technical barriers and see projects through to their completion.
When can I use it?	The Energy Symbiosis Incubator will start launching its services on May 2021 (TRL8) and will be fully operational as of November 2022 (TRL9).
Where can I use it?	The Incubator´s services will initially (and until October 2022) focus only on the project´s selected demo areas (see below). After that date, INCUBIS will be made available across Europe through the Virtual Incubator Platform
Why should I use it?	Energy Symbiosis has a number of economic, environmental and social benefits, notably: energy cost reduction due to the substitution of primary energy resources with secondary ones; new revenue generation through selling energy that was previously wasted; reduction of CO2 intensity and improvement of overall corporate environmental performance; creation of new local jobs and local investments; generation of strategic benefits due to the reduction of the resource and energy intensity of industrial activity thereby decreasing reliance on nonrenewable and/or critical and/or imported resources whose price is increasingly volatile and supply uncertain.
Project size	The area covered by the project adds up to approx. 28,000 km2 with a total population of approx. 7,500,000 people.
Summary	The overall objective of INCUBIS is to maximize the utilization of industrial waste heat/cold by unlocking the market potential of Energy Symbiosis and thus boosting the decarbonization of European Industrial and Urban sectors. In doing so, INCUBIS will achieve total energy savings of 200GWh/year, trigger €6 Million of investments in sustainable energy, generate benefits of €4 Million, achieve GHG reduction of 55k tCO2-eq/year, and convince 1450 business and 40 industrial parks to commit to energy symbiosis.

Project details	The project will develop and apply a series of tools and services, delivered in person as well as digitally, to support the coordination of energy symbiosis initiatives by providing technical and economic guidance to key stakeholders, helping them with securing public/private investments for funding project development and project implementation activities, training and capacity building within key organizations on all aspects of energy symbiosis and providing policy guidance to public authorities for facilitating the uptake of energy symbiosis in their areas of influence.
Demonstrator site description	INCUBIS will be demonstrated in five areas, each one representing different geographical and administrative scopes, different urban-industrial densities, different sectorial profiles and different legislative, economic, political, and cultural challenges. The five areas are the province of Barcelona in Spain, the city of Dunkirk in France, the South Humber area in the UK, the Agder county in Norway, and Brunsbuttel Industrial Park in Germany.
How can cities use the technology?	INCUBIS aims to support and build capacity of stakeholders that play a key role in the delivery of Energy Symbiosis projects. Cities and municipalities are such stakeholders as they are in the unique position to give permits, tender studies, (co)fund the necessary investments for delivering Energy Symbiosis (e.g. District Heating Networks), etc. The handbooks, guides, methodologies, and digital tools generated by the project will be available to help cities across Europe develop Energy Symbiosis projects in their territories while a comprehensive accelerated education programme will allow them to train their staff. Finally, the project´s experts will always be available to support the process and adapt it to the specific needs of each case.
Environmental impact	INCUBIS will achieve total energy savings of 200GWh/year and GHG reduction of 55k tCO2-eq/year.
Project coordinator's contact details	Georgios Chalkias - gchalkias@iris.cat

3.31 INDIGO

Project name	**INDIGO: New generation of Intelligent Efficient District Cooling systems**
Call identifier	H2020-EE-13-2015
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	www.indigo-project.eu/
Amount of EU funding (in EUR)	2,229,321.25
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	INDIGO contributes to the developments of a more efficient, intelligent and cheaper generation of district cooling (DC) systems by improving system planning, control, and management at all system levels. This is achieved through the development of two open-source tools for planning and simulation, and the design of a ground-breaking DC system management strategy.
When can I use it?	The project has reached an average final TRL5 considering the different developments, so it needs to be replicated in additional demonstration sites before it is a market-ready solution.
Where can I use it?	This solution can be deployed in other DC systems, and even in centralized heating and cooling systems in buildings. Some specific developments, such as an optimizer for the pumping system, can also be deployed in other sectors using similar pumping systems to the ones from DC. The greatest potential for exploitation of the INDIGO developments is in EU, Asia, USA and the Gulf Corporation Council, as they are the regions with greater cooling demand.
Why should I use it?	The INDIGO solution reduces the primary energy consumption of space cooling compared to current DC systems. Moreover, the management system from INDIGO is designed to deal with different types of cooling sources and storage systems, which effectively contributes to the integration of renewables, waste and storage in DC.
Project size	The INDIGO solution was validated in a hospital campus of small-medium size DC network with 11 buildings connected.
Summary	INDIGO aims to develop a more efficient, intelligent and cheaper generation of DC systems by improving system planning, control and management, anticipating the aforementioned scenario. The following objectives were defined to achieve this target: - Contribute to a wider use of DC systems and motivate the competitiveness of European DC market by the development of two open-source tools for planning and simulation. - Primary energy reduction over 45% addressed by a ground-breaking DC system management strategy.

	INDIGO solution achieves reductions in DC primary energy consumption compared to current systems thanks to improvements at different levels: - At building level by anticipating the building needs, the consumer optimizes its cooling needs, reaching energy savings that can be as high as 62% - At distribution level INDIGO cooling losses can be reduced up to 45% increasing at the same time the distribution temperature difference leading to further savings in the generation equipment - Optimal operation of the generation systems due to a suitable coupling between generation, storage and demand leads to additional energy savings that can be up to 50%.
Project details	On the one hand, two open-source tools have been developed within INDIGO to contribute to a wider use of DC systems: - An open-source planning tool for the evaluation/designing of existing/new DC systems have been developed. The tool binds all levels of the DC system together, incorporating a simplified version of a management algorithm. Available here: https://zenodo.org/record/4433825#.YDd462hKjcs . - A specific open-source library with parametric thermo-fluid dynamic models of DC System components, have been worked out. It provides detailed information about physical behaviour for a better system design. Available here: https://zenodo.org/record/1215665#.YDd5OmhKjcs . On the other hand, a new management strategy has been developed to schedule the energy supply in the most optimized way and satisfy the consumer demand at every moment. The overall DC efficiency is maximized, or running cost minimized, considering other factors like greenhouse gas emissions, system payback time, etc. One of its main characteristics is the predictive management, and it integrates consumer demand prediction, energy price forecast and knowledge from fine-tuned models of DC system components. The manager controller optimizes setpoints for lower control layer and integrates a real-time feedback controller. Predictive Controllers have been developed for Buildings and Generation systems, some of them including embedded self-learning algorithms. Additional challenges addressed by the management strategy are the integration of renewable energy sources, dealing with different types of cooling sources, and suitable coupling between generation, storage and demand. The INDIGO developments have been registered with software licensing. Market penetration of intelligent DHC systems will be driven not only by the cost of energy but also by stakeholders'

	capacities to make informed decisions. INDIGO will work on both factors: - Payback time for DC systems will be greatly reduced - Free and open tools, addressed to managers and developers of DC systems and components and to public administrators and end users, that will foster DC penetration.
Demonstrator site description	The developments from INDIGO have been validated at experimental level in the DC of Basurto hospital. A detailed description of this DC can be found in https://zenodo.org/record/2620931#.YDerb2hKiUk together with a description of the M&V procedure followed for the testing-phase. The Basurto hospital satisfies its heating and cooling demand through a DHC, which has a CHP based on a pair of gas engines. The DC production plant has two absorption chillers that work with the waste heat from the CHP, four compression chillers and a small storage that acts as a buffer. The DC network has 11 buildings connected, and its total length is of 2km. The two predictive controllers for the management strategy of the DC plant have been validated in Basurto: a Model Predictive Control (MPC) for the Generation plant, and an MPC for the Distribution network. The controlled operation and efficiency maximization of the system have been tested. In addition, the optimizer for the pumping system of the distribution network have also been tested in Basurto DC. The development for the management of the building's HVAC, consisting also on an MPC, have been tested in a different test-site: a building with some offices in Neuchatel (Switzerland). In this case, the comfort achieved with this control together with the efficiency maximization have been tested. All the public results of the projects can be found in the INDIGO Zenodo site (https://zenodo.org/communities/indigo/?page=1&size=20) or in the project webpage (https://www.indigo-project.eu/).
How can cities use the technology?	INDIGO developments have been designed so that they can be replicated in other places with the minimum effort. The different developments can be adapted to new sites just by modifying some tunable parameters and with automatic tools to recalibrate the specific models of some relevant components with manufacturer or operation data. Guidelines about Predictive Control development and implementation in DC systems are available in https://zenodo.org/record/2536385#.YDejSGhKiUk , where the main lessons learned during the project are gathered. This document should be checked when replicating the INDIGO solution in other sites.
Environmental impact	INDIGO solution achieves reductions in DC primary energy consumption compared to current systems thanks to improvements at different levels:

	- At building level by anticipating the building needs, the consumer optimizes its cooling needs, reaching energy savings that can be as high as 62% - At distribution level INDIGO cooling losses can be reduced up to 45% increasing at the same time the distribution temperature difference leading to further savings in the generation equipment - Optimal operation of the generation systems due to a suitable coupling between generation, storage and demand leads to additional energy savings that can be up to 50%. This reduction in primary energy directly helps the environment as it reduces the air pollution, greenhouse gas carbon dioxide and ozone-destroying refrigerants. By making easier the intrusion of free-cooling systems and renewable as well as waste energy, CO_2 emissions will be reduced even more than in conventional DC systems.
Project coordinator's contact details	Susana López Pérez Tekniker susana.lopez@tekniker.es +34 600 499 789 +34 943 20 67 44
Project name	Gorka Naveran Lanz Giroa-Veolia gorka.naveran@veolia.com +34 688 62 52 03 +34 944 02 10 60

3.32 KeepWarm

Project name	**KeepWarm**
Call identifier	H2020-EE-2017-CSA-PPI
Type of action	Cooperation and Support Action (CSA)
Project logo	
Project website	https://keepwarmeurope.eu/
Amount of EU funding (in EUR)	2,098,488.50
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	KeepWarm - Improving the Performance of District Heating Systems in Central and Eastern Europe - supports the modernisation of District Heating Systems (DHS) in Central and Eastern Europe and the reduction of greenhouse gas emissions by improving system operations and promoting a switch to less-polluting sources, like renewables. The project partners strive to ensure that best practices for environmental-friendlier heating and cooling will be taken up across Europe, replicating KeepWarm's approach in other countries and regions, even beyond the end of the project.
When can I use it?	KeepWarm's approach can be replicated already.
Where can I use it?	KeepWarm's approach can be replicated by DHS all over Europe, especially central and eastern regions.
Why should I use it?	Recommendation guidelines to: • enhancing interaction with policy makers who are able to integrate DHS in national strategies and to establish support schemes • elaborate tailor made capacity building approach, which increases the capability of staff to expand own vision as well as opportunities in ensuring sustainable retrofit actions • attract funding by reusing one of KeepWarm replicating models for DHS retrofitting • strengthen capacities on optimizing DHS plant, grid, consumer relations, management and energy input • develop viable business plans for attracting investment • enhance policy interactions to integrate the modernization of district heating networks into local to (inter-)national strategies and action plans
Project size	District Heating Systems in Central and Eastern Europe: in Austria, Croatia, Czech Republic, Latvia, Serbia, Slovenia and Ukraine.

Summary	KeepWarm's objective is to accelerate cost-effective investments in the modernisation of DHSs. It brings together eleven project partners from a variety of relevant sectors (energy agencies, national DHS associations, agricultural chambers, city networks, research institutes, consultancies on energy efficiency and NGOs) to target seven countries across Central and Eastern Europe – Austria, Croatia, Czech Republic, Latvia, Serbia, Slovenia and Ukraine. Within this region, DHSs are frequently still inefficient and for the most part keep overly relying on fossil fuels (oil, gas or coal). The aim of this initiative, launched in April 2018, is to modernise DHSs around the whole region and reduce greenhouse gas emissions by improving system operations and promoting a switch to less-polluting sources, like renewables. The project partners ensure that best practices for environmental-friendlier heating and cooling are taken up across Europe, replicating KeepWarm's approach in other countries and regions, even beyond the end of the project in September 2020. As a response to the current state of play of DHSs in the region, the project focuses its efforts on the following improvements, in order of importance: 1. Retrofitting of the existing distribution system, particularly grid and boiler efficiency; 2. Increasing the use of renewable energy sources, including waste-to-energy; 3. Re-use of excess-heat from suitable industrial and commercial processes; 4. Introduction of ICT technologies for heat distribution management. To overcome barriers to district energy deployment in Central and Eastern Europe, KeepWarm conducts the following activities: - Training and Capacity Building - Business Model Development - Attracting Funding for Uptake - Policy Integration - Demonstration Cases
Project details	Within the KeepWarm project trainings have been conducted with a total of 813 participants and 746 training hours, 24 tailor made business models have been developed (3 AT, 4 HR, 3 CZ, 3 LV, 4 SRB, 3 SI, 4 UKR) and investments have taken place. Besides, over 25 working group meetings with different DHS stakeholders engaged have been conducted, 10 retrofitting schemes/ models are elaborated and DHS retrofitting has been promoted in local, regional and/or national action plans.
Demonstrator site description	The KeepWarm Learning Centre is available with resources of interest for DHS operators/owners (and any other interested stakeholders) sorted according to thematic areas, e.g. data

	inputs, business models and funding, financing implementation, technical solutions and cases, sustainable energy sources, policy recommendations, thermal planning tools, materials in other languages (technical, managerial RES and EE, organisational and financial topics): https://keepwarmeurope.eu/learning-centre/, e.g. recent materials: "Keeping Our Cities Sustainably Warm" (https://keepwarmeurope.eu/fileadmin/user_upload/Resources/Promotional_materials/KeepWarm-marketing-brochure-A5-www.pdf) "Showroom of replicable and bankable DHS pilot projects" (https://keepwarmeurope.eu/fileadmin/user_upload/Resources/Promotional_materials/KeepWarm_DHS_Showroom_EN.pdf) KeepWarm country pages incl. replicable DHS demo cases are available: Austria https://keepwarmeurope.eu/countries-in-focus/austria/english/, Croatia https://keepwarmeurope.eu/countries-in-focus/croatia/english/, Czech Republic https://keepwarmeurope.eu/countries-in-focus/czech-republic/english/, Latvia https://keepwarmeurope.eu/countries-in-focus/latvia/english/, Serbia https://keepwarmeurope.eu/countries-in-focus/serbia/english/, Slovenia https://keepwarmeurope.eu/countries-in-focus/slovenia/english/ Ukraine https://keepwarmeurope.eu/countries-in-focus/ukraine/english/.
How can cities use the technology?	Cities can make use of KeepWarm's recommendations and other inspirational/practical resources of our Learning Centre, in particular our recent guidance booklet "Keeping Our Cities Sustainably Warm" on switching to decarbonised DH solutions (https://keepwarmeurope.eu/fileadmin/user_upload/Resources/Promotional_materials/KeepWarm-marketing-brochure-A5-www.pdf) and our "Showroom of replicable and bankable DHS pilot projects" (https://keepwarmeurope.eu/fileadmin/user_upload/Resources/Promotional_materials/KeepWarm_DHS_Showroom_EN.pdf) Otherwise, it is important that cities first and foremost liaise with their own local DHSs to ensure that they understand the importance (also politically, environmentally and socially) to retrofit towards efficiency and switch towards renewables and sustainable excess heat sources. This kind of cooperation should also be enshrined within SECAPs (and/or in other related planning processes/documents, e.g. zoning plans, smart city strategies etc.). However, it is important that it not remain just on paper, but rather that cities dedicate specific budget lines (where appropriate) to ensure implementation.

	Additionally, cities should collaborate with each other, and other relevant actors, to exert pressure on higher level policy-makers and funding decision-makers to set up supportive policy frameworks and financial mechanisms that prioritise DHS retrofits and decarbonisation.
Environmental impact	CO2 reduction of about 98.713 tons/year, or 996.782,50 over the course of the entire project, all DHS combined will achieve primary energy savings of at least 500 GWh/year.
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3.33 Life4HeatRecovery

Project name	**LIFE4HeatRecovery**
Call identifier	LIFE Program - Call for proposals CLIMA 2017
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	www.life4heatrecovery.eu
Amount of EU funding (in EUR)	€3,360,079
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	The projects aims to recover low temperature waste heat sources and integrate them in a new generation of smart district heating and cooling networks and redistribute heating&cooling to the customers with the use of heat pump powered substations. Prefabricated skids will be developed to become "Plug&Play" solutions. LIFE4HeatRecovery will demonstrate the concept with four district heating and cooling pilot networks.
When can I use it?	The solution is basically on the market: TRL is 7-8. The development is focused on the economic sustainability of the systems, replicability and in the development of standardized solutions for "plug&play" installations. LIFE4HeatRecovery will study the development of prefabricated skids that allow scalability and replicability of the project's concept.
Where can I use it?	There are no major limitations for this technology. It can be used in almost all climates, especially because the networks proposed can operate providing heating and cooling, also simultaneously, thanks to the use of heat pumps. Low temperature waste heat is widely available in every city and climate. The concept of the project is highly flexible and can be applied also to already existing district heating networks. Prefabricated skids will lower costs and implementation issues. Customized business case analysis will anyway be required.
Why should I use it?	The benefits of the solutions proposed are multiple: - recover low temperature waste heat sources and integrate them in low temperature district heating and cooling networks; - with the use of heat pumps it produces renewable, clean energy; - it allows one to produce heating and cooling simultaneously;

	- users become prosumers, fostering local economy and employment; - the development of “plug&play” solutions with the use of prefabricated skids, reducing installation times and costs; - the development of innovative financing schemes and business models; - the mitigation of the heat island effect, thanks to lower emissions; - high scalability and flexibility of the solutions proposed: the concept could be applied to all generations of district heating
Project size	(to be updated during the course of 2021)
Summary	The largest amount of waste heat available in the urban environment is rejected by low temperature sources, but for traditional district heating systems temperatures are too low to be integrated. LIFE4HeatRecovey recovers energy into DH networks with heat pumps. The solution is based on the water-loop concept of commercial buildings and extended to district and city level: the network is fed by multiple waste heat sources, balancing out users’ energy drawings. In high temperature networks, heat pumps rise waste heat temperature to the network’s level. In low temperature ones, heat recovery is directly performed and heat pumps are needed at consumers’ side. LIFE4HeatRecovery develops a new generation of smart district heating and cooling networks, where low-temperature waste heat is as distributed as consumers are. LIFE4HeatRecovery solutions integrate waste heat from urban wastewater and service buildings, where available along the network, ensuring flexibility and scalability, and reliable, secure and clean thermal energy to consumers. Control strategies assure a thermal balance among diffused energy integration, storage and utilization. Additionally, energy trading strategies manage thermal energy from different sources, and electricity use when convenient. LIFE4HeatRecovery elaborates innovative financing mechanisms based on Public Private Partnerships and active participation models to lower infrastructural costs. This strategy leverages large private capitals, putting together customers, network owners and European interests - pursued through sustainability and recovery plans-, and profits. LIFE4HeatRecovery’s social dimension creates business opportunities and participation: energy users become pivotal protagonists in the heating and cooling market.
Project details	PREFABRICATED SKIDS. LIFE4HeatRecovery will install prefabricated skids (compounds including the necessary hydraulic, electric and control/monitoring hardware and software), to develop and demonstrate a set of units capable of exchanging and storing energy with the DH network.

Prefabrication, standardisation and modularity are peculiar features of the skids developed and innovative steps forward compared to the known pilot plants. Prefabricated skids with this purpose and features are not available on the market, thus prototypes will be designed, manufactured and demonstrated in real DH networks.

BUSINESS MODELS. Despite the climate and environmental advantages related to multiple players providing thermal energy to the network, the practical achievement of this objective poses practical challenges. The distributed generation approach produces heat marketability and management issues due to the fact that any actor connected to the network potentially plays the role of both energy user and provider. However, it also triggers the transition from a monopolistic management to a free market condition.
Management schemes will be studied to promote energy utilisation from urban waste heat sources. The latter will be the basis for business models (Trading Schemes) demonstrating that the solutions can be adopted by different markets, because technically practical, legally suitable and economically viable.

FINANCING SCHEMES. LIFE4HeatRecovery moves forward compared to the traditional public funded infrastructural development. It proposes a risk mitigation approach devoted to attract private financing, based on reliable technical, economic and fiscal information on the one hand, and on balanced packages of private and public funding on the other hand.
The project LIFE4HeatRecovery has clear DEMONSTRATION character, as beneficiaries want to take over from previous laboratory and pilot experience, by testing solutions when connected to 4 real scale networks. Assessing the environmental and economic performance of full-scale systems installed in different social and legal contexts over Europe will permit to cross-fertilise the approaches to rationalise the information public available and produced by the project and to make available the results for further replication.

SOCIAL RELEVANCE/CITZEN ENGAGEMENT. The results of the project have also a wide social relevance, as the single customers are central in the schemes elaborated and they have the opportunity to become protagonists in the energy management of their buildings and community.
LIFE4HeatRecovery will have a strong and positive impact on the local population. The project poses a strong focus on actions for public awareness and communication of results.
LIFE4HeatRecovery indeed recognises the central nature of “social consensus” in climate change mitigation actions: only with the convinced support of the majority of citizens is it possible to implement truly valid climate change mitigation

	policies and to give life to alliances between social and economic development of the area. It is expected that the activity performed will convince 200 people to connect to the district heating networks and that 20 companies will be willing to analyse the opportunity and effectiveness of heat recovery measures when setup at their premises.
Demonstrator site description	(to be updated during the course of 2021)
How can cities use the technology?	LIFE4HeatRecovery shows a high replication character. A multinational approach is needed, as the comparison of multiple solutions and socio-economic boundaries would be impractical with a local or even a national project. The demonstration at the 4 networks, will be supported with dedicated monitoring activities devoted to assess both the climate-environmental and the socio-economic impacts of the solutions implemented. This will include: - monitoring of the demonstration networks - simulation of waste heat recovery penetration scenarios in terms of economical feasibility and technical reliability - elaboration of market uptake scenarios in terms of local jobs created and increase of revenues. Moreover, specific replication oriented activity will be performed: - A database and recommendations for optimal waste heat recovery configurations - Waste heat recovery planning at Early Adopters (beneficiaries) networks - Waste heat recovery planning at Partner Cities (external partners) networks - The elaboration of a GIS tool for urban waste heat recovery opportunities individuation.
Environmental impact	Recovering low temperature heat that cannot be used elsehow and re-using it to replace fossil fuels driven boilers installed at residential and tertiary buildings has a triple positive effect: 1) the Primary Energy use and Greenhouse Gas (GHG) emissions are largely reduced 2) the pollutants emitted from single (gas or oil driven) boilers replaced are avoided 3) the heat island effect is reduced as heat rejected in the environment from human activities is recycled and maintained into buildings. The use of low-temperature waste heat in place of fossil fuels strongly reduces primary energy (PE) consumptions and carbon emissions. The PE and the CO2 emissions related to waste heat can be assumed to be zero; on the other hand, the

	need to use heat pumps to raise the temperature involves electricity consumptions. Considering that the primary energy factor (PEF) of the electric grid is about 2 and that heat pumps can operate with COP values in the range 3-5, one has that the PEF related to these systems is of the order of 0.40-0.66. This is comparable with the PEF of the best high-temperature conventional DH networks and much better (i.e., lower) than the PEF of individual gas boilers (which, even assuming ideal efficiencies, is of the order of 1). A similar analysis can be done for carbon emissions. The carbon emission factor of the electric grid is typically of the order of f_el = 350 kgCO2eq/MWh, while the carbon emission factor for gas boilers is about f_ng = 200 kgCO2eq/MWh. The emission factor for systems based on these heat recovery measures is f_el/COP = 70-115 kgCO2eq/MWh (again for COP in the range 3-5), with carbon emission savings in the range of 40-65 %. The above rough estimates will be refined in the detailed monitoring of the demo sites, where all real system efficiencies (including minor aspects, like thermal losses and pumping consumptions) will be taken into account.
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3.34 MAGNITUDE

Project name	**MAGNITUDE**
Call identifier	H2020-LCE-2017-SGS
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://www.magnitude-project.eu/
Amount of EU funding (in EUR)	3,999,057.50
Other public or private project funding sources	N/A
Replication/implementation potential	2**
What is it?	Bringing flexibility provided by multi energy carrier integration to a new MAGNITUDE
When can I use it?	MAGNITUDE will be able to scale the innovation from its research in key themes concerning multi-energy system integration, with credible expectations of added value outputs at TRL 3 to 4. Since the coupling of different energy markets is not yet considered nor implemented in market simulators , it is envisioned to move from TRL2 to TRL4 “technology validated in lab” or even towards TRL 5 “Technology validated in relevant environment“ as MAGNITUDE will develop, test and validate a multi-energy market simulator based on real-life case studies.
Where can I use it?	The solutions developed in the project can be applied across the EU to provide greater flexibility to energy systems. This flexibility applies has implications for energy system planning as well as decarbonization strategies. It impacts all aspects of an energy system and can provide benefit to sectors where electricity, gas and heat networks are used as energy vectors.
Why should I use it?	The project solutions should be used to increase the synergies between different energy networks, which will give rise to a more efficient, low-carbon, sustainable energy system.
Project size	The project consists of 7 real-life case studies of multi-energy systems.
Summary	MAGNITUDE addresses the challenge to rise flexibility in electricity systems, by increasing the synergies between electricity, heating/cooling and gas networks and associated systems. The project brings technical solutions, market design and business models, to be integrated on ongoing policy discussions. The goal of MAGNITUDE is to design and develop business and market mechanisms as well as supporting coordination tools to enable an improved level of flexibility for the European electricity system, by increasing and optimizing

	synergies among electricity, gas and heat systems. MAGNITUDE aims to: 1. Provide flexibility options to support the cost-effective integration of variable Renewable Energy Sources (RES) and decarbonisation of the energy system, and to enhance security of supply 2. Bring under a common framework, technical solutions, market design and business models 3. Contribute to the ongoing policy discussions in the energy field
Project details	Built upon 7 real life case studies of multi energy systems, located in different European countries, under different regulatory and geopolitical environments and with different technological development levels. The project has four main technical and business-focused objectives: 1. Provide tools and models to enable the mobilisation of flexibility for the electricity system from the integration of multi energy systems' operation 2. Design and develop business and market mechanisms, which will enable the full potential of the flexibility provided. Identify potential regulatory barriers. 3. Validate its technical flexibility assessments and the proposed market and business mechanisms based on real life cross country case studies. 4. Maximise the Impact: Optimize external impact, addressing its results towards electricity, heating and gas related stakeholder groups. The main results can be found on the website, including a benchmark of markets and regulations for ancillary services and an evaluation of future market designs for multi-energy systems.
Demonstrator site description	MAGNITUDE relies on 7 real life case studies of multi energy systems, located in different European countries, under different regulatory frameworks and geopolitical environments, and involving different sector-coupling technologies, stakeholders and business models. The case studies cover 4 main categories of multi energy systems: Industries, Large commercial and/or public sites, District heating/cooling, Individual units. Further info available here: https://www.magnitude-project.eu/case-studies/
How can cities use the technology?	Magnitude is a conceptual project, focused on the European electricity system. However, in the future, cities can use the technology to balance their electricity grids by optimizing their

	energy systems. More specifically, they can use the results of Magnitude to quantify the benefit of multi-carrier flexibility and adapt the regulatory framework to bring these flexibility services to the market. The technology will also encourage wider renewable energy integration as a result of adopting a systems-level approach and greater collaboration among actors in the energy system.
Environmental impact	N/A
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3.35 MAKING-CITY

Project name	**MAKING-CITY**
Call identifier	H2020-LC-SC3-2018-ES-SCC
Type of action	Research and Innovation Action (RIA)
Project logo	Making City
Project website	http://makingcity.eu/
Amount of EU funding (in EUR)	18,089,582.76
Other public or private project funding sources	N/A
Replication/implementation potential	4****
What is it?	MAKING-CITY - Energy efficient pathway for the city transformation: enabling a positive future - is a large-scale demonstration project aiming at the development of new integrated strategies to address the urban energy system transformation towards low carbon cities, with the positive energy district (PED) approach as the core of the urban energy transition pathway.
When can I use it?	Most solutions are ready for replication (TRL8-9)
Where can I use it?	Positive Energy Districts (PED) consist on delimited areas of buildings and public spaces where the total annual energy balance is positive. This consideration requires an intensive energy generation on-site, playing renewables a key role together with low consumption in the buildings and very efficient equipment. District heating and cooling networks help the energy exchange that makes a district positive. MAKING-CITY is implementing three Positive Energy Districts and is defining six more in the fellow cities, covering different scales of cities, as well as different geographic and climate conditions
Why should I use it?	The implementation of Positive Energy Districts contributes to meet EU climate change mitigation and transfor cities into more sustainable environments. The solutions deployed increase share of renewable energies, waste heat recovery, reduce greenhouse gas emissions and improve air quality.
Project size	In Groningen North 6 buildings have been selected to be part of the Positive Energy District with an extension of 17,499m2. Groningen Southeast Positive Energy District has 3 buildings and 27,515m2 and the Positive Energy District of Oulu is composed of 5 buildings with a surface of 15,200m2.
Summary	The main objective of MAKING-CITY project is to develop new integrated strategies to address the urban energy system transformation towards low carbon cities, with the positive energy district approach as the core of the urban energy transition pathway. The project is focused on achieving evidences about the actual potential of the PED

	concept and it is addressing procedures and methodologies to support cities in their long term urban planning towards and adequate energy transition. MAKING-CITY has developed a systematic procedure to support the definition of positive energy districts and is defining a methodology to support the long term planning process as a City Vision 2050. MAKING-CITY is developing innovative business models associated to the PED deployment in order to foster the creation of a business ecosystem behind the PED concept.
Project details	MAKING CITY is deploying a deep co-creation and citizen engagement process to foster further acceptance taking into account the stakeholder ecosystem. A set of solutions is being deployed to reach high performance buildings further than national building standards and codes, new and retrofitted, residential and tertiary. Innovative high performance, cost-effective and RES-based HVAC systems, integrating PV facilities, high performance heat pumps, geothermal heat pumps, solar hybrid panels, energy storage and advanced energy management systems is being demonstrated as the most relevant technologies to reach annual positive energy balance in primary energy units. Innovative solutions for building interaction are going to be developed for maximizing the potential synergies through the optimal management of the energy flows among them, managing appropriately the energy surpluses among the different energy grids and the mobility infrastructures. Low temperature district heating, geothermal-based district heating, seamless grid integration, demand-response strategies and energy storage (tanks, batteries and ground) will favour this interconnection among buildings for sharing energy surpluses among them and other urban areas through the large energy heating system.
First demonstrator site description	GRONINGEN **Groningen North and Groningen South** are the two districts selected to implement the PED concept developed in the MAKING-CITY project. Overall, the PED implementation in Groningen North and Groningen South involves **the retrofitting of residential buildings** (floors, roofs, fronts, windows, smart thermostats and sensors to real-time measuring of energy consumption…) in order to maximise infrastructure performance. **Solar panels** will be installed on the roofs of some buildings and car parks. In addition, **solar thermal panels** will support geothermal heat pumps which are directly connected to **the geothermal district heating system.** The surplus of thermal energy produced by some residential buildings will be stored and used during energy demand peaks. On the other hand, **biogas technology** will be used to collect and “digest” -under high pressure and thanks to bacteria-, waste and waste water produced by public sport and catering facilities.

	A special focus is made on **cycling and electric mobility.** For instance, an existing cycling lane will be converted into **a “SolaRoad”** by the integration of solar panels in its surface able to produce around 60,000 kWh yearly. Moreover, smart charging stations for electric vehicles will be installed and directly connected to the current grid.
Second demonstrator site description	OULU In Oulu, **the district of Kaukovainio** was selected to implement the PED concept developed in MAKING-CITY. Located 3 km away from the city center, this urban area gathers nearly 4,700 inhabitants and is mainly dominated by high-rise buildings and individual houses. Overall, the PED implementation in Kaukovainio are driven by the 2012 Master Plan for “land use, environmental, and transport” which is based on open meetings gathering residents, key players and Oulu representatives. Firstly, **the retrofitting of residential buildings** (windows, home energy controllers to monitor air quality and the energy consumption…) will allow to maximise infrastructure performance. Furthermore, **geothermal technology and solar panels** will support the existing heating district system. One other innovative feature is the installation of geothermal heat pumps and **thermal energy storage tanks** at the earth of the Arina shopping centre. Coupled with solar panels covering the roof of this building, the tanks will assure a seasonal energy storage: on summer, the extra energy produced will be redistributed into the district network (heating and hot water), or stored for winter energy demand peaks.
How can cities use the technology?	MAKING CITY has developed a systematic procedure to support the definition of Positive Energy Districts. In this procedure, a detailed and comprehensive definition of PED is addressed according to the different implementation scenarios, where technical, regulatory, economic and social aspects can condition the suitable solution to reach annual positive balance. A catalogue of solutions of the demonstrations tested in the two lighthouse cities and a set of guidelines according to the different application scenarios is being developed to facilitate designers the identification and combination of solutions to transform a district in a positive one.
Environmental impact	Three PEDs will deliver 60,214m2 of high performance buildings of different typologies, a RES power near to 1,000kW and a potential energy surplus to be shared with other urban areas around 348MWh/yr of primary energy, being the total thermal energy exported 1,264kWhth/yr and the total electricity imported 528MWe/yr. More than 1.4ktons of CO2 emissions will be avoided due to the RES facilities, 73% of the total electricity needs in the demonstrator will be covered by RES and 88% of the thermal energy needs. In terms of primary energy, the RES contribution will be 80%. MAKING CITY will achieve a 63% of improvement and 637tCO2 emissions avoided.

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3.36 MAtchUP

Project name	**MAtchUP – Maximizing the Upscaling and replication potential of high level urban transformation strategies**
Call identifier	H2020-SCC-2016-2017/H2020-SCC-2017 GA-Nr.: 774477
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://www.matchup-project.eu/
Amount of funding from EU	Entire MAtchUP (17.4 Mio €) District Heating act ions of SachsenEnergie: 177,000 € (8.1 Mio. € equity capital from SachsenEnergie)
Other public or private project funding sources	Entire MAtchUP (total funding sources not known) or just DH-actions? For SachsenEnergie: national funding sources (2.5 Mio. €)
Replication/implementation potential	2**
What is it?	*Dr. Robert Franke, Head of the Economic Development Department of the city of Dresden, explains the motivation: "The greatest potential for achieving an energy transition lies in the heating sector. District heating in the cities is a supporting pillar."* For that, SachsenEnergie AG combined three measures to reduce GHG-emissions: (1) increasing the volume of the existing heat storage facility by 7,800 m³ to 14,400 m³ and capability to integrate fluctuating renewable energy sources (RES) into the grid, including installation of long-time measurements systems to observe the operating and charging/discharging behaviour (2) “LowEx”: lowering inlet-temperatures of the entire district heating (DH)-system (3) analysing suitable interconnections of large scale RES-sites to the central DH-system and for development of peripheral areas.
When can I use it?	Solution is ready to deploy if pre-analysis in the particular cities have been carried out: (1) DH-system need for increased thermal storage due to improved operation in a CHP-based DH-system with integration of fluctuating RES (TRL 8) (2) “LowEx”: first test weeks of operational use successful (TRL 6) (3) DH-pipeline concept ready for implementation (TRL 7)
Where can I use it?	Usability for meshed district heating systems with potential to lower inlet temperatures (boundaries from CHP-generation-process and client’s needs.)
Why should I use it?	- Save money and GHG-emissions by improved operation of a DH-system - Reduce thermal losses and increase lifetime of DH-system - Enable integration of RES into a DH-system and flexibilise the heat supply

	- Fulfill ecological, economical and political demands of municipality
Project size	Impact on entire DH-system of Dresden (~600 km pipeline-length; 120,000 households and 5,700 B2B-clients)
Summary	As a municipal energy supplier and partner of the EU-funded project "MAtchUP", SachsenEnergie AG aims to implement the German energy policy goals on a regional and municipal level by reducing CO_2 emissions about 90 – 95 % in 2050 compared to 1990. An important contribution is to couple individual sectors of the energy industry and to view their supply as an interactive system in which energy flows are transferred across sector boundaries in a demand-oriented manner. Kindly supported by HORIZON 2020 (MAtchUP-project), SachsenEnergie implemented an interlinked bundle of Actions in the DH-field to (1) Improve operation of an increased thermal storage unit (2) Lower the temperatures of the DH grid (3) Facilitate connection of a future RES-site to the central DH-grid The majority of households in Dresden are connected to the district heating network, so optimising the district heating supply offers great potential for decarbonisation. New technologies that use renewable energy sources (RES) will be enabled to be coupled into the district heating network.
Project details	The heat supply for 5,700 industrial customers and 120,000 households in Dresden is secured via the central district heating network. This 600 km DH grid is going to be densificated and expanded in the upcoming years. Several construction projects are currently being implemented or planned. The integration of RES into the system has priority. Since the temperature level of technologies using RES is lower, there are considerations to lower the overall temperature level of the district heating network. This would: • reduce exergetic grid losses and fuel costs, • compensate for long-term declining sales through improved building insulation, • lifetime extension of the district heating grid, • lower CO2 emissions. As RES are not continuously available, sufficient capacities must be available to cover the energy demand even in times of low supply. The expansion of RES-plants, again in times of high availability, causes an oversupply of energy and leads to lower electricity prices. Already visible in the fluctuating and increasingly negative prices on the market, the flexibilisation of energy supply is therefore a central component of the German energy transition. In order to integrate a higher share of RES, compensate the volatility and raise the flexibility, within the MAtchUP-project following action bundle was facilitated to carry out by H2020: (1) investigations of operation optimisation of the DH-system. The volume of the existing heat storage

	facility has been increased by 7,800 m³ to 14,400 m³. The new plant can temporarily store approximately 900 MWh of thermal energy. The storage facility serves as a buffer for part of the energy generated from RES. (2) operational assessment of reduced DH-system-inlet temperatures. Perspectively, it can be seen that the supply temperatures will have to be lowered further below the current level in order to feed in the energy generated from RES. In several assets of the DH-grid, different investments in adaption measures might be necessary for that. The lower temperature difference compared to normal operation required larger volume flows to cover the same heat demand. (3) evaluation of DH-pipelining through dense rural infrastructures to facilitate future RES-sites for heat-generation. DH provides several benefits to the citizens of Dresden. In essence, it is a preferable solution regarding investment and operating costs. We keep residents informed about the numerous advantages by use of different marketing measures, as for instance product presentations on our website, local press and social media posts by SachsenEnergie. Furthermore – as a part of the municipal SEAP/SECAP- the overall DH-development in Dresden is part of the political agenda of the city of Dresden. Financial scheme: All measures are financed by H2020/MAtchUP and SachsenEnergie internal funds. Furthermore, for investive parts, german national funding programs are used (combined heat and power act).
Demonstrator site description	Further information on SachsenEnergie's district heating (in german): https://www.drewag.de/wps/portal/drewag/cms/menu_main/privatkunden/produkte/waerme/fernwaerme Dresden Lighthouse interventions detailed definition (Deliverable at MAtchUP project): https://www.matchup-project.eu/wp-content/uploads/2021/10/MAtchUP_D3.14-Dresden_lighthouse_interventions_design_final_2.0-1.pdf Technical information at Webinar « Green District Heating » on 08/03/2022. https://my.hidrive.com/lnk/soULFow9

How can cities use the technology?	In the MAtchUP-reporting all deliverables provide a detailed picture of measures, technologies and methods. Cities may use the technologies by assessing these deliverables and checking similar needs and technological boundary conditions to replicate Dresden's solutions.
Environmental impact	By using an increased heat storage system, the CHP plants selectively run at full load in times of high electricity prices and, if necessary, to store too much generated thermal energy. Therefore, bigger storages displace uncoupled power generation which is less efficient. In case of an oversupply of electricity from wind and sun, it is important to use the surplus energy sensibly in order to avoid having to shut down plants. By lowering inlet temperatures of the grid, the exergetic losses are redced. A saving of 204 tCO2/p.a. could be determined by implementing storage expansion and therefore displacing uncoupled power generation with CHP.
Project coordinator's contact details	Valencia City Council: **Ernesto Faubel Cubells** Innovation Department MAtchUP project Coordinator Email: efaubel@valencia.esv
Contact information for demo site or specific solutions	MAtchUP Office Dresden Mayor | Economic Development Office | Smart City City of Dresden Ammonstraße 74, 01067 Dresden 0049 - (0) 351 - 488 87 52 Email: matchup@dresden.de

3.37 MUSE GRIDS

Project name	**MUSE GRIDS**
Call identifier	H2020-LC-SC3-2018-ES-SCC
Type of action	Innovation Action (IA)
Project logo	
Project website	https://www.muse-grids.eu/
Amount of EU funding (in EUR)	5,877,577.26
Other public or private project funding sources	N/A
Replication/implementation potential	4****
What is it?	MUSE GRIDS aims to demonstrate, in two weakly connected areas (a town on a top of a hill in Italy, Osimo and a rural neighbourhood in Belgium, Oud Heverlee), a set of both technological and non-technological solutions targeting the interaction of local energy grids (electricity grids, district heating and cooling networks, water networks, gas grids, electrical mobility etc.) to enable maximization of local energy independency through optimized management of the production via end user driven control strategies, smart grid functionality, storage, CHP and RES integration.
When can I use it?	Several technical solutions will be developed. The main ones related to DHC will be: - Large insulated thermal energy storage developed by GALU that will be ready for the market within project end (2022) - Smart Electro-Thermal Storage developed by Glen Dimplex ready for the market in 2023
Where can I use it?	The technical solutions could be installed in any Countries in EU and extra-EU. In particular the TES could be integrated in any DHN while the SETS could be installed both in residential and tertiary buildings for heating purposes MUSE GRIDS Planning Tool: An assessment framework that can help energy utilities and cities make local integrated energy planning decisions on their future energy mix and investments, in close correlation with national strategies and local RES potential/energy demand
Why should I use it?	Smart Electro-Thermal Storage: Electric heaters able to act as deferrable loads Large insulated outdoor TES: Pre-insulated easy to install Hot Water TES MUSE GRIDS Planning Tool: First of its kind support tool for planning areas with interacting local energy networks
Project size	MUSE GRIDS solutions will be deployed in two real demo: - Osimo: 35,000 inhabitants. 2,000 users connected with water smart meters

	- Oud-Heverlee: around 40 houses connected to the grid
Summary	MUSE GRIDS project aims to demonstrate, in real-life operational conditions, technological and non-technological solutions adapted to local urban energy grids (electricity, heating & cooling, water, gas, e-mobility) to enable maximization of local energy independence by optimized management of the production via end users' centred control strategies, smart grid functionalities, storage and energy system integration. The interconnection of the existing networks is achieved integrating flexible technologies (EVs, electro-thermal storage, large thermal storage, batteries) and managing them via proper multi-energy Demand Side Management (DSM) driven by end-user habits. Moreover, a multi-energy planning tool for EU cities is under development and will be tested to provide an assessment framework that can help energy utilities and cities make local integrated energy planning decisions on their future energy mix and investments, in correlation with national strategies and local RES potential/energy demand. Cross-cutting activities among the demo are devoted to solve technical, organizational, legal, regulatory and market-related issues and to evaluate solutions from the economic and business points of view. During the first year and half, the activities were focused on the requirements definition, on the design of the overall architectures, the selection of the technologies to be installed in both demo and the definition of a KPIs panel to evaluate the baseline condition to which compare the MUSE GRIDS impacts.
Project details	Large Insulated Outdoor water tanks: GALU' is specialized in manufacturing and delivering customized, easy to install, large size hot water tanks. GALÚ Colossus has superior heat retention capabilities, and it is normally delivered Pre-insulated and pre-finished, minimising on site works making GALU' Colossus a big flexible giant. A specific solution for OSIMO DHN and coupling with local high temperature HP will be realized, considering local weather and internal temperature. A suitable insulation will be identified also facilitating stratification in the TES to avoid thermal losses. GDHVI Power to Heat and SETS: Smart Electric Thermal Storage (SETS) are energy storage technologies in which electrical energy is converted to heat, this heat is then stored within a heavily insulated core until it is needed to meet the space or water heating needs of the property – the SETS cylinder delivering water heating and the SETS heater providing space heating. MUSE GRIDS Planning Tool: the purpose of the framework developed in MUSE GRIDS is to create a streamlined approach for urban and local integrated energy planning that will be able to produce energy system analysis and give a basis for assessing different energy systems scenarios and improving decision-making. The assessment framework (that will be directly integrated in a freeware tool) is to be

	considered a guidance model indicating where the investments in renewable energy and energy efficiency should be directed to. Starting from mapping local energy demand and sources, the tool can be used by municipalities, energy managers and planners, but also by companies, utilities or consultancy companies to screen and make pre-feasibility studies before going into further detailed feasibility studies. Within the Project, special attention will be focused on the engagement of end-users and creation of energy communities. The examination of the social aspects of MUSE GRIDS' innovations will be focused on the evaluation of the social, economic, and environmental impacts of the demo via KPI. Several physical workshops are under organization in all the pilots (also in the virtual ones in Spain, Israel and India) to engage and actively involved the users. In particular, MUSE GRIDS' energy communities will be studied as frontrunners in the development and uptake of novel energy systems. A comparative study of multiple cases in various EU contexts will be carried out.
First demonstrator site description	OSIMO The demosite is the whole town of Osimo (~35,000 inhabitants), in Italy. This is a historical city (low efficient buildings) on the top of a hill in the Marche Region. Indeed, since it has just one point of connection with the national grid/TSO, it configures itself as a municipal microgrid. Most of the energy networks are managed by the local utility ASTEA or by its subsidiary companies (e.g. DEA, the local DSO). Osimo's microgrid is characterized by several distributed generation technologies. The demo will demonstrate that the interaction among several energy networks – gas, electricity, district heating and water network (all assets managed by ASTEA) – together with energy storage systems, will contribute to the decarbonisation of the municipal microgrids. This will be achieved thanks to the optimal coordination of the assets managed by ASTEA in all the energy networks (CHP district heating network, pumping stations on water networks, flexibility of office buildings). MUSE GRIDS' DSM will be applied to ASTEA production assets to minimize interaction with the national grid, operating OSIMO as an energy island.
Second demonstrator site description	OUD-HEVERLEE The last dozen of houses in a rural street (which is at the end of local distribution line) in this Belgian municipality (more or less 40 houses) are currently equipped with a range of technologies to provide a maximum of load shifting potential: fuel cells, batteries, small scale thermal storage and seasonal thermal storage. The distribution line has not been changed in over 30 years, while most buildings are more recent than that. There is already a considerable amount of heat pumps and EVs, and most people use electricity for cooking. The line is thus not fit for additional load, and the local electricity supply is affected by grid problems – phase disbalance, voltage swings, blackouts. The aim is to demonstrate the

	synergy of a neighbourhood strategy for flexibility and grid balancing. In order to accomplish this, a centralized system needs to be able to control all the flexible devices that can shift their electricity consumption. The participating companies (THNK, ABB, ENGIE-LAB) want this neighbourhood to be the first effective Local Energy Community, future-proof thanks to the significant presence of EVs and heat pumps and the effective communication and order of operation in case of a blackout.
How can cities use the technology?	N/A
Environmental impact	OSIMO -25% of NG consumption for H&C -25% of local CO_2 OUD HEVERLEE -25% primary energy consumption -25% of local CO_2 It is estimated to achieve a GHG emission savings equal to 1,750 tCO_2/year. All these numbers are estimation that will be confirmed during the demonstration phase.
Project coordinator's contact details	alessandra.cuneo@rina.org
Contact information for demo site or specific solutions	Osimo: Matteo Lorenzetti – matteo.lorenzetti@gruppoastea.com Odu-Heverlee: Leen Peeters – leen@thnk-e.be

3.38 mySMARTLife

Project name	**mySMARTLife**
Call identifier	H2020-SCC-2016
Type of action	Innovation Action (IA)
Project logo	
Project website	mySMARTLife.eu
Amount of EU funding (in EUR)	21,191,771.50
Other public or private project funding sources	Co-financing from private partners, co-financing of dwelling owners, co-financing from other investment programmes (ERDF-ESIF) from Municipalities
Replication/implementation potential	4****
What is it?	mySMARTLife - Transition of EU cities towards a new concept of Smart Life and Economy - project aims at the development of an Urban Transformation Strategy to support cities in the definition of transition models, as a suitable path to reach high level of excellence in its development process, addressing the main city challenges and progressing to the smart people and smart economy concepts. The main instrument to achieve this very ambitious strategy will be the definition of the Advanced Urban Planning, consisting of an integrated approach of the planned city interventions on the basis of a rigorous impact assessment, an active citizen engagement in the decision-making process and a structured business approach, from the city business model perspective, to the economic framework for big companies and local SMEs and Start-Ups. Nantes (France), Hamburg (Germany) and Helsinki (Finland) are the lighthouse cities and Varna (Bulgaria), Bydgoszcz (Poland), Rijeka (Croatia) and Palencia (Spain) the followers. All of them will be involved in the overall project development assuming different and complementary roles.
When can I use it?	The integrated advanced urban planning is an instrument that can be applied in EU cities (and worldwide) as a valid mean to plan and evaluate the city transformation fo the decarbonisation of the city. Proposed solutions that are demonstrated in the project start at least in TRL7, therefore at the end of the project will be in the market (or at least close to the market).
Where can I use it?	EU cities. The sectors covered are: energy (energy efficient buildings and districts, district heating and cooling, sustainable mobility and all of them enabled by ICT

Why should I use it?	The more than 150 actions developed in mySMARTLife showcase how the three Lighthouse Cities of Nantes, Hamburg and Helsinki become more environmentally friendly by reducing the CO2 emissions of cities and increasing the use of renewable energy sources. The interventions planned and carried out in the three Lighthouse Cities include innovative technological solutions in connection with refurbishments of buildings, usage of renewable energies, clean transport and supporting ICT solutions
Project size	102,950 square meters to be high/performance (new buildings and retrofitting) 326 electric buses, 2227 e-cars, 1505 e-bikes
Summary	The mySMARTLife project aims at making the three Lighthouse Cities of Nantes, Hamburg and Helsinki more environmentally friendly by reducing the CO2 emissions of cities and increasing the use of renewable energy sources. Activities are focusing on "Inclusive Cities", offering a high quality of life to residents. "Smart People" are playing a vital role in their city's development. "Smart Economy" is an innovative and dynamic economic concept aiming at guaranteed employment and an adequate income, attracting talents and providing goods and services according to the actual requirements. The interventions planned and carried out in the three Lighthouse Cities also include innovative technological solutions in connection with refurbishments of buildings, usage of renewable energies, clean transport and supporting ICT solutions. An integrated planning process, where citizens are actively involved in the decision making, links the actions in different fields (e.g. mobility, sustainable energy, ICT). Following a structured city business model leads to an integrated urban transformation strategy, which can be easily transferred to other cities
Project details	mySMARTLife primary objective is the development of an Urban Transformation Strategy that must support cities to reach a high level of excellence in terms of energy efficiency and sustainability. This is done at two levels: for lighthouse cities and for fellow cities. The main instrument to achieve it is an advanced integrated urban planning, and the smart people and the smart economy concepts are the basis to build this Urban Transformation Strategy. The Advanced Urban Planning is an integrated approach that includes the LHCs interventions and their impact assessment, an active citizen engagement in the decision-making process and a structured business approach from the city business model perspective (big companies, local SMEs and start-ups). The follower cities are developing and in some cases implementing a Replication plan, following the same Integrated urban planning approach. Moreover, more than 150 smart actions are being designed, implemented and evaluated in the Lighthouse cities for energy, mobility and ICT sectors.

	CARTIF is acting as project coordinator, leading a consortium of 27 partners where Nantes (France), Hamburg (Germany) and Helsinki (Finland) are the three lighthouse cities, and Bydgoszcz (Poland), Rijeka (Croatia) and Palencia (Spain) the fellow ones.
First demonstrator site description	Nantes In a new Building Area new buildings will be built to be smarter, more efficient, with lower environmental footprint, and providing services to citizens. Some retrofitting activities are carried out. Pierre Landais was reconstructed to provide a social restaurant, showers, and social space. It was connected to the high-performance district heating. Digital boilers were integrated into this building as well as Oiseau des Iles. High-level energy retrofitting was implemented for five multi-owner buildings, representing around 18,000 m2 and 270 dwellings with an energy target below 80 kWh/m2 gross area. Also, 32 individual houses were retrofitted. Other energy interventions are implemented, like solar plants deployed on public buildings, smart public lighting integrated and now monitored by the Urban Platform, along with charging stations. At a larger scale, city-level actions can be grouped as: infrastructure actions (deploying 13,000 smart meters – more than 8,000 initially planned –, optimization of the district heating operation through data management, modelling, decision aiding), RES development (citizen solar projects, PV plants, organic PV plant, solar plant on public buildings), shifting mobility transportation modes, and finally, extension of Nantes Metropole's Urban Data Platform.
Second demonstrator site description	Hamburg A new construction area "Am Schleusengraben" is a focus development area of the City of Hamburg. MySMARTLife is considered as a new planning instrument to foster innovative and sustainable energy supply systems. A largely completed subarea "am Schilfpark" is in the special focus of mySMARTLife. A district heating with high shares of hydrogen in the conventional gas network is tested. The retrofitting area "Bergedorf-Süd" has promoted retrofitting projects. More than ten projects, each with several buildings (with approx. 26.000 sqm and 200 apartments) could be retrofitted or equipped with new heating systems, of which three examples with a total area of more than 18,000 m² will be monitored in a refined monitoring process.
Third demonstrator site description	Helsinki A retrofitting area with residential buildings from 1970s and 1980s in Merihaka and Vilhonvuori is the target group were long-term retrofitting in privately owned buildings (consisting of 12 buildings, 1323 flats and nearly 120 Km2) is promoted. In Kalasatama, a new district, still being built various smart solutions have been implemented and the coal power plant in the area will be phased out by the end of 2024. Viikki Environment House is a high-performance office building where RES contribution and optimization of heat and

	electricity systems is maximized. There are also demonstrations with a city-wide impact, such as the renewable energy production plants, and ICT improvements. The demonstration has aimed both to the retrofit actions within the area and to create a model for the facilitation of energy renovations for typical housing types in Helsinki, as part of the Energy Renaissance strategy for the city. In Kalasatama, the project has contributed to update the plot assignment stipulations to incorporate the preparedness to monitor energy use of the buildings and implement smart home solutions, as well as RES solutions following a so-called SunZEB block to have a major impact to the building related emissions. A smart light implementation of Korkeasaari Zoo is implemented. Regarding Energy, a technical integration of renewable energy sources, waste heat sources and storage systems in the district heating and cooling network has been done. Aso, a new solar power plant has been implemented, together with RES business models and electric energy storage and V2G charging station integrations to the electricity network. Regarding non-technical actions, a District-level energy renaissance strategy and decommissioning of Hanasaari coal power plant plans are part of the project.
How can cities use the technology?	Replication of solutions in their cities.
Environmental impact	102,950 square meters to be high/performance (new buildings and retrofitting) 3.1 MWh/yr of RES contribution 6.6 MWh/yr of energy savings compared to normal practices or regulation
Project coordinator’s contact details	Rubén García Pajares – rubgar@cartif.es
Contact information for demo site or specific solutions	Nantes - Benoit Cuvelier - Benoit.CUVELIER@nantesmetropole.fr Hamburg – Julian Sahr - julian.sahr@bergedorf.hamburg.de Hamburg – Marie Finke - marie.finke@sk.hamburg.de Helsinki – Maria Viitanen - maria.viitanen@hel.fi

3.39 OPTi

Project name	**OPTi**
Call identifier	H2020-EE-13-2014
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	www.opti2020.eu
Amount of EU funding (in EUR)	2,100,000
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	OPTi has developed a methodology for efficient engineering of a Digital Twin of a DHC system for demand forecasting, predictive optimization of production and thermal comfort assessment of consumers.
When can I use it?	Several modules of OPTi are now in use and are market ready, like the automated model generation (AMG), OPTi-Sim and the OPTi Forecaster. Thermal comfort assessment method has reached TRL 6 and needs further validation. OPTi-Sim is a generic validated concept that can be easily replicated and is provided by a project partner
Where can I use it?	It can be used in production optimization, optimal control of operation and what-if analysis of the operational aspects of any DHC system.
Why should I use it?	The results from OPTi offers several modules that can be used to increase the energy efficiency of your DHC system and give you the freedom to tailor it to your use-cases. It requires in depth engineering competence
Project size	Results of OPTi have been tested on city-scale with 31000 households. It considers buildings, distribution and production. Can be extended to the integration of thermal energy storages and data centers
Summary	The OPTi project will explore the usage of a virtualization of the real physical infrastructure, also called Digital Twin, in order to re-design and optimize DHC systems. The Digital Twin of the real physical system, which we call OPTi-Sim, will be used to design and test new approaches to control and optimize the DHC systems.
Project details	OPTi-Sim – Co-Simulation approach for large scale complex energy systems where the grid model is automatically generated. Uses the FMI standard and FMUs to interconnect the components. OPTi-Forecaster – Production and demand forecasting including market prices. Can be used as an operator tool to run production in a predictive way to pre-heat and pre-cool the grid, exploiting the passive thermal storage of the grid.

	On building level the forecaster can be used for peak load reduction AMG – Automatic model generation and simplification for the grid to include the models in a co-simulation environment OPTi-Substation Tuning tool – Data driven modeling and controller tuning for the substation hot tap water circuit OPTi-Thermal Comfort Assessment – Concept to assess the consumer thermal comfort through a feedback collection device and statistical analysis.
Demonstrator site description	The technologies have been tested and demonstrated in the pilot sites Luleå and Palma de Mallorca.
How can cities use the technology?	The project results are maintained by the partner companies and can be replicated in any DHC system.
Environmental impact	Energy savings of up to 12% could be shown during the project trials
Project coordinator's contact details	Wolfgang Birk Wolfgang.birk@ltu.se +46725390909

3.40 PITAGORAS

Project name	**PITAGORAS - Sustainable urban Planning with Innovative and low energy Thermal And power Generation from Residual And renewable Sources**
Call identifier	FP7-ENERGY-SMARTCITIES-2012
Type of action	Research and Innovation Action (RIA)
Project logo	PITAGORAS Sustainable urban planning with innovative and low energy thermal and power generation from residual and renewable sources
Project website	https://pitagorasproject.eu/
Amount of funding from EU	€5.871.454,67
Other public or private project funding sources	Total budget - € 9.145.179,13
Replication/implementation potential	4****
What is it?	The Pitagoras pilot plant of Brescia will contribute to cover the heat demand of 400 buildings approximately linked to the city district heating network, reducing primary energy use and CO^2 emissions. The project has a replication potential to other industries with excess heat.
When can I use it?	It is a deployed solution at TRL 9.
Where can I use it?	The Organic Rankine Cycle (ORC) system in demonstration has the potential to be replicated in other heat intensive industries allowing the recovery of the waste energy either by the industry itself or - if in the proximity of a city (here Brescia) - producing useful heat for the city heat network.
Why should I use it?	The waste heat recovery plant is designed to generate heat (hot water) from steam at the cold season (from October to May approx.) when the heat demand is high. On the other hand, during the hot season (from June to September), the demand decreases so the ORC is ready to generate electricity for plant self-consumption.
Project size	Thermal power on the steam generator: 16MWth. District heating installation installed power: 10 MWth. ORC system installed power: 2MWe.
Summary	The project is focused on efficient integration of city districts with industrial parks, through smart thermal grids. The overall objective is to demonstrate highly replicable, cost effective and high energy efficiency large scale energy generation system that will allow sustainable urban planning of very low energy city districts. The main focus of the project is medium (150-600ºC) and low (30-150ºC) temperature waste heat recovery from industry and its use for energy supply to cities. The concept of the project will be demonstrated in Brescia (Italy) including an Organic Rankine Cycle for heat and power generation based on the waste heat produced by a steel foundry and heat supply to the city district heating net.
Project details	The technological solution implemented is a waste heat recovery unit in order to recover waste heat from fumes from an electric arc furnace (EAF) and valorize them in a ORC unit and hot water generation to a DH network.

	Financing solutions: the investment was done by the company itself, it has been supported by the European Commission (through PITAGORAS FP7 project) and White Certificates from Italian Government are as well applicable. The revalorization of the waste heat from the EAF, which otherwise would be wasted, is the main benefit of this project. This means that with this waste heat it is possible to provide heat for about 2,000 homes
Demonstrator site description	Useful technical documents are available on project website: https://pitagorasproject.eu/documents2
How can cities use the technology?	Every city which has energy intensive industries with a high waste heat recovery potential. Essential to have a district heat network infrastructure.
Environmental impact	The installation of a system like this also results in the saving of fossil fuels and thus reducing the CO^2 emissions, about 8,000 tons of CO^2 can be avoided every year.
Project coordinator's contact details	Mr Patricio AGUIRRE, Tecnalia, patricio.aguirre@tecnalia.com Mrs. Maider Epelde, Tecnalia, maider.epelde@tecnalia.com
Contact information for demo site or specific solutions	ORI MARTIN: Andrea Panizza: andrea.panizza@orimartin.it Tecnologia di Fabbricazione Meltshop Division **ORI Martin S.p.A.**

3.41 PLANET

Project name	**PLANET**
Call identifier	H2020-LCE-2017-SGS
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://www.h2020-planet.eu/
Amount of EU funding (in EUR)	3,999,695
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	PLANET - Planning and operational tools for optimising energy flows and synergies between energy networks. The project aims at delivering a holistic and integrated ICT framework, the PLANET Decision Support System (DSS), that will incorporate models of electricity, gas and district heating networks in a joint exploration framework in order to properly account for all their interconnection aspects and specificities. The framework will provide the necessary functionalities for the optimal planning of network reinforcements and deployments as well as operational management that are needed by policy makers, regulators and system operators in order to achieve the desired EU energy transition. The project investigates the possible economic impact of conversion/storage technology mass scale deployment (such as Power to Gas - P2G, Power to Heat – P2H, etc.), new business opportunities and models in electricity, natural gas and district heating markets as well as the necessary adaptations of the regulatory and standardization landscape to facilitate technology adoption.
When can I use it?	The PLANET DSS tool will be ready for deployment in a beta version by the end of the project (February 2021); in fact the PLANET project presents a TRL 7 in other words is a system prototype demonstration in operational environment. This means that the DSS tool will be complete and exploitable, but some consultancy by consortium experts will be necessary for the implementation of final user scenarios. In a period of time of max 1 year after project end, the tool will be ready for the final exploitation.
Where can I use it?	The PLANET DSS should enable all decision-makers in the energy network system to be able to quantitatively assess multiple complex scenarios and use cases to examine 'what-if' scenarios to maximize RES integration into the energy system. There are no geographical limitation and the areas of application are mainly the district level.
Why should I use it?	The benefits of using the tool can be summarised as follows:

	- The PLANET DSS should also be capable of forecasting future energy scenarios and potential synergies between energy networks. - It will quantitatively assess the impact of the deployment of energy conversion or storage (P2G, P2H, Virtual Energy Storage in buildings - VES) on the relevant energy networks so as to facilitate investment and decision making towards full energy system decarbonisation. - The PLANET system will not only provide technical information, but also economic feedback for users. It will enable the user to explore the impact of the conversion unit economics on the business value so as to identify the target economics that can enable profitable business cases in the real world. - The software will be intuitive to use through functions like dashboards with various indicators based on simulation results, login using personal credentials, and the ability to edit, save and revisit scenarios. - It will provide a graphical user interface allowing the user to specify the sizing and deployment of P2G and P2H assets on relevant district-level distribution grids and visualize results of simulations on the network topology. These functions allow users to tailor scenarios specifically to their own region, or interest. It also makes the software more useful commercially as users can save and send scenarios to others as well as provide KPI graphs and view various simulation results visually to allow them to present their findings to decision-makers within their company or externally.
Project size	The areas covered for the simulation of the different networks (electricity, gas and district heating) are the district level but it will be possible to extend the results to city level when necessary.
Summary	Renewable energy sources (RES) offer unpreceded opportunities to reduce greenhouse gas emissions and mitigate the detrimental effects of climate change. A challenge to be solved is tackling the impact of intermittency of their electricity supply on the grid. Energy conversion and storage has been touted as a very promising solution. The PLANET tools will enable market actors and regulators to optimally plan, install, commission and dispatch energy conversion units along the electricity distribution grid in order to ensure maximum absorption of excess RES generation and immediate consumption or conversion into alternative carriers. In particular PLANET will develop a holistic Decision

	Support System (DSS) integrated in a ICT monitoring and orchestration cockpit (IDOC) that will aid to leverage innovative energy conversion in alternative carriers & storage technologies in order explore, identify, evaluate and quantitatively assess optimal grid planning and management strategies (SCCE) for future energy scenarios that target full energy system decarbonisation.
Project details	Objective 1: Development of PLANET DSS tool that will enable the evaluation of energy exchanges among networks and the optimal design and coordination of technology and policy deployment for a system-level optimal solution. Objective 2: To provide policy makers & network managers and operators with the necessary tools for the grid planning, optimization, impact assessment and operational management through enhanced interconnection between diverse energy networks with the deployment of decentralized conversion/ storage solutions. Objective 3: To contribute to the creation of a viable route for the adoption of decentralized storage/conversion solutions in the Energy Union by means of a market-driven policy. The market penetration and operation of the necessary conversion/storage technologies relies on novel business models and actors that will have to engage in commercially viable practises within a new policy/regulatory landscape. PLANET will contribute toward both the identification of business models as well as policy impact assessment. Objective 4: To contribute to the creation of new regulation recommendations for changing energy environments and policy suggestions to improve market efficiency.
First demonstrator site description	The two demonstrator sites set up in the PLANET project have the role of providing the data necessary for the validation activity. In particular one of the main development activities of PLANET concerns the modelling of Virtual Energy Storage in buildings through pre-heating and cooling. This process entails the profiling of comfort preferences of building occupants as well as health/hygienic conditions within the buildings. The calibration of these models requires the availability of data from real-life settings. The first pilot site has this purpose and involve residential and tertiary buildings of SOREA (consortium partner) and located in Saint-Julien Montdenis in the Maurienne Valley, France. The second pilot site is implemented in a residential building operated by IREN (consortium partner, operator of the Turin district heating network) and will concern the application of an innovative heat pump with heat storage and its influence in heat and electricity production, to extrapolate a more general effect on future electricity distribution network and district heating network. The heat pump will use electricity from the electricity grid and the boiler will use natural gas, in combination producing heat that can be consumed in the building or stored locally. The purpose of the pilot test is to assess the impacts – the concrete benefits and shortcomings – of such local P2H units along the electricity, gas and DH networks and to

	quantitatively evaluate their capability to resolve problems of the various grids, such as congestion of the DH network or instability/imbalance on the electricity grid due to intermittent renewables integration.
Second demonstrator site description	In order to give more detail of the pilot sites, the French pilot site involve over 18,000 consumers of various types, each of the residential pilot buildings (a pool of 5 similar buildings) has a built of area of 3,500 sq.m. and an annual energy consumption equal to 440,000 kWh (only electricity). They are 5-story buildings hosting 10 apartments per floor. There are a number of systems in the buildings that may be used to complement and/or validate the network of sensors needed, such as temperature sensors, which will be integrated in the sensing infrastructure of the project. The total annual electricity consumption per building is 440,000 kWh with an average per household cost of €870. The tertiary building was constructed in 2010. It is a 2-floor building with an area of 800 sq.m. hosting the 55 employees of the local utility and relies solely on electricity. Related to the incorporation of local intermittent VRES production in the total energy mix, a set of existing Solar Panels (80 kW roof-top installed capacity) are considered to investigate demand vs supply patterns in a realistic setting. The total annual energy consumption of the building is approximately 75,000 kWh and the average annual energy cost is approximately €5,000. A cost-efficient monitoring and building amenity control system based on off-the-shelf UIs, sensors and actuators communicating via a standards-based network (e.g. ZigBee, BLE, Wi-Fi) will be deployed in the buildings to collect information about ambient conditions and user preferences.
How can cities use the technology?	The project intends to establish a novel system for network operators to investigate network reinforcement and use of conversion and storage assets. The consortium explored new business models that allow network operators to own and operate storage and conversion assets. One business model will involve the introduction of new market roles for parties that can take advantage of the synergies investigated in the PLANET project. For example, Power to Heat Aggregators would be able to act in a similar way to the current role that demand side aggregators fulfil. This could involve district heating providers, or a new third-party and rely on the P2H and VES models created in the PLANET project, as well as their own historic data to be able to bid for services similar to demand side aggregators that do so currently by using generation equipment. Other actors that could take advantage of the synergies displayed from the PLANET DSS could be P2G flexibility providers who will be able to provide links between the electricity and gas network, bulk-buying electricity and converting to gas before selling this into the gas grid. This enables a double-sale for the flexibility providers who can provide a demand turn-up service for the electricity grid, and potentially cheap gas to the gas grid.

	A similar actor to P2G flexibility provider would be a re-electrification provider. This role could even be delivered by a P2G provider. Instead of selling gas into the gas grid, they could store gas, and convert back to electricity to provide balancing and ancillary services to the distribution grid. There are some inefficiencies associated with this strategy, and it may be simpler for gas-fired generators to take directly from the gas grid for re-electrification.
Environmental impact	The wide deployment of the PLANET solution and technologies will ensure the progressive full decarbonisation of the electricity grid as well as partial decarbonisation of the gas and transportation sectors, allowing the cost-efficient and grid-friendly integration of 100% distributed variable renewable generation and minimizing dependence on fossil fuel-fired plants. The combination, optimal deployment and management of different forms of energy conversion and storage will allow the avoidance of the anticipated curtailment of VRES in the high-RES scenario of the EU Energy roadmap 2050, estimated at 217 TWh. Regarding emissions reduction, the Commission has put forward a proposal for an energy and climate policy framework up to 2030, in line with the objectives of a competitive European economy and the long term GHG emission reduction of 80-95% by 2050 compared to 1990 levels. The European Council agreed on 23 October 2014 on a domestic greenhouse gas reduction target of at least 40% by 2030 compared to 1990. The avoidance of the aforementioned extra conventional generation capacity, achieved by the elimination of VRES curtailment, will lead to 100 million tons of GHG emissions reduction annually, while the (almost) full decarbonisation of the electricity grid with the integration of large shares of renewables (over 90%) until 2050 will result in over 1 billion tons annual GHG emissions reduction (through the avoidance of more than 2,500 TWh generated in conventional power plants).
Project coordinator’s contact details	Prof. Marco Badami marco.badami@polito.it

3.42 PLANHEAT

Project name	PLANHEAT
Call identifier	H2020-EE-2016-RIA-IA
Type of action	Research and Innovation Action (RIA)
Project logo	PLANHEAT
Project website	www.planheat.eu
Amount of EU funding (in EUR)	2,977,212.50
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	PLANHEAT - Integrated tool for empowering public authorities in the development of sustainable plans for low carbon heating and cooling The PLANHEAT Open Source tool is a Q-GIS plug-in and it is composed of three modules: mapping, planning and simulation as foreseen by the GA. In order to be operated by as many cities as possible in EU (in accordance to the different level of availability of data), two parallel approaches have been designed: a bottom-up one (DISTRICT) and a top-down one (CITY).
When can I use it?	The Tool is currently downloadable from the project website and it has been validated by PLANHEAT validation cities. The current TRL of the tool is 6 and it could be enhanced also in a cooperative way thanks to the Open Source nature of the tool.
Where can I use it?	For district and city-level heat planning, replacing pre-feasibility studies for projects.
Why should I use it?	First of its kind tool integrating in a single tool mapping, planning and simulation for low carbon H&C scenarios.
Project size	We tested the tool in Lecce, Velika Gorica and Antwerp cities, with a specific focus on some districts.
Summary	PLANHEAT main objective is to develop and demonstrate an integrated and easy-to-use tool which will support local authorities (cities and regions) in selecting, simulating and comparing alternative low carbon and economically sustainable scenarios for heating and cooling that will include the integration of alternative supply solutions (from a panel of advanced key technologies for the new heating and cooling supply) that could balance the forecasted demand. The PLANHEAT integrated tool will be designed to support local authorities in 1) mapping the potential of locally available low carbon energy sources (with specific reference to available RES and waste energy recoverable at urban and industrial level) 2) mapping the forecasted demand for heating and cooling 3) define and simulate alternative environmentally friendly scenarios based on district heating and cooling as well as highly efficient cogeneration systems matching the forecasted demand, levering on the use of RES and waste

	energy sources and with proven economic viability 4) understanding the interactions of these new scenarios with the existing infrastructures and networks (among which district heating and cooling gas, electricity, sewage, transportation) and identify potential for further extension and upgrade of district heating and cooling networks 5) evaluate the benefits (in terms of energetic, economic and environmental KPIs) that the adoption of the new scenarios will generate against the current situation (i.e., baseline). Moreover sound training and replication strategies involving a number of other public authorities have been set-up towards the empowerment of the expected project impacts.
Project details	The PLANHEAT Tool is Q-GIS plug-in, based on an open-source code, whose goal is to analyse, plan and simulate low carbon H&C scenarios to support EU Public authorities in updating/developing new sustainable energy plans. The tool is composed by three open source modules that could be operated via the integrated tool or separately : the mapping module, the planning module, the simulation module. The platform allows the visualisation and mapping of results, the visualisation of the scenarios selected with the planning tool, and the visualisation of results coming from the simulations via a specific KPI Panel. The user is guided by a step-by-step procedure that, starting from the assessment of the local heating and cooling demand and potential sources, conducts the end-user through the whole planning process towards the simulation of future low carbon scenarios. The PLANHEAT tool is unique in this moment in the H&C planning tools panorama as it is not a H&C/RES Sources mapping only tool, neither an optimisation tool, nor a simulation-only tool. It is an integrated tool that is able to facilitate heating and cooling scenario creation, enabling their simulation. Furthermore, thanks to its city and district approach, PLANHEAT tool can be used both for policy and masterplanning oriented activities (that also require less data – City Approach) as well as for more detailed/pre-feasibility study simulation of potential interventions in some city specific areas (District Approach). It's therefore a flexible and modular tool, that can be also used in a "partial way", thus using single modules of the tool and/or giving the opportunity to the end-user to use the tool at different moments of the strategic planning process of the city. You can always import and export scenarios and load partial results. In this way, the end user can save at the end of each step (DMM or CMM/SMM/DPM) the results of its work in order to keep on working on it in at a later stage
Demonstrator site description	Cities of Lecce, Velika Gorica and Antwerp were the three validation cities, being representative of different climates, urban energy efficiency objectives and availability of local energy data situations.
How can cities use the technology?	Target market of PLANHEAT tool is public authorities, energy experts and consultants for Public Authorities.

	As public authorities and energy utilities have to decarbonize their H&C generation system (thus promoting renewables and low carbon technologies), update SEAP into SECAPs and trying to target EU 2030 Environmental and Energy agendas, it can be considered that there will be more and more demand of tools like this
Environmental impact	Depending on the type/level of plan or project developed/simulated
Project coordinator's contact details	Stefano Barberis – stefano.barberis@rina.org

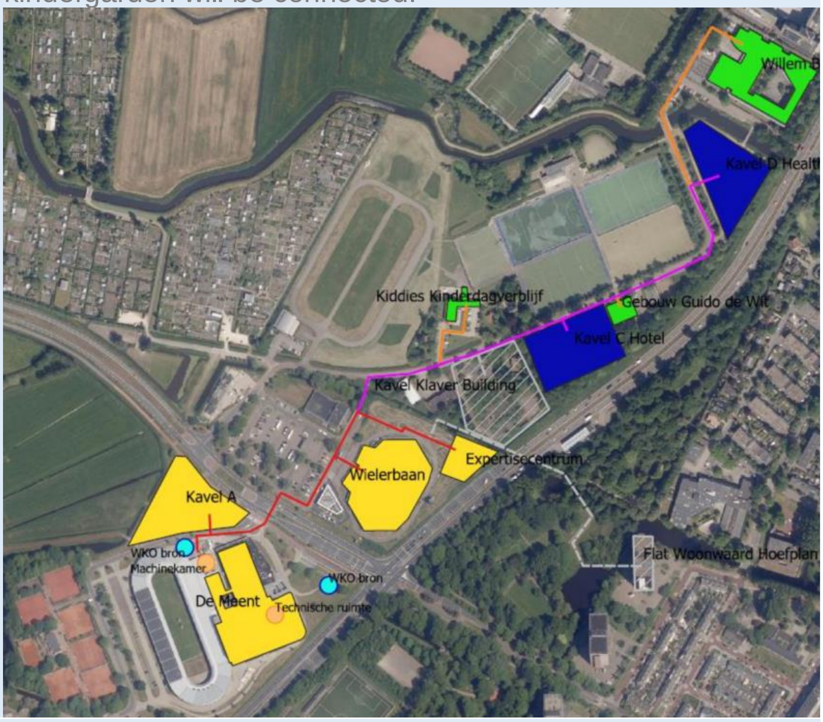
3.43 POCITYF

Project name	**POCITYF**
Call identifier	H2020-LC-SC3-2019-ES-SCC
Type of action	Innovation Action (IA)
Project logo	POCITYF
Project website	https://pocityf.eu/
Amount of EU funding (in EUR)	19,998,275
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	Waste heat from the ice rink at Sportcomplex De Meent will be connected to a heat buffer and to a heat/cold storage system Aquifer Thermal Energy Storage (ATES), which will be the source to a local, collective, low temperature transport grid for heat or cold supply to several customers in the vicinity of the ice rink.
When can I use it?	Utilization of the Aquifer Thermal Energy Storage (ATES) system for heat/cold storage (TRL7). Utilization of technologies that take advantage of otherwise wasted heat streams such as waste heat from the cooling of the icing rink (TRL7). Expected commissioning year is 2022.
Where can I use it?	Required is an heat source with excessive heat, e.g. an ice rink or industry. Energy losses make heat much more difficult to transport over long distances. The temperature and the required infrastructure can also differ greatly per heat source and customer. Because the coordination between heat source, transport and distribution system and customers is so closely related, and the heat cannot come from too far, competition between different suppliers is not possible in practice.
Why should I use it?	DHC leads to a number of significant energy, economic and environmental benefits, whereby it should be noted that the local situation and the specific circumstances determine the extent to which these benefits can be achieved. For the situation at sports complex De Meent in Alkmaar, the following advantages can be named: a) realizing significant energy savings at both i) building level and ii) neighbourhood level by lowering the energy bill (energy efficiency first); b) enabling a high share of locally produced / consumed renewable energy at building and neighbourhood level. This is further enhanced by the combination of DHC with various innovative other techniques such as the use of waste heat, smart distribution management systems, ATES heat / cold storage. c) maximizing self-consumption d) reducing grid stress and avoid load and generation curtailment e) increasing the financial value through flexibility services to the grid.

Project size

The goal of the EU funded project POCITYF is to achieve the necessary energy transition in cities. For this, it is essential to increase energy systems integration, to push energy performance levels significantly beyond the levels of current EU building codes and to realize Europe wide deployment of Positive Energy Districts (PED) by 2050. One of the PED's as identified in the POCITYF Project is located at Lighthouse City Alkmaar PED1_B1: De Meent. De Meent consist of two ice rinks and a large sports complex and is located in the area Olympiapark in the city Alkmaar in The Netherlands. The municipality of Alkmaar is responsible for realization of the several innovative elements within PED1_B1 De Meent.

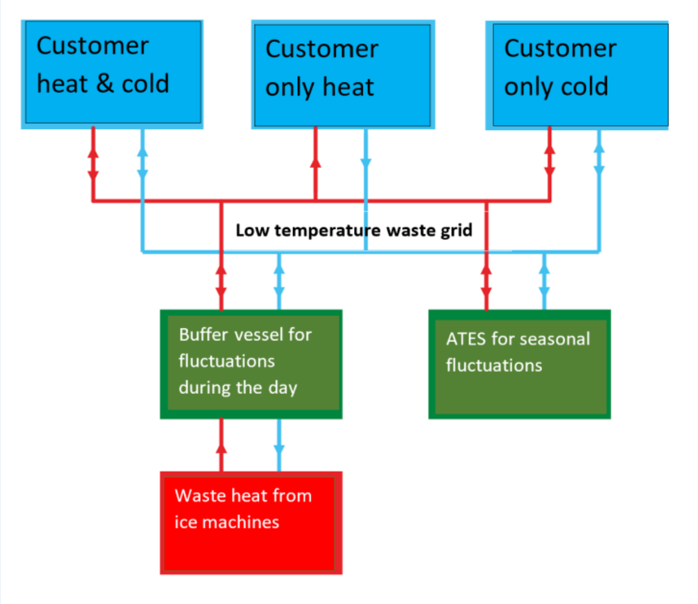
The Total heat demand from all customers in Olympiapark is approx. 2.400 MWh/yr & the cold demand is 400 MWh/yr (and rising in the future). The waste heat from the ice machines is over 6.000 MWh/yr and is currently "wasted" by two large cooling towers. In the picture below is the planned thermal grid with the several customers visualized. This area is a commercial area, focused on sport & leisure and marked as an area with innovative renewable energy technologies. In the left south, the ice rink with the sport complex can be seen. During the first phase (red grid), the yellow buildings will be connected (4 commercial buildings, three of them related to sport activities). In the second phase the grid will be extended (purple line) to connect the new buildings like an hotel and leisure facility (blue). During the third phase (orange part) the existing buildings (green), like a large secondary school and kindergarden will be connected.



Summary

POCITYF aims to demonstrate and replicate success stories for waste streams (heat and material) utilization, originating from different sources, as an alternative highly efficient pathway for satisfying energy needs and reducing waste, in line with EU policies regarding the promotion of industrial

	symbiosis and circular economy. POCITYF will further demonstrate and replicate solutions that are able to advance the flexibility and environmental sustainability of district heating networks through the utilization of innovative technologies and the exploitation of waste heat. The POCITYF project aims related to DHC are focused on: a) achieving significant energy savings on both i) building and ii) district level reducing energy bills (energy efficiency first); b) enabling a high share of locally produced/consumed renewable energy on building and district level. Innovative solutions to be demonstrated and replicated include both positive energy building (level) retrofits with the inclusion of innovative elements such as district heating and cooling (DHC) by waste heat, smart distribution management systems, ATES heat/cold storage. c) maximizing self-consumption d) reducing grid stress and avoid load and generation curtailment e) increasing the financial value through flexibility services to the grid. The heat produced by the two ice machines in De Meent 1.0 is “wasted” by cooling towers. Simultaneously, sports complex De Meent requires a lot of heat for space heating and showering purposes. For this purpose, fossil fuel (natural gas) is used, with the associated CO2 emissions. By using the waste heat created by the ice machines, there is no need for heating De Meent 2.0 with fossil fuels. Besides this, neighbouring commercial buildings can make use of a small-scale low temperature waste heat grid.
Project details	As the POCITYF project has started recently (1 oct. 2019), the project is in the phase of basic engineering (dimensioning of the system, routing, etc.). The relevant technical elements of the system concern an innovative hot/cold storage, heat matcher, heat pump, 2 pipes system and small-scale, low temperature thermal smart grid (16-8 degrees Celsius). Heatmatcher is an innovative dynamic simulation program to give insight in the most cost-effective heat system solution, taking into account the complex interaction of the several customers. The future exploitation of this small-scale thermal grid has to be investigated and forms a innovative part of this project. A majority of the thermal grids in The Netherlands is integrally controlled by heat companies; from production and distribution to delivery. For this project, the municipality of Alkmaar seeks for a cooperation partner for the exploitation of the thermal grid; the heat / cold will be supplied by the icing machines owned by the municipality of Alkmaar, but the exploitation of this system forms no core business of the municipality. User engagement is also very important as new and existing neighbors shall be connected to this low temperature waste grid to ensure the business case of this system. A special

	taskforce from the municipality of Alkmaar is present for the development of Olympiapark.
Demonstrator site description	 The picture above shows a simple principal scheme about the system as it will be installed at PED1_B1 De Meent.
How can cities use the technology?	Cities with an excessive heat supply from their installations (like from ice machines in an ice rink) can initiate a thermal grid to make use of this waste heat as a renewable energy source, supplying heat or cold to neighboring buildings.
Environmental impact	The sports complex De Meent uses natural gas for heating purposes of their building of 130,000 m3/yr. By using an renewable waste heat grid it saves approx. 250,000 kg of CO2. All neighboring buildings together are now using approx. 90,000 m3 natural gas per year for heating purposes (170,000 kg CO2 saving when connected to the thermal grid). In total for heating purposes 420,000 kg CO2 can be saved by using this thermal grid instead of fossil fuels. For cooling purposes by this low temperature waste grid, approx. 51,000 kg CO2 reduction of all customers has been estimated (amount will increase in the future as more electrical air conditioners will be bought in the increasingly hotter summers caused by climate change).
Project coordinator's contact details	Josemiguel.costa@edp.com
Contact information for demo site or specific solutions	https://www.alkmaar.nl/duurzaamheid/energie-en-duurzaamheid/europees-project-pocityf/ www.pocityf.eu

3.44 Policy Support for Heating and Cooling Decarbonisation

Project name	**Policy Support for Heating and Cooling Decarbonisation**
Call identifier	#ENER/C1/2018-495
Type of action	Tender
Project website	N/A
Amount of EU funding (in EUR)	N/A
Other public or private project funding sources	N/A
Replication/implementation potential	1*
What is it?	This assignment aims to develop a roadmap that will illustrate the various decarbonsation routes that can be taken to decarbonise H&C systems, across different sectors and different local circumstances. It will identify different types of barriers that prevent or hinder the decarbonisation of the H&C system and come up with measures to overcome these barriers.
	The results will be published in 2021.
When can I use it?	EU
	To deploy a H&C decarbonization roadmap
Where can I use it?	EU – decision maker level
	The demand for heating and cooling (H&C) represents around half of the energy demand in Europe and today, this demand is still predominantly satisfied through the use of fossil fuels. The revised Renewable Energy Directive has set out a target to increase the share of renewable energy in EU H&C demand with 1.3 percentage points per year in the period 2021-2030. Furthermore it has set the non-binding ambition to increase the use of waste heat and cold by at least 1 percentage point per year. The decarbonisation of the H&C system is possible through a range of different technological routes and which route is optimal depends strongly on local conditions. This assignment aims to develop a roadmap that will illustrate the various decarbonsation routes that can be taken to decarbonise H&C systems, across different sectors and different local circumstances. It will identify different types of barriers that prevent or hinder the decarbonisation of the H&C system and come up with measures to overcome these barriers. The entire process of roadmap development will take place with extensive engagement of relevant stakeholders, through workshops, a conference and an online stakeholder platform. This will ensure that the roadmap is supported by the H&C community and focuses on the most important challenges.
Why should I use it?	The study comprises 5 tasks to be executed: 1. A meta-analysis of existing literature on the decarbonisation of the H&C sector; 2. The development of an online platform for stakeholder engagement;

	3. The development of a draft roadmap for the decarbonisation of the H&C sector; 4. Stakeholder engagement through the engagement of three workshops and a conference; 5. Finalisation of the roadmap.
	Local authorities may also be concerned by the roadmap, to guide local planning of &C decarbonization
Project size	H&C decarbonization guidance
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3.45 PUMP-HEAT

Project name	**PUMP-HEAT**
Call identifier	H2020-LCE-2017-RES-CCS-RIA
Type of action	Research and Innovation Action (RIA)
Project logo	PUMP HEAT
Project website	https://www.pumpheat.eu/
Amount of EU funding (in EUR)	5,904,426.25 euro
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	PUMP-HEAT integrates heat pumps, thermal energy storage and advanced controls to take advantage of the unexploited flexibility in power plants, in particular those in co-generative layout. PUMP-HEAT will allow to untap existing flexibility opportunities in power plants, acting as technology enabler for further renewable penetration, with solutions applicable both to existing and new gas turbine combined cycles
When can I use it?	The project will demonstrate the technological solutions at TRL6, afterwards rapid uptake will be possible, reaching TRL 8 in one year.
Where can I use it?	Power plants all across the globe, with primary market entry in gas turbine combined cycles, both power only and co-generative layouts. Geographical area: all across the globe, with preference for mid and hot climates.
Why should I use it?	Increase the power flexibility of existing power generation assets, increase the average annual efficiency, enables more renewable power installations.
Project size	The project technologies are targeted to 100-800MWe combined cycles, as first product. Smaller size power plants can be addressed in a second stage.
Summary	Existing co-generative CCs are usually constrained by thermal user demand, hence can provide limited services to the grid. At the same time, CHP plants are highly promoted for their high rate of energy efficiency (> 90%) and combined with district heating network are a pillar of the EU energy strategy. To un-tap such unexploited reserve of flexibility, and to further enhance turn-down ratio and power ramp capabilities of power oriented CCs, this project proposes the demonstration of an innovative concept based on the coupling of a fast-cycling highly efficient heat pump (HP) with CCs. The integrated system features thermal storage and advanced control concept for smart scheduling. The HP will include an innovative expander to increase the overall

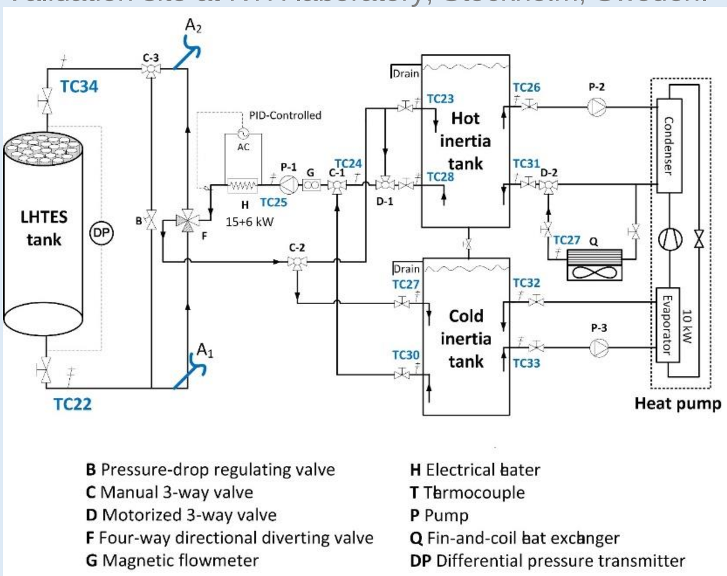
	efficiency of the HP. In such an integrated concept, the following advantages are obtained: - the HP is controlled to modulate power in order to cope with the CC primary reserve market constraints; - the high temperature heat can be exploited in the district heating network, when available; low temperature cooling power can be used for gas turbine inlet cooling or for steam condenser cooling, thus reducing the water consumption; - in both options, the original CC operational envelope is significantly expanded and additional power flexibility is achieved. In general, the CC integration with a HP and a cold/hot thermal storage brings to a reduction of the Minimum Environmental Load (MEL) and to an increase in power ramp rates, while enabling power augmentation at full load and increasing electrical grid resilience and flexibility.
Project details	WP1 – Scenario analysis, requirements definition and business models This WP focuses on the analysis of CC flexibility enhancement through HP and thermal storage integration, identifying and quantifying the economic drivers for different EU market conditions. A complete thermo-economic optimisation of the PHCC configuration, considering time-dependent analysis, is performed to maximize the economic benefits from the added flexibility, to identify the best size of equipment including thermal storages, to investigate the best management strategy with relevant time resolution. This WP analyses also suitable business models for all the stakeholders of the plant: end-users, energy provider, heat provider, technology manufacturer. WP2 - Flexibility enhancement through balance of plant innovations This WP develops balance of plant innovations for enhancing the CC power flexibility, with two distinct focuses: (a) HP and thermal storage at warm temperature for flexibility enhancement and recovering waste heat in CCs for DHNs and (b) HP and thermal storage at low temperature for flexibility enhancement of Power Oriented CCs. The innovative two-phase fluid turboexpander for heat pumps is under investigation and prototyping. The planned activities that have been performed are both related to experimental ones and computational ones: a new two-phase static test rig has been realized and the two-phase CFD analysis has been initiated. WP3 – Advanced solutions for warm/cold storage The focus of this WP is related to the selection of the most techno-economically suitable thermal storage technology and materials towards integration of thermal storage as a counterpart to electrical storage, thus adding further flexibility to the combined cycles in both thermal energy and electric power supply. Aiming at maximizing the sustainability in

	terms of low-cost, long-life and environmental-friendliness for large-scale deployment, options on eco-sustainable materials and water-based phase change fluids will be investigated. WP4 – Intelligent predictive control of the integrated system This WP investigates and develops the control algorithms for the PHCC integrated system, with focus on flexibility enhancement and power grid interoperability. A predictive control algorithm for real-time supervision and management of the PHCC is being investigated, prototyped, virtually tested at simulation level, verified in hardware-in-the-loop, and will be implemented in the demosite. WP5 – Integration and Demonstration The focus of this WP is related to the integration of the developed technologies and control systems into a gas-fired CC demo site (CHP configuration) to demonstrate the overall concept in the relevant industrial environment and to monitor the performance during normal operation. WP6 – Scale-up design, replication and dissemination This WP will upscale the PHCC technology to a full scale gas-fired CC system in order to promote the PHCC concept among industrial and energy stakeholders and foster its adoption as retrofit or for future fossil power plants. The best International scientific conferences in the field of GT and turbomachinery (ASME TurboExpo, GPPS Forum, ETN workshop) and outreach media have been addressed. An original conference – https://www.supehr19.unige.it/ – in collaboration with the sister projects FLEX-TURBINE and TURBO-REFLEX has been held at Savona UNIGE campus, Italy, in 4-6 September 2019: the “SUstainable PolyEnergy generation and HaRvesting – SUPEHR 2019” conference. https://www.pumpheat.eu/documentations/project-deliverables
First demonstrator site description	Validation site at University of Genoa laboratory, Savona, Italy

The UNIGE validation site represents at lab scale a Power Oriented Combined cycle equipped with heat pump and cold thermal storage, to condition the compressor intake: the new experimental set-up is, in fact, a combined cycle emulator where the gas turbine is represented by a real T100 microturbine, the heat pump has been provided by MAYEKAWA and a cold thermal storage has been installed; the virtual part is represented by a dynamic model of the steam bottoming cycle, developed in collaboration with CRIEPI, Japan. The whole set-up is coordinated by a tailored model predictive controller, under current validation.

Second demonstrator site description

Validation site at KTH laboratory, Stockholm, Sweden.



Three latent heat thermal energy storage (LHTES) units have been developed and tested for validating the concept of using scaled-up storage units with similar heat exchanger configurations at combined heat and power plants for load shifting. Amongst the three designs, the one with submerged spiral coil heat exchangers shows highest energy density however with the largest capital investments, while the other

	two based on macro-encapsulated solutions exhibit higher charging/discharging rate but with lower storage density. Phase transition of the incorporated phase change materials (PCMs) was validated during the charging and discharging tests on all the three designs, suggesting latent heat storage and retrieval in the storage operation.
Third demonstrator site description	Demonstration site at IREN combined cycle, Turin, Italy  The whole PHCC concept will be demonstrated at reduced scale in a cogeneration CC plant. The demonstrator will include an innovative fast-cycling highly efficient HP (HP) and thermal storage, synergistically controlled with the actual CC. The testing site will be the power plant of Moncalieri, a 2x400 MWel CC facility connected to the DH network of Turin. One of the two units has been chosen for the interfacing with the demonstrator, taking into account the best solution identified by techno-economic analysis. The experimental skid will contain a MW size Warm Temperature (up to 120°C) and an Advanced Thermal Storage. It is worth to note that the IREN DHN is already equipped with 14.000 m^3 heat storage capacity (and it is going to add additional 7.500 m^3 in the next years) and comparison between the two TES technology can be made from a performance and market points of view, using the perspective and experience of one of the largest DH supplier in Europe.
How can cities use the technology?	The technological solutions will be demonstrated (TRL 6) in a Combined cycles supplying thermal energy to the district heating of the city of Turin, in Italy. Therefore, it can be rapidly scaled up and replicated in many other cities of Europe, with existing District heating networks.
Environmental impact	With reference to a 400MWe combined cycle, focus is made on a power-only layout or co-generative layout. In case of power only layout, peak production increase an Increase of the Pmax of +14% was assessed using the cold TES , up to +12% adopting direct cooling with HP with a slight negative effect over the efficiency (-1.2 pt%) Reduction of the Minimum Environmental Load (Pmin -17%), with a reduction of just 1.5 pt% of efficiency. Reducing Start-up and Shut-Down number. Enhancement of annual average efficiency by inlet heating of ca 2% delivering the same amount of Electricity (estimated on 1 year operating data of an actual CC in North Italy), with equivalent saving in overall CO_2 emissions. Such technical performance will be used to increase CC profitability in the Day Ahead Energy Market and in the Ancillary Service Market.

	In case of co-generative layout, with the combined cycle producing heat for a district heating network, the main advantage is related to operate the HP as a smart load, producing the heat cheaper than the one produced by Combined Cycle or Heat Only Boiler, reducing both generation cost and fuel consumption. The integration of CC and HP increases the global efficiency up to 1 pt%, for retrofit installation and up to 11 pt% for new installation with flue gas latent heat recovery (with equivalent saving in overall CO2 emissions).
Project coordinator's contact details	Prof. Alberto Traverso Chair of Energy Systems University of Genoa - DIME via Montallegro 1, 16145 Genova - Italia ph. +390103352442 www.tpg.unige.it email : alberto.traverso@unige.it

3.46 R-ACES

Project name	**R-ACES - fRamework for Actual Cooperation on Energy on Sites and Parks**
Call identifier	H2020-LC-SC3-EE-2019
Type of action	Cooperation and Support Action (CSA)
Project logo	R-ACES Energy Cooperation Platform
Project website	www.r-aces.eu
Amount of EU funding (in EUR)	1,980,376.25
Other public or private project funding sources	N/A
Replication/implementation potential	4****
What is it?	Creation of ecoregions where multiple stakeholders engage in energy cooperation by exchanging heat/cold streams, investing together in renewable energy solutions, or managing energy streams through smart energy management platforms for reducing CO2 emissions by at least 10%.
When can I use it?	Since the deliverables of R-ACS are a toolbox, you can use them as soon as they are available in the project:
Where can I use it?	All practitioners in ecoregions that want to assess the potential and ambition of joint energy services in the region can use the tools during the process of planning or extension of their joint energy services. This includes representatives of all organizations in a region coming from industry, local and national government, and society. We expect ESCO, DHC managers, business park facilitators and energy professionals to be the first that are interested in the tool. The first usage will be in the learning community meetings of the R-ACES project.
Why should I use it?	The tools provided by R-ACES facilitates and supports the investigation by condensing best practices and conclusions of projects and research to industrial symbiosis and joint energy services.
Project size	During the project preparation a first overview of European organisations was used to validate the effectiveness of R-ACES replication and dissemination approach. This approach is based on a general communication on an outreach to network organisations instead of a communication to all individual sites and locations. The first list of network organisations includes approximatively 960 members organisations (industrial parks, regions, companies, policy makers, ESCO's, energy producers, innovation intermediaries, DHC networks). This list will be completed during the project and use the gathered information is input for the communication planning.

Summary	R-ACES means a step-change in the contribution of European Industry to the climate targets of the EU. The sector after all represents 25% of all energy demand – and 50% of all cooling and heating - on the continent; yet only 16% comes from renewables. By focusing on collective measures and clustering, the efficiency of industry can be drastically increased. The focus of R-Aces therefore is to turn high-potential, high-impact industrial clusters into EcoRegions that achieve at least a 10% reduction in emissions. An Eco-region is an area where energy, material and information exchanges occur between various companies and actors to reduce waste and energy/material consumption. Each region is centered on an (eco-)industrial park or (eco-)business park, linked to its surroundings by a 4th/5th generation district heating/cooling network. The consortium sees this project as a capping stone, condensing the knowledge and experience gathered throughout H2020 into a set of three focused tools embedded in selected support actions. The tools consist of an assessment tool; legal decision support for joint contracts; and a smart energy management platform for clusters. The support actions are built around peer-to-peer learning, more formal coursework and serious games. Together they enable a cluster to really become an EcoRegion and set up meaningful energy collaboration. The entire package of tools and support is aimed at the high-potential clusters identified in the European Thermal Roadmap. It will be validated in three of them (all are part of the consortium); actively deployed in another seven; and disseminated to ninety of them. In addition, the tools and support methodology will be made available to third parties in a sustainable way after the end of this two-year project. The project consortium consists of the entire value chain needed for energy collaboration – suppliers, ESCO, cluster managers, support – and represents many years of proven experience in this field.
Project details	This Coordinated and Support Action encourages the market uptake of new products and knowledge developed by EU-funded projects and other initiatives (e.g. privately funded, R&D from the industry). It proposes among other objectives the development of replicable and adaptable tools, innovative business models, but also combinations of existing and emerging technologies. Each of these features shall play the role of facilitators to EU industries to integrate new knowledge and increase their innovation capacity.
Demonstrator site description	Antwerp, Belgium: Terbekehof (TBH): industrial park (167 ha) next to water purification plant and important green area and ISVAG Waste Management Organisation. The ambition is to expand the heat network beyond the city of Antwerp and surroundings.

	Kanaalkant (KK): industrial park one of the largest industrial zones in Flanders) is consisting of 6 clusters; nearby the Port of Antwerp and close to residential area. Exchange-projects for heat and cold can function as a leverage. The realisation of a heat network with the nearby residential area is realistic. Other cases can be investigated with the R-ACES tools. Nyborg, Denmark: Nyborg: converting normal DH networks based on combined heat and power plants (often based on fossil fuels) to an energy system without fossil fuels. 95% of the heat in the district heating system comes from industrial waste heat. Use Industrial waste heat to reduce natural gas consumption in nearby industrial sites (process to process) Use industrial waste heat for heating existing and perhaps expanding nearby greenhouse areas. Extend the DH network to natural gas areas and to nearby villages. Connect the Nyborg DH network to the very large (10 PJ/y) Fjernvarme Fyn DH network which is partly based on coal fired CHP. Furthermore, the opportunities of district cooling for both industrial sites, business parks and other buildings with the need of comfort cooling will be investigated. Lombardy, Italy: Cartiera CA-MA: The plant with recoverable potential of around 20%, equal to around 500 MWh per month TURBODEN: Turboden, global leader in Organic Rankine Cycle (ORC) systems, highly suitable for distributed generation. A2A Calore&Servizi: A2A Calore & Servizi, a company of the A2A Group, is a leader in Italy in the district heating sector, its main objective is to develop and spread the district heating service, Ori Martin is a steel giant. Current levels of production and generation of waste heat add up to about 23,000 MWh, the recovered heat is transferred to the city's district heating network. iRecovery has been conceived to heat 2000 families each year (25 GW/h per year) and to produce clean electricity equivalent to the needs of 700 families.
How can cities use the technology?	Cities and regions can apply the tools to plan extensions or start of joint energy services, DHC networks, waste heat usage etc.
Environmental impact	The vision of R-ACES is to support high-potential industrial parks and clusters to become fully-fledged ecoregions that reduce emissions by at least 10%. They do so by exchanging surplus energy, making extensive use of renewables, and bringing everything together with smart energy management systems. The following observations can be made first with respect to the energy efficiency improvement potential of industrial parks, districts and clusters: - The highest impact is achieved by starting new initiatives of industrial heat exchange towards an urban region using a

<table>
<tr><td></td><td>district heating network. Italy has the greatest potential in R-ACES project.
- The smaller business parks - which often have SME companies at their sites - can all make small but significant steps in evaluating cooperating on energy services. They can achieve reductions of 0.1PJ per business park per year.
- Upgrading an existing District Heating and Combined Heat & Power (DHC) network is also very interesting and may give 20-25% energy reduction especially when smart energy concepts are applied as well.
GHG impact as result of optimizing existing DHC networks:
This enables the estimation of the range of reduction of the greenhouse gases emissions (in tCO2-eq/year) \ (in kg/year) triggered by R-ACES.
Conversion factors kWh to kg of carbon saved is 0.28307 kg CO2 saved for each kWh. This factor includes other greenhouse gas such as methane and nitrous oxide which are converted to their carbon dioxide equivalent, so the metrics is precisely kg CO2 eq. per kWh12.
<table>
<tr><th>Performance indicator</th><th>PJ/a</th><th>TWh</th><th>MtCO2eq</th></tr>
<tr><td>Short term min-max</td><td>151-265</td><td>41-74</td><td>12 - 21</td></tr>
<tr><td>Long term min-max</td><td>293-494</td><td>81-137</td><td>23 - 39</td></tr>
</table></td></tr>
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3.47 READY

Project name	**READY - Resource Efficient cities implementing ADvanced smart citY solutions**
Call identifier	FP7-ENERGY-SMARTCITIES-2013
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	http://www.smartcity-ready.eu/
Amount of funding from EU	Budget: €19,213,448 used: €15,936,660,57
Other public or private project funding sources	Overall budget - €33,340,202
Replication/implementation potential	4****
What is it?	Based on thorough integrated climate planning the READY project demonstrates a Whole City Approach including the development and demo of new solutions for low-temperature district heating, components and management ICT systems and the development and demonstration of flexible combined grid balancing/energy storage solutions for buildings and RES systems including combined heat pumps for heating and cooling, electrical vehicles charging, new PVT systems and 2nd life reuse of EV batteries in buildings. The concept of the project was demonstrated in the cities of Aarhus (Denmark) and Växjö (Sweden).
When can I use it?	Several of the innovative solutions developed in READY are now to be replicated in 10 large housing districts, with support from "Landsbyggefonden" (National Building Fund for Social Housing) in the greater Copenhagen area. The aim is to create new standard solutions that will be demanded as prerequisite to get attractive funding schemes for renovation of multi-family housing. It is primarily the solutions with PV(T), batteries, EV charging, microgrid and distributed heat pumps. This impact together with the developed battery storage systems are considered as a big success for the impact of the READY project. The average TRL of the technologies is around 6, where most of the technologies are developed and demonstrated, but in some cases it is necessary to continue with further developments. Some of the technologies reach TRL 7-8.
Where can I use it?	Part of the measures adopted during READY project can be implemented in renovation projects within the residential sector, with particular focus on housing associations and large building complexes as tested in READY project. Other solutions, such as the seawater heat pump can be implemented in harbour cities that have a high share of electricity from RES, which can produce district heating with low environmental impact. Most of the technologies have no area limitation and can be implemented and replicated in most of the cities around Europe. However, some limitations can be related to the

	weather conditions of certain places, for example due to low temperatures and limited amount of solar radiation during winter.
Why should I use it?	The measures demonstrate how the demand for energy and particularly the need for fossil fuels and release of CO_2 can be reduced to nearly zero, showing a sustainable way to go for other European cities.
Project size	The total building refurbished area involved in the project was equal to 82,616m² including both residential buildings and office buildings. In Denmark, the renovated area was 49,062m² of which 1,446m² were an office building and the remaining 47,616m² were residential buildings. The number of residential buildings renovated was 18 multi-family buildings and 1 single-family house. In Sweden, the total renovated area was 33,554m² of which 30,214m² were residential buildings for a total of 17 multi-family buildings and 3,340m² for one office building.
Summary	Based on thorough integrated climate planning the READY project will demonstrate a Whole City Approach including: 1) Demo of a balanced and holistic approach towards affordable retrofitting of residential buildings and offices 2) Development and demo of new solutions for low-temperature district heating, components and management ICT systems 3) Development and demo of flexible combined grid balancing/energy storage solutions for buildings and RES systems including combined heat pumps for heating and cooling, electrical vehicles charging, new PVT systems and 2nd-life reuse of EV batteries in buildings 4) Resource and energy smart solutions for kitchens 5) Solutions for water efficiency and waste water energy recovery 6) Demo of new innovative industrial equipment for use of RES and integration of demand and supply, - based on business plans, and follow-up by promotion and dissemination activities. The concept of the project will be demonstrated in 2 cities: Aarhus (Denmark) and Växjö (Sweden). The follower city is Kaunas (Lithuania).
Project details	The READY project made a remarkable contribution to the development a new type of photovoltaic heat absorber (PVT), which was developed by the project partner Racell Saphire. The new technology eliminates the use of a glass cover, the absorber consists of capillary tubes that equalise the flow pattern and improve the heat transfer. Furthermore, this type of panels can be used as building component since it comes in different colours and it can be glued to existing roofs and still utilise heat transfer from both sides though a vented aluminium-sandwich plate. The project partner Lithium Balance developed a residential battery pack of 120 kW installed in one of the retrofitting projects related to READY. The battery is formed by 79 kW of new cells, and additional 40 kW of 2nd-life cells. The use of 2nd-life batteries is based on the prolonged use of batteries having about 50% capacity left compared with new batteries.

	Furthermore, Lithium Balance has developed a Smart-Building-Energy-Hub, consisting of two main parts a local controller called "Site Controller" and a "Cloud" part. The system collects data and optimizes the use of the battery system. The two READY project partners Affaldvarme Aarhus and COWI have collaborated to introduce the seawater heat pump, which is one of the core demonstration activities in Aarhus. The system will deliver heat to the DH network thanks to a 1 MW (thermal) heat pump, which uses seawater as a primary energy source, and water as refrigerant in first cycle. In Växjö an innovative district cooling project named “energy used three times” was developed, where the district cooling flow is used twice for cooling and once for heating. Furthermore, the energy company VEAB in Växjö has installed Smart Heat Grid technology solutions. With this technology, VEAB balances the production and the consumed energy in a very efficient way. Software sensors and control equipment enable VEAB to optimize the operation of the district heating network and increase safety of district heating supply. The two READY project partners Boligforeningen Ringgaarden (housing association) and COWI introduced two small-scale heat pump systems for recovering heat from wastewater. In Ringgaarden’s department named Trigeparken, a special heat exchanger was installed in a prefabricated plastic manhole. A similar system was installed in Växjö. A second heat recovery system was installed in Ringgaarden’s department named Rydevænget, where the heat exchanger is installed to replace part of a drain downpipe. The READY project partners Aarhus Municipality and E.On Denmark collaborated to strengthen the EV charging network in Aarhus Municipality by installing 208 publicly accessible charge points with 106 of these located centrally in Aarhus. The objective of Aarhus Municipality is to promote sustainability and to reduce congestion and change citizens behaviour. Various campaigns have been launched to change the behaviour mainly aiming to reduce use of fossil fuel cars and increase use of other vehicles, e.g. bicycles and EV-cars. Some of the campaigns included: “365 days on a bike” “Is your second car an electric bike?”, “Mobile bicycle library” and “Test an electric bicycle”.
Demonstrator site description	In relation to the newly developed PVT panels, the product is revolutionary for the thermal part of a PVT panel as it can theoretically be delivered in up to 3x6m size for one panel. In the project, the PVT implemented in Denmark used 1.5x3.8m panels, as they were easier to handle and could fit better to

	the actual size of the roof. The new technology eliminates the use of glass cover, the absorber consists of capillary tubes that equalise the flow pattern and improve the heat transfer. The panel can be produced with a weight of less than 12 kg/m², so that two persons can carry a 5m² panel. 1) http://www.smartcity-ready.eu/test-of-future-green-energy-at-trigeparken/ 2) http://www.smartcity-ready.eu/factory-visit-of-racell/ The seawater heat pump in Aarhus is located in a bespoke machine building in an area where a boost in the local DH supply is needed. The large-scale heat pump is also expected to contribute to a better integration of the DH system with the electricity market. The 1MW unit is only the first of 12 modules that are considered to installed in the dedicated building, so that total capacity will reach 12MW. The Danish ambitions for introducing heat pumps in the district heating supply is significant and the Aarhus' heat pump and its achievements is followed with great interest. The unit was first officially inaugurated on the 11th of January 2020 and taken into real-life operation as of February 2020. The building was designed to allow public access and raise awareness about heat pumps and the Aarhus DH system. 1) http://www.smartcity-ready.eu/seawater-becomes-district-heating-in-aahus/ 2) http://www.smartcity-ready.eu/invitation-come-and-join-us-at-the-initiation-of-the-future-district-heating/ http://www.smartcity-ready.eu/d-3-5-2-concept-for-holistic-design-of-integrated-energy-systems-for/ The newly developed battery storage system uses 2nd-life batteries based on the prolonged use of batteries having about 50% capacity left compared with new batteries. Regarding the Smart-Building-Energy-Hub, the site controller is installed in the system and physically connects the components of the battery system (battery, meters, etc.) to the cloud. The cloud collects all the data and from equations, forecast, local consumption/production and user inputs, generating a schedule for the battery behaviour. 1) http://www.smartcity-ready.eu/prototype-of-battery-pack-unit/ The triple use of the district cooling flow consists of the three different steps/systems that uses the flow for cooling or heating. In the first step, the district cooling supplies cooling load to the air conditioning system of a shopping mall. The system is connected in series to a data centre, which needs cooling load at a slightly higher temperature. Lastly, the heat absorbed in the previous steps is used to heat up the football turf of the local stadium. 1) https://www.districtenergyaward.org/innovative-district-cooling-cycle-network-vaxjo-sweden/

	In Ringgaarden's department named Trigeparken, a special heat exchanger was installed in a prefabricated plastic manhole. The manhole collects wastewater from two building blocks (36 apartments) and the heat pump connected to the heat exchanger uses the wastewater as heat source, which is then used to produce domestic hot water and space heating for one of the two blocks. The second heat recovery system installed in Ringgaarden's department named Rydevænget, consists of a heat exchanger installed to replace part of a drain downpipe and the heat pump system connected reuses the heat to produce domestic hot water and cover circulation losses for the same building. 1) http://www.smartcity-ready.eu/d-6-3-report-on-energy-performance-of-the-project-in-close-collaboration-with-wp7/ 2) http://www.smartcity-ready.eu/heat-recovery-of-waste-water-at-alabastern-in-vaxjo/
How can cities use the technology?	PVT and heat pump systems can be implemented in large multi-family building complexes, which can be integrated with district heating supply. In the same way, the small wastewater recovery heat pump can be used to recover heat and integrate the heat supply from the district heating network. Seawater heat pumps can be further developed and installed in cities that have access to large bodies of water. If the electricity supply is based on renewables, this type of heat pump can contribute to the decarbonization of the district heating supply. Battery storage systems integrated with Smart-Building-Energy-Hub can be largely integrated in cities in order to optimize the use of RES energy sources, such as photovoltaic panels, and in cooperation with heat pumps, it can contribute to cover part of the heat demand of the building stock, reducing the carbon dioxide emissions.
Environmental impact	The total final energy consumption measured during the monitoring activities in the different demonstration sites in Aarhus Community was about 2,886MWh, when referring to the actual reference year. It was evaluated that the achieved energy saving as direct consequence of the building refurbishments undertaken during READY project was approximately of 6,303MWh, when compared to the Building Energy Specification Table (BEST) reference consumption. The weighted buildings total final energy consumption was 187kWh/m² for the BEST reference case and was reduced to approximately 59kWh/m² for the actual reference year. The actual consumption resulted 69% less than the BEST reference and resulted even lower than the renovation target defined in the BEST tables. The expected CO_2 emissions from the demonstration buildings was calculated to be approximately 429 tons normalised to a standard reference year, which results in a reduction of approximately 80% compared to the BEST reference value, equal to 1,668 tons. The average weighted reduction is about 34 kg/m² per year.

	The demonstrated local renewable energy systems produced 380MWh in the actual reference year, which corresponds to a displacement of 218 tons of CO_2. An extra reduction of CO_2 emission of 648 tons is the expected by heat production of the seawater heat pump. The average weighted CO_2 reduction is about 17.5kg/m² per year. The total final energy consumption measured during the monitoring activities in the demonstration sites in Växjö Community was 2,835MWh, when referring to the actual reference year. The energy saving as a direct consequence of the building refurbishments undertaken during READY project was evaluated to be approximately 2,413MWh, when comparing to the BEST reference consumption. The weighted buildings total final energy consumption was 156 kWh/m² for the BEST reference case and was reduced to approximately 72kWh/m² for the actual reference year. The actual consumption resulted 54% less than the BEST reference, which resulted also lower than the target defined in the BEST tables. The expected CO_2 emission from the demonstration buildings was calculated to be approximately 276 tons for the actual reference year, which results in a reduction of approximately 48% compared to the BEST reference value, equal to 255 tons. The average weighted reduction is about 7.6kg/m² per year. The demonstrated local renewable energy systems produced 107MWh in the actual reference year, which corresponds to a displacement of 12 tons of CO_2. The average weighted reduction is about 0.42kg/m² pr. year. Additionally, the improvement of the district heating network in Alabastern district saves 7.3 tons every year, while the innovative district cooling project “energy used three times” in Växjö reduce the CO_2 emission for at least 230 tons per year.
Project coordinator’s contact details	Reto Michael Hummelshøj, COWI, RMH@cowi.com

3.48 REEEM

Project name	**REEEM**
Call identifier	H2020-LCE-2015-2
Type of action	Research and Innovation Action (RIA)
Project logo	R E E E M
Project website	https://www.reeem.org/
Amount of EU funding (in EUR)	3,997,458.75
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	Within the REEEM project - Role of technologies in an energy efficient economy: model-based analysis of policy measures and transformation pathways to a sustainable energy system – a study was conducted on the expansion potential of DH systems in Kaunas municipality, Warsaw municipality and Helsinki region through to 2030 and 2050, through optimization modelling tools.
When can I use it?	The models are ready for use, especially to inform citizens and municipalities on potential price changes due to new investments and changes in fuel supply.
Where can I use it?	Currently applicable to Kaunas, Warsaw and Helsinki regions. The models include detail of currently installed capacity and fuel balances and all investment plans by municipalities and local DH utilities.
Why should I use it?	The models help assess the impacts of municipality and utility plans in terms of changes in DH costs, changes of fuel mix, decrease of fossil fuel supply and of related emissions, vulnerability of consumers to all above changes.
Project size	Entire Kaunas municipality, Warsaw municipality and Helsinki region.
Summary	The key aim of this analysis was to investigate how carbon neutral DH production could be reached in three European regions i.e. Helsinki region, Kaunas and Warsaw. The results suggest that even though there is potential to cut the CO2 emissions, rather large changes may be needed in the studied DH systems, which can further increase the heat production costs. The studied DH system differ from each other, e.g., in the fuels currently used for DH production, which further affect the changes required. The heat production costs are prone to increase through the investments required for reaching the emission target.
Project details	The analysis showed that in order to reduce emissions, rather large changes are needed in the DH systems. These changes include especially increased use of biomass, waste, heat storages and heat pumps. In addition, the use of CCS technologies could be considered and energy efficiency improved. According to the results of this analysis, heat production in Kaunas would be based solely on wood chips and waste in 2050. In Warsaw, biomass, waste and electricity

	would be the main fuels for DH production. In addition, natural gas was also used in plants equipped with CCS.
Demonstrator site description	N/A
How can cities use the technology?	This project was aimed to provide information on the feasible future pathways of developing low-carbon DH systems.
Environmental impact	In Kaunas where the share of biomass and municipal waste has increased rather much in recent years, emissions can be cut by 15% with modest cost increase. Yet, if emissions are cut to zero, the marginal heat production cost increases by 55%. According to this analysis, the changes required in the DH system of Warsaw are large and increase the heat production costs rather much. In Helsinki region, costs increase rather modestly by 2050. Cost increase is hindered by significant revenues from electricity sales, use of heat pumps in heat production and utilization of inexpensive fuels such as waste and wood pellet.
Project coordinator’s contact details	sanna.syri@aalto.fi

3.49 RELaTED

Project name	**RELaTED**
Call identifier	H2020-EE-2017-RIA-IA
Type of action	Innovation Action (IA)
Project logo	RELaTED
Project website	http://www.relatedproject.eu/
Amount of EU funding (in EUR)	3,943,253
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	RELaTED - REnewable Low TEmperature District Concept and technologies for the reduction of temperature levels in DH, with the integration of renewables at district and building scale. Heat Pumps and Solar Systems are connected to the DH at building scale through purpose-specific building substations. Industrial Waste Heat is integrated as energy source to the Districts.
When can I use it?	RELaTED Technologies (Substations, heat pumps and solar systems) are already installed in demonstration sites (2020) with a TRL level of 8. RELaTED Ultra Low Temperature and Smart District Concepts have been adapted to 4 demonstration sites, with a TRL level of 7.
Where can I use it?	RELaTED operates for (mainly) heating-oriented DH networks. Building-level technologies (substations, solar systems and reversible heat pumps) can be used together with the RELaTED concept, or in de-centralised medium-large scale centralized heating systems. Waste Heat recovery can be implemented starting from low grade heat (~30ºC) with Heat Pumps up to direct connection (~>70ºC). New DH networks can be designed according to the RELaTED Ultra Low Temperature Concept. Existing networks can be ported towards the RELaTED Ultra Low Temperature Concept. Depending on existing network status, specific adaptation schemes may need to be implemented.
Why should I use it?	Reduced heat loss in networks. With associated reduction in operational expenses. Modular solution for integration of renewables together with DH.
Project size	4 DH networks, with estimated intervention on 150 buildings of various sizes (detached, multi-rise, educational, offices,…), 8 waste heat recovery interventions and integration of RELaTED technologies in 11 buildings.
Summary	District heating (DH) systems are one of the most energy efficient heating systems in urban environments, with proven reliability within many decades already. DHs have

	traditionally been designed to be operated in a hierarchized way, with central energy production facilities delivering heat to a variety of distributed consumption locations. DHs are identified as key systems to achieve the de-carbonization of heating energy in European Cities. Renewable and waste heat sources are foreseen at the same time as de-carbonized heat sources and the way to guarantee competitive energy costs with limited influence of fossil fuel supply price volatility. To achieve this, conversion of DHs is needed regarding: - The reduction of their operation temperature to avoid current technical constraints in the integration of low-grade industrial heat sources, - The introduction of larger shares of renewable energy sources (RES) in the DH network. - The introduction of distributed heat sources (reject heat from cooling equipment...). - To guarantee economic viability with the trend of DH heat load reduction due to the evolution of the building stock toward NZEB (Near Zero Energy Buildings). RELaTED Provides an innovative concept of decentralized Ultra-Low Temperature (ULT) DH networks, which allows for the incorporation of low-grade heat sources with minimal constraints. Also, ULT DH reduce operational costs due to fewer heat losses, better energy performance of heat generation plants and extensive use of de-carbonized energy sources at low marginal costs. The RELaTED ULT DH concept is demonstrated in four complementary operation environments (new and existing DH, locations, climatic conditions, dimension…) in Denmark, Estonia, Serbia and Spain. RELaTED approach follows the strategy of the electrical smart grids, in which energy generation is decentralized and consumers evolve to prosumers (they consume and produce energy).
Project details	RELaTED develops an ultra-low temperature (ULT) heat distribution concept beyond traditional low-temperature district constraints, where thermal energy is produced at low temperature, with large shares of renewable and residual energy sources, and heat load is modulated with advanced control, and thermal storage, allowing for heat delivery at 40-45ºC. To achieve so, specific technologies are developed and/or ported to the ULT Dh environment: - A triple function substation (3FS) for heat delivery, rejection (cooling mode) and injection of surplus local solar heat - A reversible DH-connected heat pump (DHRHP), adapted to dual function for reject heat delivery to district network at low temperature. - An adapted concept for Building Integrated Low Temperature Solar Thermal System (BILTST) without local thermal storage, and direct connection to the district network.

	The ULT heat distribution concept allows the DH to use surplus heat in some buildings (e.g. NZEB) to reduce the overall carbon intensity of the network. Focused not only into new networks, RELaTED develops adaptation schemes for existing DH systems to progressive operational temperature reduction, while keeping continuous service. Also, for the integration of new DH networks in consolidated urban environments. In line with existing local potentials, RELaTED takes profit of local industries and other local waste heat streams to incorporate these into the ULT DH concept. RELaTED concept and Technologies are developed in 4 complementary environments: - New ULT DH in a green field development, with NZEB in Denmark - Operational DH, with high share of biomass heat production, in Estonia - Large DH network, in Serbia - Corporate DH network in Spain
Demonstrator site description	RELaTED is demonstrated in 4 sites: Large DH in operation in Serbia The urban area of the City of Belgrade has a population of 1.34 million, while over 1.65 million people live within its administrative limits. The city is served by the DH operated by BEOELEKTRANE, with an installed capacity of CA 3GW from 60 heat sources over a DH network comprising 750km, which delivers 3500GWh to approximately 50% of the city of Belgrade. Each year several dozens of kms are added to the network. Within RELaTED, BEOELEK will deploy the following conversion activities to the DH network in Belgrade: - LT conversion of one subnetwork comprising several households and apartment buildings with modern insulation levels. - Integration of RELaTED technologies into a DH-connected School building. - Feasibility studies, engineering projects, tendering, construction and/or commissioning of several waste heat and RES projects totalling more than 600 MW of installed capacity. Conversion of power plant to CHP, heat pumps, waste incineration plants and large solar thermal technologies. New urban development in Denmark Vinge is a green field development and the largest urban development project in Denmark. Located near Frederikssund, Vinge will be fully developed in a 20 year time frame. It is expected to comprise 20,000 inhabitants and 4,000 new jobs. Vinge will demonstrate the scalability of the ULT DH concept for new urban developments, where grid design should adapt to steady increases in energy loads by connection and

	diversification of energy sources, particularly of renewable nature. Existing DH with large share of biomass in Estonia With over 90,000 inhabitants, Tartu is the second largest city of Estonia. Tartu is served by a DH system privately owned and operated by FORTUM TARTU, with a heat production capacity of 250MW, comprising Biomass CHP systems, Biomass and gas boilers, and Heat pumps systems connected to its heating and cooling network. Yearly 500GWh are delivered to over 1,500 consumers in the city. 94% of this energy is obtained from biomass and peat. Every year, 40-60 new connections are performed to the grid. Within RELaTED, the ULT conversion of the TARKON-TUGLASE subnetwork has been performed, and technical limitations of the ULT conversion of an existing network have been investigated. Also, heat purchase strategies from waste heat producers are being developed, with several interventions in the range of 1 to 10MW. Corporate DH in Spain A corporate DH network is used to heat the headquarters of emergency, rescue and fast intervention teams of the Ertzaintza (regional police of the Basque Country). A total of 14 multi-rise buildings with different characteristics and mixed uses (offices, accommodations, training rooms, sport facilities, swimming pool, heliport,…) are heated by a centralized heat production of 650 kW serving space heating and domestic hot water, with additional independent heat pumps for a subset of the buildings, and cooling applications. Within RELaTED, the network will be converted into ULT, with systematic intervention with DHRHP systems to integrate all remaining buildings into the network, and BILTST to reduce the carbon intensity of the heat production. This will result in a densified DH network with reduced carbon intensity.
How can cities use the technology?	Develop ULT transition plans for existing Networks. Inspire new networks by RELaTED ULT networks. Integrate technical solutions to particular buildings, networks to facilitate DH connection. Solutions are/will be commercially available even before the end of RELaTED project.
Environmental impact	>700MW of RES integrated Reduction of 1.5GWh/year of fossil fuel heat production (estimated 20Million €/year)
Project coordinator’s contact details	Garay Martinez, Roberto roberto.garay@tecnalia.com
Contact information for demo site or specific solutions	IURRETA: Josu Martinez villabeitia jmartinez@seg.euskadi.eus TARTU: Margus Raud margus@fortumtartu.ee DENMARK: Chsitian Holm Cristiansen cnc@teknologisk.dk BELGRADE: Ljubisa Vladic LJUBISA.VLADIC@bgdel.rs

3.50 REMOURBAN

Project name	**REMOURBAN**
Call identifier	H2020-SCC-01-2014
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	http://www.remourban.eu/
Amount of EU funding (in EUR)	21,541,949.13
Other public or private project funding sources	Public co-funding by Municipalities and private co-funding from owners of dwellings
Replication/implementation potential	4****
What is it?	REMOURBAN (Regeneration Model for accelerating the Smart Urban Transformation) is a large-scale demonstration European project (Grant Agreement No 646511), the purpose of which is to accelerate the urban transformation towards the smart city concept taking into account all aspects of sustainability.
When can I use it?	Most solutions are ready for replication (TRL8-9).
Where can I use it?	The solutions deployed cover different fields and scales of cities: buildings and districts, city mobility and digital solutions. The districts retrofitted cover different geographic and climate conditions, while the mobility and ICT technologies have been implemented at different scales and in different sectors as public transportation, private transportation, car sharing or last mile delivery.
Why should I use it?	The solutions have contributed to transforming the cities into smarter and more sustainable environments, implementing technological and non-technology related projects aiming at improving the living conditions of the citizens. These contribute to reducing the energy consumption (and therefore the energy bill), to reduce CO2 emissions and other pollutant through the integration of renewable energy sources and sustainable mobility solutions, to provide mechanisms for more informed decisions and to ensure appropriate engagement of stakeholders (particularly citizens) and to implement workable business models that ensure an appropriate implementation of the technologies.
Project size	The three cities are mid-size cities. The scale of the interventions address different levels but in the field of energy, a total of 63.000 sqm have been retrofitted in total (920 properties).
Summary	An Urban Regeneration Model has been developed and validated in the three lighthouse cities of the project (Valladolid-Spain, Nottingham-UK and Tepebaşı/Eskisehir-Turkey) accelerating the deployment of innovative technologies, organizational and economic solutions to

	significantly increase resource and energy efficiency, improve the sustainability of urban transport and drastically reduce greenhouse gas emissions.
Project details	The three cities have deployed actions in terms of energy efficiency, sustainable mobility and enabling ICTs. A total of almost 64,000 m2 have been retrofitted in the three cities, where also 95 alternative fueled vehicles have been deployed for public transportation, car sharing and distribution of goods. The three cities count now with ICT platforms that have permitted the implementation of services for evaluating the actions and for providing added-value services to the citizens (as energy and transport maps or virtual games on energy savings). Important lessons have been learnt in the lighthouse cities during the implementation of these actions, mainly related to non-technical aspects linked to existing barriers for the implementation of innovative technologies and processes, which is especially remarkable for the public actors. These learnings, accompanied by a thorough and continuous evaluation of the financial sustainability of the actions, have feed into the outcomes provided during the whole project which have been collected in this period into the Best Practices and the Urban Regeneration Model e-Books.
First demonstrator site description	VALLADOLID Energy efficient retrofitting of 398 properties (in 9 blocks and 1 tower) integrating external insulation of roofs and walls, LED lighting in common areas, thermostatic valves and heat allocators in radiators, retrofitting of the existing gas-gasoil DH into a biomass-based DH with a gas boiler to cover peaks, retrofitting of the whole distribution network including insulated pipes and leak detection systems, improvement of the pumping system (with variable flow pumps) and change of all substations including also thermal storage systems, and implementation of a BIPV façade in the south of the tower (64 kWp). Resources: http://www.remourban.eu/technical-insights/infopacks/optimisation-of-existing-district-heating-and-cooling.kl http://www.remourban.eu/technical-insights/infopacks/district-retrofitting.kl
Second demonstrator site description	NOTTINGHAM Retrofitting of 400 properties following different standards and approaches. Two of the most remarkable actions are the Energiesprong homes and the Courts retrofitting. Within the first a Zero Energy retrofitting project (Gold Standard) has been implemented with an energy centre testing fifth generation heat networks with ground source heat pumps fed by bore holes. Also solar PV panels in the roofs feed into the energy centre via a private wire where a battery and heat storage system has been deployed as well as smart controls. The second (the Cours) include the retrofitting under a Silver Standard and deploying a Low Temperature District Heating using the return temperatures of a pre-existing heating

	network. Also PV panels with a private wire and batteries have been installed in these properties to maximize on site energy consumption. Resources: http://www.remourban.eu/technical-insights/infopacks/low-temperature-district-heating-ltdh_1.kl http://www.remourban.eu/technical-insights/infopacks/energiesprong-2050-project.kl http://www.remourban.eu/technical-insights/infopacks/building-integrated-photovoltaics-bipv--energy-storage-and-smart-grid-management.kl
Third demonstrator site description	TEPEBASI/ESKISEHIR 17 buildings have been retrofitted including wall and roof insulation, triple glazing, HVAC system and smart lighting systems. A 250kW capacity air sourced heat pump with heat recovery system has been installed and a pellet boiler with a capacity of 290 kW. 50 kWp PV panels have been mounted into a park canopy, while other 100 kWp BIPV solution has been deployed in the roofs of the buildings accompanied by 27 kW solar thermal panels. All this contributes to a nearly zero energy district where the 72% of the current energy consumption comes from renewable energy sources. Resources: http://www.remourban.eu/technical-insights/infopacks/district-retrofitting.kl http://www.remourban.eu/technical-insights/infopacks/building-integrated-photovoltaics-bipv--energy-storage-and-smart-grid-management.kl http://www.remourban.eu/technical-insights/infopacks/retrofitting.kl
How can cities use the technology?	The project has developed a replicability framework aimed at connecting the supply with the demand side, providing supporting tools for the stakeholders in the value chain of the city transformation to characterize the city needs and identify suitable technology solutions accompanied by relevant business models and engagement mechanisms for the actors involved. This framework, developed as a toolbox, gathers relevant technical and non-technical information about the solutions developed in the project (e.g. energy retrofitting, deployment of H&C networks, LTDH, e-buses, etc.) including details on barriers and overcoming mechanisms to ensure an appropriate implementation. Further information on this can be found within the Urban Regeneration Model booklet: http://www.remourban.eu/technical-insights/best-practices-e-book/, and within the information packages produced for the solutions deployed: http://www.remourban.eu/technical-insights/infopacks/
Environmental impact	• Number of dwelling in the retrofitted districts: **920** • Total area retrofitted: **63,316.4 m^2** • Total inhabitants of the retrofitted districts: **3,080 citizens** • Average of energy savings in the retrofitted districts: **92.63 kWh/m2·yr (39%)**

	• Average of energy savings per citizen affected by the retrofitting works: **1,913.2 kWh/person·yr** • Average of CO2 emissions avoided in the retrofitted districts: **34.02 $kgCO_2/m^2·yr$** • Average of renewables in the retrofitted districts: **47% of thermal consumption and 42% of the electricity** (**74%** of thermal consumption for heating and DHW in Valladolid and Tepebaşı and 100% of the electricity in Tepebaşı) • Total number of electrical vehicles deployed in the three lighthouse cities: 73 cars, 22 buses and 30 e-bikes • Citizens directly affected for the mobility actions: **308,647 citizens.** This figure is much higher than the 11,120 citizens estimated at the beginning of the project • Average of energy savings due to the mobility actions: **45%** (1,267 MWh/year) • Average of CO_2 emissions avoided due to the energy savings by the mobility actions **66%** (505.7 TonCO2/year) • Average reduction of **40%** the energy consumed in the households and **59.3%** of the CO_2 emissions associated • Average reduction of **54%** in the energy bill of the households and **43%** in the energy bill of the electric vehicles • **45%** of the energy spent in transportation has been reduced due to the use of electric vehicles • TOTAL**: 60%** of CO_2 emissions avoided and **40%** of energy savings among retrofitted districts and electric vehicles
Project coordinator's contact details	Mr Miguel Á. GARCÍA-FUENTES CARTIF Technolgy Centre Contact: miggar@cartif.es / 0034 983 548 911
Contact information for demo site or specific solutions	Valladolid Ddemosite: Ms Elena Hoyos (ehoyos@ava.es) Nottingham demosite: Mr Owen Harvey (Owen.Harvey@nottinghamcity.gov.uk) Tepebasi/Eskisehir demosite: Mr Murat Aksu (4maksu@gmail.com)

3.51 Renewable Cooling under the Revised Renewable Energy Directive

Project name	**Renewable Cooling under the Revised Renewable Energy Directive**
Call identifier	#ENER/C1/2018-493
Type of action	Tender
Project website	/
Amount of EU funding (in EUR)	N/A
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	In order for EU member states to count renewable cooling according to the renewable energy directive II, a methodology for calculating renewable energy utilized for cooling and district cooling is developed and its impact is assessed. In order to substantiate this step, a thorough analysis of cooling technologies and current cooling consumption is being done.
When can I use it?	The project will be completed in late summer 2021.
Where can I use it?	The definition of renewable cooling is elaborated in a way to ensure an effective application by each EU Member State.
Why should I use it?	Up until today renewable energy used for cooling was not considered in the calculation for a countries RES shares. In order to give an incentive for the use of renewable cooling and for Member States to account renewable cooling in their target achievements, the calculation methodology created in this project will be used.
Project size	The data for cooling technologies and consumption is collected from all EU member states on a national level.
Summary	The project aims to provide an overview of technologies for cooling and related technological development trends. The final energy consumption for cooling is quantified for the base year (2016) as well as for 2030 and 2050 and options of renewable cooling definitions, which are in line with the RED II are developed and compared. In addition, environmental, social and economical impacts as well as benefits and costs of proposed definitions on renewable cooling are investigated. Finally, a well grounded recommendation for choosing an adequate definition of renewable cooling as well as calculation methods, which base in legal requirements of the RED II, is provided. Additionally, recommendations on how statistical reporting can be utilized for renewable cooling considering the energy statistics framework of the EU are given. Results can not be shown yet, since the project is still ongoing.
Project details	In order to asses the impact of any chosen definition for renewable cooling, related data for all EU member states was collected. The increase in cooling consumption was estimated under consideration of different political as well as technological scenarios. Technologies, which are suspected

	to have the largest market shares in the future are used to estimate the impact of different renewable cooling definitions on the resulting RES shares. Economic effects and possible CO2 reductions are derived for every MS.
Environmental impact	The cooling related energy consumption and GHG emissions for different scenarios and different definitions of (renewable) cooling are carried out in the project.
Project coordinator’s contact details	Lukas Kranzl, TU Wien, kranzl@eeg.tuwien.ac.at

3.52 REPLACE

Project name	**REPLACE**
Call identifier	H2020-LC-SC3-EE-2018
Type of action	Cooperation and Support Action (CSA)
Project logo	replace
Project website	Replace-project.eu
Amount of EU funding (in EUR)	1,999,878.75
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	With over 80 million inefficient heating & cooling (HC) systems still installed across Europe, motivating consumers to replace those units with more efficient, greener alternatives will be key for a decarbonised Energy Union fueled by renewable energy. REPLACE therefore aims to improve coordination in local networks to implement replacement campaigns targeting households in ten target regions by means of action plans fortified with policy and business-related improvements.
When can I use it?	The starting point for the action is challenging: generally speaking, heating systems and related decisions are considered to be “unexciting” or “unsexy” for households, which is why hardly anyone deals with them voluntarily. Therefore, outdated heating systems are only replaced when they fail completely or are about to fail. This often means that there is no time for informed decisions or the consideration of a change in energy source. In such situations like-for-like replacements can occur, which in many cases mean a lock-in heating system based on coal, oil or natural gas. Currently, the heating and cooling sector comprises 50% of final European energy consumption and over 68% of all gas imports. REPLACE addresses the main barriers households are confronted with, including fuel poverty and gender aspects, and reduces the risk of a heating crisis by supporting the use of regional renewable energy sources (such as solar, ambient heat or biomass-based sources in individual in-house or grid-based district or smaller micro heat systems) and TRL 8-9 HC equipment produced within the EU (biomass boilers, heat pumps, solar collectors, district heating system components, etc.). The approaches and solutions developed during the action, running from 11/2019 to 10/2022, will be made available partly in the course of the project or at project end.
Where can I use it?	The amount of information required for a boiler or oven replacement for a household is high and many different actors have to be consulted. In many cases, consumers often do not have enough money to invest in potentially more

	expensive low-CO2 heating or cooling systems, even if life cycle costs are significantly lower and the investment is less risky. REPLACE wants to tackle those and other regional challenges and barriers by developing and testing locally adapted, tailor-made replacement campaigns – for the first time, in parallel – across ten European pilot regions with a total population of 8 million. The replacement campaigns are to be launched and supported by the project partners on-site by Local Working Groups (LWG), bringing public authorities, end consumers, installers, chimney sweepers, energy consultants, boiler and oven manufacturers, representatives of RE-based systems, DH-suppliers, policy makers and other key players who are in direct contact with consumers to one table. The LWG decides what activities and how they will be rolled out and communicated during the replacement campaigns running from 04/2021 to 10/2022 in 10 European target regions.
Why should I use it?	The project aims to raise awareness of the benefits of heating and cooling replacements by highlighting success stories.
Project size	The geographical focus of REPLACE lies in Western, Central and South-Eastern Europe. It covers 9 countries with 10 representative target regions and altogether 8.3 million inhabitants: Austria: Federal State of Salzburg Bosnia and Herzegovina: Canton of Sarajevo Bulgaria: Rhodope Mountain Region Croatia: Primorsko goranska County, City of Zagreb incl. three bordering counties Germany: Bavarian Oberland North Macedonia: Skopje Region Republic of Serbia: City of Šabac Slovenia: Slovenia Spain: Castilla y León Region By concentrating on these regions, REPLACE investigates a broad portfolio of heating and cooling technologies and appropriate renewable systems. The project further develops individual approaches, examines possible similarities and generates solutions that can be shared within and beyond its target regions In addition to helping households replace their old heating systems with more environmentally friendly alternatives, the action also includes simple renovation measures that reduce overall energy consumption. These measures are expected to save up to 144,000 tons of greenhouse gas emissions per year immediately after the two campaign years. This is the amount emitted by 60,000 to 70,000 diesel passenger cars per year.
Summary	With over 80 million inefficient heating & cooling (HC) systems still installed across Europe, motivating consumers to replace those units with more efficient, greener alternatives will be key for a decarbonised Energy Union fuelled by renewable energy. REPLACE therefore aims to improve coordination in local networks to implement replacement

	campaigns in ten target regions by means of action plans fortified with policy and business-related improvements. Based on lessons learnt from previous projects and sound on-the-ground research on stakeholders' mind-sets, local working groups (LWGs) will connect all key actors in each region – local governments, consumer associations, intermediaries, manufacturers and associations of RE-based and DH systems – to steer the direction of a wide range of replacement activities. For the first time, REPLACE will explicitly unite intermediaries, such as installers, chimney sweepers and energy advisors, who have constant access to consumers, and policy makers to develop common activities with maximum impact by facilitating an enabling environment. REPLACE supports the LWGs by providing a communication framework and a rich toolbox of online and offline actions targeted to the needs of all relevant stakeholders. The "REPLACE Your Heating System Calculator" will be central in raising consumers' and investors' awareness of the monetary and wider benefits of HC replacements. Collective actions are also envisaged. By making all materials openly accessible and highlighting success stories the uptake of activities can be multiplied beyond the target regions. In addition, all activities will be firmly established within local policy programmes to ensure that the overall impact of REPLACE is sustainable and the networks forged during the action will continue beyond project life. Together with a dedicated focus on capacity-building measures and knowledge transfer, REPLACE identifies and merges all elements necessary to successfully make heating and cooling for European consumers efficient and climate-friendly.
Project details	The local working groups, as far as it is in their power, will create an enabling environment, offer attractive "packaged replacement solutions" and enable end consumers to take informed decisions. Based on preliminary investigations, elements of these packaged solutions, in the best case, include the following: ○ a "**boiler age label**" by chimney sweepers, serving – besides improving consumer awareness – the purpose of a hand-over of a replacement information package / folder ○ independent energy advisors who act as "**one-stop shops**" for intensive consulting regarding the most suitable new renewable heating systems, take care that the corresponding "all-round carefree package" offers of "listed all-in package providers" are complete and comparable and monitor the customer satisfaction regarding taken technical and procedural measures ○ an "**all-round carefree package**" offered by "listed all-in package providers": they are asked to put together a "package deal"

including all costs and services needed for the
  - disposal of old equipment and fuel,
  - installation and commissioning of the new system, incl. electric installations etc.,
  - (eventual) temporary, mobile “bridge-over” heating solutions, as well as
  - application for permissions and subsidies, if any.
  - etc.
- “**financing package**”, i.e. public authorities
  - offer financial incentives or bridge-over existing stop-and-go funding, respectively,
  - negotiate with banks for predictable and attractive loan instalment rates (preferably lying in the range or below of the annual money savings after a fuel-switch),
  - negotiate with suppliers of green HC systems for discounts for equipment or fuel, and
  - grant mortgage loans in case of energy poverty or to older people with difficulties to apply for a loan,
- a “**collective action**” that addresses energy efficiency measures before or in parallel to a heating system replacement, collectively organized (by a public “care taker” organization), like
  - collective thermal insulation of the top floor ceiling, e.g. at single family houses,
  - collective implementation of cheap and simple “heating system check” measures, or
  - the establishment of local micro biomass heating grids,
  - joint purchase of PV systems, e.g. with hot water heating elements or split room air conditioning systems (e.g. recommended by topten.eu).

Deviations from this preliminary concept (drafted at an early planning stage of the project) are quite possible depending on local conditions and possibilities.

Accompanying the overall implementation concept, consisting of the packaged solutions listed above, the local working group in its replacement campaign will implement at least six further supporting activities from those listed here below:

1. REPLACE **information points** at municipalities and other public bodies

	2. **“Open cellar events**“ at houses of pioneer families 3. A **study tour** to best practice systems 4. **Labelling** of houses e.g. with regard to climate friendliness 5. Three **webinars** on the use of the „Replace your Heating System Calculator“ 6. Six boiler replacement **feasibility studies** per target region, offered for free 7. **Information stands** at fair trades, installer events etc. 8. Information stands on the subject of cooling and air conditioning 9. Show case of a **mobile heating container**, e.g. as a part of „carefree packages“ 10. Show case of an energy supplier/energy service company/installer **becoming a contractor** 11. Show case of an **installer** (door opener, equipment supplier) & **contractor** (planning, financing) **cooperation** 12. Show case of a multifunctional facade system Essential for campaign implementation is a target group-specific communication strategy with diverse online and offline (know-how & show-how) marketing activities. With this bundle of activities, REPLACE will create the necessary momentum to bring joint implementation solutions to the local population and to enable stakeholders in other regions and countries to replicate similar approaches, making heating in Europe efficient and climate-friendly.
Demonstrator site description	N/A
How can cities use the technology?	Cities can implement the findings, methods and approaches regarding implementing a boiler/oven replacement campaign and dedicated supporting measures, when adopted to local framework conditions and needs. One project partner actually has its city as Replace pilot region, this is the local energy supplier, Grad Šabac in the City of Šabac. Several other of the ten pilot regions include cities and towns too.
Environmental impact	See above
Project coordinator’s contact details	Herbert Tretter Herbert.Tretter@energyagency.at

3.53 REPLICATE

3.53.1 Lighthouse City of San Sebastian

Project name	**REPLICATE (Lighthouse city of San Sebastian)**
Call identifier	H2020-SCC-2015
Type of action	Innovation Action (IA)
Project logo	
Project website	www.replicate-project.eu
Amount of EU funding (in EUR)	726,000
Other public or private project funding sources	3.379.525€: Own resources from the city council: 1,597,310€ Public funding from energy entity: 75,000€ Private funding from the operator: 1,045.000€
Replication/implementation potential	5*****
What is it?	The District Heating (DH) provides a system for distributing heat for Domestic Hot Water and heating generated in a centralized location through a system of insulated pipes for the new residential area Txomin Enea in Donostia - San Sebastian. The DH is promoted and coordinated by Fomento San Sebastian. The heat is obtained burning biomass from local forests and with the support of two gas boilers for peak needs. The district heating scheme has been sized to meet the needs of 1500 dwellings of a district including the connection of new and 156 retrofitted houses.
When can I use it?	The District Heating generation plant is currently in operation, the construction was finished in October 2018 and is currently giving service to approximately 770 new homes, 156 retrofitted houses and 7 commercial premises. The district heating scheme was sized to meet the needs of 1458 dwellings, including the connection of 156 retrofitted houses. 2018 Service to 182 dwellings 2019 Service to 611 dwellings 2020 Service to 773 dwellings Next delivery dates expected: In 2022: 262 dwellings more, total 1035 From 2024, next phase of urban development is planned and it will allow reaching 1458 homes in service Additional public buildings will also be connected to the system (sports center, etc.).
Where can I use it?	The intervention could be deployed in new urban developments in the cities, while replicating in existing districts seems more complicated due to the required civil

	works. In fact, the city is analysing the possible implementation of similar systems in other potential areas of the city.
Why should I use it?	Environmental benefits • The use of renewable energy (biomass). • Thanks to its superior performance, lower primary energy consumption • Reduction of CO_2 emissions Economic Benefits • Lower spending on preventive maintenance (carried out by specialist staff) • Lower spending on primary energy procurement (used to generate thermal energy) • Fewer incidents and therefore lower spending on corrective maintenance Advantages for Users • 15% savings on the price of the thermal energy consumed • Non-individual maintenance actions for each building • 365x24 availability and greater guarantee and quality of service Benefits for developers • Reduction of investment required in each building. • Removes the need for each home to have its own central heating system and gas mains connection • Avoids the need to invest in the building's gas network • Better use of floor space in each building
Project size	The District Heating project in San Sebastian encompasses the implementation of a district heating system for the area of "Txomin Enea" neighbourhood, 160,000m2, which is becoming a new residential area. The District Heating system is giving service to 770 new dwellings and the 156 retrofitted households, by the year 2024 it will give service to 1,500 households. It is the first urban District Heating of this size in the city and the region.
Summary	The DH distributes heat for Domestic Hot Water and heating generated in a centralized location through a system of insulated pipes. The District Heating project encompasses the implementation of a district heating system for the area of "Txomin Enea" , supplying mainly homes in this area and including other public services. The district heating scheme has been sized to meet the needs of 1458 dwellings, including the connection of 156 retrofitted houses. The framework for this project spans the development of the DH building, installation, setup, operation and maintenance. It will

	guarantee continuity and quality of the thermal energy supply to meet the heating and domestic hot water (DHW) demand of 1458 homes. For this purpose, the installations are composed of two biomass boilers (1400 kW) and two gas boilers (2300 kW). The infrastructure has been designed for its integration in urban area and river side. The building is integrated in the urban environment with vegetation -covered in curved form as continuity to the natural space, this reduces the visual impact and facilities are installed in a large semi-basement glazed building. The surface is of 923 m2.
Project details	The District Heating system is largely innovative because of the business model implemented. The Business Model developed for the District Heating is based on a public-private collaboration in which Fomento de San Sebastián (municipal company) is the owner and responsible of the service provided by the District Heating system, and the contracted company rents the installations from Fomento, and operates and maintains the service. The most important aspects of this collaborative model are that FSS, within the framework of public management, is responsible for setting the rates to be paid by users, and the contractor participates in the initial investment by making an advance payment for rent. After that, and later during its management that lasts for several years, the contractor will only charge for the heat actually produced. The hypotheses and calculations made on the proposed centralized system for Txomin neighborhood approximate that 97.2% of the energy demand for heating and domestic hot water (DHW) will be produced by biomass-based heating technology. In 2019, for an occupation of 611 homes, the demand was covered with 83% of biomass-energy production. The gas system mainly covers the demand peaks and heat generation during the maintenance of the biomass system. For decentralized boiler systems, efficiency is usually around 55%. The project will deliver better results in terms of performance, energy efficiency, and greenhouse gas emissions than a decentralized boiler system.
Demonstrator site description	The district Heating in San Sebastian has been deployed in the Txomin neighbourhodd, this neighbourhood was urbanized during the first half of the 20th century, with low energy efficiency buildings, whereby it had connection problems with the city centre and it was at risk of social exclusion. The Urumea River, that characterizes Txomin neighbourhood, crosses the district acting as the main axis of the district, which also represents a barrier, as well as being the cause of the area's flooding problems. To address this problem, San Sebastian City Council defined a special Urban Plan for the regeneration of the district in 2008, responding to the flooding problems, fostering the regeneration of the residential area, improving its connection with the city centre and fostering the transformation of the area's economic activity from the traditional industry to services-oriented activity. Almost 1.500 households are planned to be built in

	the neighbourhood (approximately 1.000 are already built), this makes Txomin a new neighbourhood in the city. On the other hand, the city of San Sebastian, through Fomento de San Sebastián, designed a Smart Plan for the city with an Action Plan for 2016-2020, establishing strategic line with shared objectives and some actions in this neighbourhood. Apart from the new houses that are being built, 156 households have been retrofitted under the Replicate project framework. The actions that were carried out within the framework of the Replicate project in the San Sebastian pilot for the development of the smart district are: energy efficiency, sustainable mobility and ICT-infrastructures actions. Furthermore, other specific projects have also been carried out in the district, pursuing the neighbourhood positioning strategy. These actions are enabling the district to position itself as a smart district with nearly zero emissions.
How can cities use the technology?	The intervention might be deployed in new urban developments in the city, while deploying in existing districts seems more complicated.
Environmental impact	The use of renewable energy contributes to guarantee sustainability Closer forest biomass is used Thanks to the high performance of the DH, lower primary energy consumption is needed Reduction of CO_2 emissions. The monitoring of 2019 and 2020 shows a reduction in primary fossil energy of more than 85%, and the same reduction in CO_2 emissions. Currently 53% of the homes are connected to the DH.
Project coordinator's contact details	Elisabeth_jorge@donostia.eus
Contact information for demo site or specific solutions	https://www.districtheatingtxomin.eus/eu/

3.53.2 Lighthouse City of Bristol

Project name	**REPLICATE (Lighthouse city of Bristol)**
Call identifier	H2020-SCC-2015
Type of action	Innovation Action (IA)
Project logo	
Project website	www.replicate-project.eu
Amount of EU funding (in EUR)	560,000
Other public or private project funding sources	Public Sector Capital Programme
Replication/implementation potential	3***
What is it?	The Bristol district heating intervention is to enable the linking of two Energy Centres to provide lower carbon heat to the businesses and residents of the Redliffe Area of Bristol.

	The eventual operation of the network will be able to balance improvement between local air quality, carbon emissions and cost of the heat production
When can I use it?	The heat network currently serves a large number of residents and businesses but in a limited geographical area, the work continues to expand the network in the Redliffe Area of Bristol currently and the plan is that the area around Redcliffe Quarter and Temple Back are to be ready and live by the end of 2021. Certain sections are live today.
Where can I use it?	Businesses and Residents via their building owners will be able to access the Heat Network in the Redcliffe Area of Bristol
Why should I use it?	The infrastructure is a key part of Brsitol's plan to be a carbon neutral city by 2030
Project size	Over 700 residential flats and an office for 1000 people connected
Summary	The Purpose of the Bristol Pilot District Heating Project is to provide a lower carbon and more efficient heat to the existing and new District heating systems by linking together the operational Heat Network connecting 13 social housing blocks with a new network that will be powered by a Combined Heat and Power Engine. Each system has peak and reserve back up gas boilers but by linking the two energy centres the whole system will better utilise the low carbon heat from the Biomass and the CHP providing more efficient and cheaper heat across the network. The project also includes upgrades to existing and the addition of new metering and control units on the existing network in order to ready the old equipment to be integrated into a smart network in the future.
Project details	Bristol City Council (BCC) installed a 150DN pipe with associated cabling and controls within the Broughton House energy centre at a cost of 1.4m euros that will allow the heat network to grow further to connect to other nearby buildings. The project will enable Bristol to develop the connections to the wider energy demand management work (the energy demand management system) in the district including where applicable ICT architecture designs and possible systems integrations. The initial connection supplying heat to 100 Temple Street will be 100% renewably fuelled from the existing 1MWth wood pellet boiler. As additional buildings are connected via additional pipe branches from the main REPLICATE-funded pipe (see map 2), they are likely to be heated by a gas CHP from a proposed installation in 100 Temple St. These additional pipe branches are facilitated by the REPLICATE connection to 100 Temple Street, but would be funded through a combination of heat sales and developer contributions. Where economically viable, the CHP fuel input will be biogas – regular reviews to ensure heat customers are not overcharged will be required for this.
Demonstrator site description	Provision of Data convertor/Provision of data streams/Set up Registers

	The development of an additional I/O controls schedule for all new or modified equipment and sensors (following the design changes outlined in Task 1) for the Trend control system upgrades. Review of the overall specification of all controls changes needed, including Functional Control Description for the Trend controls upgrade to provide additional capacity to allow Broughton House to be a producer and consumer of heat from the network, as well as facilitating data transfer from the Danfoss outstations (Yeamans, Proctor, Patterson, Spencer etc) Supply and install of data converters required to link the Broughton Trend BMS and any outstations to common protocol; this will convert data from Trend and Danfoss controllers to open source data that can be transferred to cloud data storage. This will include conversion of Broughton Modbus output to MQTT/API The specification of the database has been finalized to provide individual identifiers for all components. The structure has been created to be infinitely expandable without repetition. An identifier database has been subsequently been created for Broughton House and all associated substations. This has been created with planned expansion for 100 Temple Street as the initial connection and our future commercial connections. Data Collection at local level All devices at substation connected to the network have been configured or upgraded to collect level at a local level. Fibre Optic connections – resilience and forward planning A strategic decision was made to provide resilience on the data network for both the Heat Network controls and other uses. The decision was made with Bristol City Council to combine the data collection form the 13 social housing blocks with future plans to provide each flat with fibre optic Broadband connections. Therefore an investment was made in this infrastructure and the fibre has now been installed – the final connections are planned to be completed next month allowing all of the data to be combined and presented. Hosted Space on Cloud Data/ Server Interface for Data Reviewing and Access Graphical interfaces, representing both Broughton House Energy Centre and House substations, have been engineered and are hosted on the cloud server. The graphical interface structure is ready to be expanded to all associated substations, once the fibre connections between the associated buildings are finalized. Link to full replicate report - REPLICATE_D5.2_disrtict Heat_v9_30072019 https://replicate-project.eu/public-deliverables-download/

How can cities use the technology?	Cities that are looking to expand or join heat networks will value from the lessons learned and the technical experience of this installation. There has been a number of unexpected changes to renewable heat subsidies and housing policy which posed a number of challenges to overcome to ensure completion.
Environmental impact	The new scheme provides 17,235Mwh of energy across the scheme once all connections are complete. The amount of energy that is supplied to the connection that is certain to be delivered within the Replicate timescale is estimated at 14,611 MWh of energy supplied. Additionally there will be an additional 4332Mwh of energy supplied per year post Replicate. Scheme the estimation there will be 11,000 people benefiting from the building connections to the Heat Network within the replicate timescale and an additional 3500 benefiting post Replicate. The impact in terms of CO2 for the original DH proposal with the biomass boiler and the new solution proposed are the following:52239 tons / year.
Project coordinator's contact details	Replicate project : Elisabeth_jorge@donostia.eus heatnetwork@bristol.gov.uk
Contact information for demo site or specific solutions	city.innovation@bristol.gov.uk

3.53.3 Lighthouse City of Florence

Project name	**Replicate (Lighthouse city of Florence)**
Call identifier	H2020-SCC-2015
Type of action	Innovation Action (IA)
Project logo	
Project website	www.replicate-project.eu
Amount of EU funding (in EUR)	2,000,000
Other public or private project funding sources	4,000,000 EUR
Replication/implementation potential	3***
What is it?	Micro district heating network equipped with a seasonal thermal storage connected to a solar thermal plant
When can I use it?	Solar energy is certainly the most available and distributed renewable source in the context of urban areas but while photovoltaic technology is now sufficiently mature and already sufficiently applied widely, solar thermal technologies could be more and more exploited thanks to new panels developments but also to new configurations and solutions foreseeing the integration with storage systems. A significant facilitation could be the possibility of building the storage on the ground and not under.

	Thermal energy storage (TES) is a technology that stocks thermal energy by heating (or cooling) a storage medium so that the stored energy can be used at a later time for heating applications and power generation. TES systems are used particularly in buildings and industrial processes. In these applications, approximately half of the energy consumed is in the form of thermal energy, the demand for which may vary during any given day and from one day to next. Therefore, TES systems can help balance energy demand and supply on a daily, weekly and even seasonal basis. They can also reduce peak demand, energy consumption, CO2 emissions and costs, while increasing overall efficiency of energy systems. Furthermore, the conversion and storage of variable renewable energy in the form of thermal energy can also help increase the share of renewables in the energy mix. The ranking list of European solar heating plants developed by IEE SDH project (http://solar-district-heating.eu) reports only 14 similar plants for technology and size, located in the northern part of EU (Denmark and Sweden mainly, some examples in Germany and Switzerland). No examples in Italy (only feasibility studies or solar plants directly connected to DH without any storage).
Where can I use it?	The challenge consisted in increasing the efficiency of residential buildings realizing such an innovative plant in a difficult urban environment (regulatory constrictions in such an urban area as Florence, low income users, single boilers replacement,…) to demonstrate its replicability in more favourable boundary conditions. The optimal conditions for a solar thermal storage implementation are • new buildings/districts • old buildings with centralised heating plants • existing district heating In any case there should be room (preferably above ground) to host the storage volumes.
Why should I use it?	After retrofitting, it is expected to achieve a reduction of the thermal demand of the buildings by a 35% through the improvement in the thermal properties of the envelope (insulation, elimination of thermal bridges, windows) and with optimized control strategies that will be implemented along with the renovated heating distribution system. Thanks to the solar production, the primary energy demand from fossil fuels will decrease of (by) the 50%. Tenants will save about 5-10% of their actual bills (considering consumption and private boilers maintenance costs)
Project size	The intervention consists in the retrofitting of two residential social housing buildings in Florence and the creation of a dedicated District Heating network exploiting solar heating through a seasonal thermal storage. The total surface selected is about 20.000 m2 with an actual consumption of about 3 GWht and 500 MWhe. The building blocks structure is made of reinforced concrete and bricks and the flats to be connected are 300 with 700 people. The solar plant covers about 1.000 m2 while the energy storage is 4.000m3.

Summary	The pilot action main purpose is to put in practice in a district the policies adopted within the Florence Smart City Plan, testing the integration among different smart measures and analysisng the replicability potential. The main objetive is to demonstrate the city of tomorrow: “zero” volume, green, sustainable, inclusive, active, resilient - in a word “smart”. Florence City has chosen Novoli district in the north-west of Florence, where a major expansion as a result of the construction boom of the fifties and sixties of the twentieth century took place. The residential sector in Novoli district needs a substantial energy refurbishment in line with the requirements of the “Zero Volumes” structural plan and the provisions of the urban planning rules. The buildings selected are social houses with high consumption and single boilers set in the Piagge area: the total surface involved (from a total social housing volume of about 184.000 m3 in the district which could be useful also for the replication plan) is about 20.000m2 The main objective of the intervention is the refurbishment of the two buildings (external insulation) and the disposal of old existing individual heating systems, with a high performance micro DHS producing energy with high efficiency and RES exploitation through an innovative solar thermal seasonal storage. The network reaches the flats where the single boilers have been replaced with small heat exchangers without disruption for the tenants who will benefit from the change in terms of maintenance and energy costs. The project foresaw also the installation of customer interfaces “Smart Info” in 600 residential flats (the 300 mentioned above, plus another 300 in the district to be selected), linked with the electric Smart Meter and able to provide clear information about energy consumptions to tenants, will allow the testing of energy efficiency measures in buildings and enable Active Demand services. An app for raising awareness about energy saving through smart gaming has been provided to district citizens.
Project details	Technical description available in D7.3 (see link reported in the next section) Lessons learnt: Regarding the storage, a sensible cost reduction could be obtained by using prefabricated elements, but being its calculation strictly bounded to the producer, in order to launching a public tender this solution is not available in this phase. In order to reduce as much as possible, the volume of new technical rooms, part of plants and equipment has to be placed in the basement of existing buildings, increasing development costs. A site with less boundaries could result cheaper allowing the construction of new volumes (not underground) both for the storage and the technical rooms. A dynamic simulation could be a very useful support to the design phase in order to select the proper size of the storage, optimizing RES coverage and costs.

	Capacity building is needed for designers and plant managers as far as there are no national examples already in place. In advanced economies, a limit to the TES development is represented by the low rate of construction of new buildings, while in emerging countries the TES have a wider dissemination potential. For this purpose, it is very important to try to develop, test and optimize economically sustainable TES while retrofitting existing complexes. A key role is played by supporting research and development (R & D) of new materials, as well as policy measures and incentives.
Demonstrator site description	The project has been analysed form the technical and management model point of view in two public deliverables available on Cordis: D7.3 Analysis of technical solutions v2 https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5c34765b0&appId=PPGMS And D7.5 Report on management models v2 https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5c3aa5a26&appId=PPGMS The roll out plan with the analysis of possible replications in other contexts has been included in D7.6 Lightgouse cities' replication plans, soon available at https://cordis.europa.eu/project/id/691735/results/it
How can cities use the technology?	Small distributed generation plants are suitable for cities that are starting from the scratch and have different boundary conditions in districts. Possible extension of the network and interconnections could be planned as second step. Supporting policy framework (regional, national or even local level) for DH and/or RES is the best promotion for these implementations
Environmental impact	The RES energy production is 750.000 MWh/y, the total CO2 savings 450 t/y
Project coordinator's contact details	Replicate project : Elisabeth_jorge@donostia.eus Pilot contact : alessandra.barbieri@comune.fi.it

3.54 RESTORE

Project name	**RESTORE**
Call identifier	H2020-LC-GD-2020-1
Type of action	Research and Innovation Action (RIA)
Project logo	RESTORE Renewable Energy based seasonal Storage Technology in Order to Raise Economic and environmental sustainability of DHC
Project website	https://www.restore-dhc.eu/
Amount of funding from EU	5.667.736 €
Other public or private project funding sources	Not applicable
Replication/implementation potential	2**
What is it?	Renewable Energy based seasonal storage technology in order to raise economic and environmental sustainability of DHC
When can I use it?	At the end of the project the technologies will be validated in laboratory (TRL 4). After the project, the technology must be demonstrated at higher TRL, in a real DHC network, probably those considered for simulation analysis within RESTORE project (may be carried out the next two years after project). After two year of additional tests and improvements, as rough estimation, the technology may be ready for deployment, 4 years after the project finalization (2029-2030).
Where can I use it?	RESTORE presents a flexible solution that can be adapted to the different DHC networks conditions and using different renewable energy and waste heat sources. Thanks to the use of heat pumps and ORC cycles that could be used to adapt the temperature levels following the different facilities requirements.
Why should I use it?	High energy density storage, competitive costs, huge recyclability potential, high annual efficiency of seasonal energy storage, ease higher integration of renewable sources and waste heat., affordable (based on abundant materials).
Project size	Project developments will be validated at laboratory scale (TRL4). Although the impact of the RESTORE solution will be quantified in 6 different use-cases (real DHC networks) via modelling and simulation (described in demonstrator site section).
Summary	RESTORE proposes a radically innovative solution for DHC, based on the combination of two key innovative technologies (TCES+ORC), that allows integrating a wide variety of renewable technologies combined with competitive seasonal storage in DHC networks, allowing them to be 100% renewable to radically improve their economic and environmental sustainability. The first technology the project aims to develop is an innovative Thermo-Chemical Energy Storage (TCES), that provides daily and seasonal competitive energy storage due to its high energy density, very low energy losses and its low-

	cost. It allows harnessing the enormous amount of energy that is normally wasted due to the mismatch between energy demand (loads) and energy generation (renewable resource and/or waste heat). The second technology considered is based on Heat Pump and ORC, it adapts the energy generation to feed the storage system, thus a wide variety of renewable technologies as well as waste heat can be integrated into the whole system to finally supply the energy demand under the specific conditions laid down by each DHC. This innovative solution would tackle the main barriers for a wide deployment of renewable energy technologies and waste heat in the existing and future DHC networks. The projects consider the experimental validation of the RESTORE concept and also the demonstration of the concept replicability potential, modelling and optimizing the proposed solution to different real sites (different network conditions and local particularities as the available renewable technologies/waste heat) spread over the EU, and quantifying its potential benefits via virtual use- cases.
Project details	RESTORE aims to provide a novel solution based on the combination of two innovative technologies. Some of the advantages of the RESTORE concept are stated below: Local RES and waste heat integration: RESTORE exploits low and high-grade heat and electricity from any kind of RES and waste heat from industries, limiting waste of energy. COST-EFFECTIVE & RELIABLE: RESTORE maximizes plant utilization and enables a consistent reduction of the payback period of investment costs by the use of cost-effective and durable components. HIGH PERFORMANCE: RESTORE ensures high energy density and low heat losses thermal storage unlocking the possibility of short-term and seasonal storage of both heat and electricity. ZERO EMISSION: RESTORE provides electricity, heating and cooling to communities, reducing fuel consumption and greenhouse gas emissions from the DHC sector Regarding the technologies to be developed within the project: On the one hand, the thermo-chemical energy storage (TCES) is able to store the summer surplus heat until winter when energy demand is higher. During the charging of TCES, heat is added to an endothermic chemical reaction, which results in products that can be stored separately without energy losses for any period of time. For discharging, the products are combined again in order to release the reaction enthalpy. Different candidates for the reactions are under study, all of them with promising results, such as low cost and high energy densities. On the other hand, the RESTORE reversible HP and ORC technology gives the unique possibility to unlock the integration of any kind of renewable energy sources and waste heat, adapting also the temperatures to those required by the TCES and the DHC networks and ensuring their exploitation all year long with positive effects on

	environmental and economic aspects. This power system is based on a thermodynamic cycle that can operate as both HP during charging mode and as a direct power cycle in discharging mode. Different configurations are under study depending on the specific requirements of each site (DHC and energy sources available). In addition, Six Virtual Use-Cases will analyze potential configurations of the RESTORE technology for integrating RES and waste heat recovery into different plants connected to DHC networks, spread over different locations in Europe. The impact of the RESTORE solution (economic, environmental and social) will be quantified in each of these cases. i) Residential and industrial DH with biomass and solar collectors in Denmark; ii) Integration of different heat sources in district heating (DH) of a cement factory in Austria; iii) Integration of different heat sources in DH of a paper mill in Slovakia; iv) Integration of different heat sources in DH of a steel industry in Italy; v) district heating with geothermal technology in a plant in Germany; vi) small-scale DHC network of the Politecnico di Milano university campus in Italy. Also, the project will develop a web platform where additional cases can be simulated and analyzed. Finally, the project also considers specific activities related to business model development, stakeholders engagement and general dissemination and communication.
Demonstrator site description	The RESTORE project will validate the technology at laboratory scale (TRL4). The Thermo-chemical energy storage will be implemented, tested and validated in the TU Wien laboratories. In addition, a reversible Organic Rankine Cycle will be tested in the University of Milan and then transported to TU Wien in order to be coupled to the TCES, thus the full prototype (TCES+rORC), will be validated and tested. In addition, the RESTORE solution will be modelled and optimized for real sites (DHC networks) spread over Europe in order to quantify the impact of the RESTORE concept in different sites. This “virtual use-cases” are: Virtual use-case I: Bronderslev. A district heating network which involves: renewable sources (biomass and parabolic trough collectors), pressurized water thermal energy storage and ORC. Virtual use-case II: Gmunden. A district heating network coupled to a cement factory (Rorhdorf) with a connection capacity of 8 MW. Virtual use-case III: Ružomberok. A district heating network coupled to a paper mill industry (Mondi SCP plant), the factory energy generation has a high biomass contribution. Virtual use-case IV: Brescia. A district heating network coupled to a steel working industry in Italy, based on the use of electric arc furnaces. Virtual use-case V: Holzkirchen. A district heating network in Germany with renewable energy generation based on geothermal energy and including electricity production via ORC.

	Virtual use case VI: Milan. A small district heating and cooling network of the university campus of Politecnico de Milan.
How can cities use the technology?	The RESTORE solution can be adapted to the different district heating and cooling networks of the cities. It will allow integrate additional energy sources (renewable energy and waste heat of close industry) as well as store the in order to increase the economic and environmental sustainability.
Environmental impact	Highly depends on the final application, RESTORE has the potential of reach 100% renewable DHC. The quantification of those and additional indicators in each of the "virtual demonstrators" will be carried out during the project and will be public.
Project coordinator's contact details	fcabello@cener.com

3.55 RES-DHC

Project name	**RES-DHC "Transformation of existing district heating and cooling systems from fossil to renewable energy sources"**
Call identifier	H2020-LC-SC3-2018-2019-2020
Type of action	Cooperation and Support Action (CSA)
Project logo	RES DHC
Project website	https://www.res-dhc.com/en/
Amount of funding from EU	EUR 2,582,946.25
Other public or private project funding sources	Click or tap here to enter text.
Replication/implementation potential	2**
What is it?	RES-DHC stands for a wider introduction of Renewable Energy Sources (RES) in the District Heating and Cooling (DHC) sector. The aim is to transform existing DHC systems into a high share of RES-DHC technologies.
When can I use it?	The project will run until August 2023, and in the meantime the findings and results will be published on the project website.
Where can I use it?	In existing district heating and cooling systems
Why should I use it?	To speed the energy transition up by increasing the share or renewable energy sources in heating and cooling.
Project size	Six regions (in DE, AT, IT, PL, FR and CH) are the target regions and are covered by the project.
Summary	The RES-DHC project addresses the manifold market uptake challenges related to the transformation of DHC systems to higher shares of RES. In particular, it aims at the development of solutions and instruments which support policy and sector stakeholders in (over-)fulfilling Art. 24 of the Renewable Energy Directive II (directive 2018/2001), requiring a yearly increase of RES in DHC by 1%. The main objective of the RES-DHC project is to support the transformation of existing urban DHC systems to RES in six participating regions and thereby to derive - from these practical cases - technical and organizational solutions for such transformation processes. This is reached with two key approaches: A vertical pillar of the project is a close-to-market implementation process of concrete actions and measures by regional stakeholder consortia in the six regions (in DE, AT, IT, PL, FR and CH). The phases of this implementation process are 1) strategy and action planning based on local stakeholder consultation 2) an implementation phase starting already at an early stage of the project including capacity building, legal framework improvements, market support, and triggering investments in RES DHC. Technical enablers are, beside RES, also sector coupling and the use of low grade heat sources. A key horizontal beam of the project is to organize and give transnational support to the regional stakeholder consortia.

	This support is provided by an international team of expert partners with specific and complementary competences and coordinated by Danish experts.
Project details	The market uptake challenges for RES DHC are manifold and addressed in their full width in this project. Key topics to be mentioned are improvements of the policy and regulatory framework, introduction of planning and assessment processes, holistic transformation strategies, public acceptance and participation, technological solutions and financing, enabling marketing of green heat, etc. The concrete and individual actions planned for the regional implementation cases are presented in more detail in the concept and the work plan of the project. Examples are the elaboration of concrete case studies and transformation strategies in all regions, the introduction of improved heat planning tools and procedures as well as training activities for stakeholders concerned. The specific actions meet the market uptake challenges of this call to a great extent, e.g.: − Introduction of RES at a large scale − Engagement of relevant stakeholders − Assessment of legal, institutional and political frameworks as barriers or enabler − Assessment or environmental, economic and social impact of solutions − Use of successful approaches
Demonstrator site description	1. Baden-Württemberg (DE) 3 case studies for demonstration and elaboration of technical solutions and strategies based on concrete cases in cooperation with suppliers, consideration of the whole value chain 2. Styria – Graz (AT) 1) Potential and design studies for the integration of large heat storages for grid flexibility in Graz; 2) Analyses for further expansion of other RES; 3) Detailed studies on the expansion of heat pumps in connection with efficient low-temperature sources; 4) Potential studies for the direct integration of industrial waste heat; 5) Use of intelligent data technologies to develop forecasts for district heating demand (e.g. intelligent forecasting tool); 6) Review of the potentials for a DH supply from the return flow to reduce the network return flow temperatures 3. Auvergne-Rhône-Alpes (FR) 1) Support implementation of DH network mapping within the regional energy planning tool (Terristory ©). 2) Develop a simulation tool for DH network design regional energy planning tool (Terristory ©) (low temperature DH and RES integration) 4. Parma and Aosta (IT) 1) Study of the renewable heat options and of their economic sustainability in the existing DH networks. 2) Evaluation of the

	possible temperature reduction in the distribution line in the DH networks specified above. 5. Szczecin and West Pomerania (PL) 1) Conducting feasibility study for including RES in DH grid in Szczecin/Regional DH networks; 2) Detailed study on implementing a large scale solar thermal system in Dabska, including a storage, which could also be used for the new CHP plant 3) Potential studies low temperature heating and cooling network using wasted heat from the industrial production processes in Szczecin; 4) Investigating whether forecast application in connection to building management systems in buildings to reduce and manage energy demand in DH network 6. Swiss Cantons (CH) 1) Development of guidelines with a decision-making tree for stakeholders on which renewable energies are more suitable for their boundary conditions and what are the advantages and inconveniences, to support them in the development of a strategy to reach a 100% renewable mix 2) Seek cooperation with the programme "heat networks" from Lucerne University 3) Demonstration and elaboration of technical solutions and strategies based on concrete cases in cooperation with heat suppliers in 2 case studies
How can cities use the technology?	Within the project, surveys at regional and EU level will be performed and could be used as support tool for replication initiatives beyond the project consortium. The EU level survey will have a particular focus on cities as a key element for an increase share of RES in DHC and potential multipliers for clean DHC. Secific recommendations on how to transform DHC systems from fossil to renewable energy sources will also be elaborated for cities.
Environmental impact	Contribution to installed or planned new RES DHC capacity triggered EU wide by the project during its project lifetime due to its effect on reached market stakeholders: a new RES capacity for 650 GWh/a installed, and a cumulative GHG reduction of 0.14 Mio.t CO2 equiv.
Project coordinator’s contact details	STEINBEIS INNOVATION GGMBH (SIG Solites), Patrick Geiger, Geiger@solites.de

3.56 ReUseHeat

Project name	**ReUseHeat**
Call identifier	H2020-EE-2017-RIA-IA
Type of action	Innovation Action (IA)
Project logo	
Project website	www.reuseheat.eu
Amount of EU funding (in EUR)	3,998,061.38
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	ReUseHeat intends to overcome both technical and non technical barriers towards the unlocking of urban waste heat recovery investments across Europe.
When can I use it?	As per M60 (September 2022) TRL 8
Where can I use it?	Urban waste heat recovery (hospital, sewage, datacenters and metro)
Why should I use it?	To speed the energy transition up and make use of a resource that is otherwise lost.
Project size	4 demo sites: 2 in Germany, 1 in France and 1 in Spain
Summary	The project aims to reduce the need for primary energy and reduce emissions of greenhouse gases. Attention is also given to urban waste heat potential (mapping the low temperature heat sources in EU28 and assessing the implications in the energy systems from using them at national and city level) and to the business models linked to the solutions. Risks, contracts, business models and stakeholder perceptions are captured within the project's scope. The experience from running the demonstrators and from other examples across the EU will be consolidated into a handbook that will provide guidance for investors and project developers and support future uptake of using urban excess heat. It will include innovative and efficient technologies and solutions, suitable business models and contractual arrangements, estimation of investment risk, bankability and impact of urban excess heat recovery investments and authorisation procedures.
Project details	The H2020 Innovation Action, ReUseHeat demonstrates three system innovations for recovering low temperature waste heat (urban waste heat) in existing district heating systems, by means of a heat pump.
Demonstrator site description	Heat is recovered from a metro system, from a data centre and from the cooling process of a hospital (representing a service sector building). The fourth demonstrator addresses awareness-building amongst end users, by developing and demonstrating a dashboard showing the use of low

	temperature heat sources (sewage water in this case) locally, in a district. Further details can be found here: https://www.reuseheat.eu/category/demo-sites/
How can cities use the technology?	ReUseHeat solutions can be replicated by any city with available urban waste heat sources. The implementation can be facilitated through the handbook that will also outline business models, contractual and legal arrangements, financing and technology solutions.
Environmental impact	135 ktons-CO2/yr of GHG emissions saved through the implementation of ReUseHeat investment plan
Project coordinator's contact details	IVL (SE), Kristina Lygnerud, kristina.lygnerud@ivl.se
Contact information for demo site or specific solutions	Metro – Karl Ochsner, Ochsner Process Energy Systems, karl@ochsner.at Data centre – Oliver Rosebrock, Veolia, oliver.rosebrock@veolia.com Hospital – Pablo Perez Granados, ASIME SA, pperez@asimesa.com Dashboard – Christian Keim, EDF, christian.keim@edf.fr

3.57 REWARDHeat

Project name	**REWARDHeat**
Call identifier	H2020-LC-SC3-2019-RES-IA-CSA
Type of action	Research and Innovation Action (RIA)
Project logo	REWARDHeat
Project website	https://www.rewardheat.eu/
Amount of EU funding (in EUR)	14,999,481.63
Other public or private project funding sources	4,023,817.12 EUR
Replication/implementation potential	4****
What is it?	REWARDHeat will 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.
When can I use it?	REWARDHeat will demonstrate a new generation of highly efficient district heating and cooling (DHC) networks at TRL 6, which will be able to increase production and distribution efficiency by recovering, renewable and waste heat available at low temperature, i.e. lower than 40°C. REWARDHeat technological results all aim to reach TRL 6 at the end of the project, in order to be available on the market after a short industrialization phase.
Where can I use it?	The project focus is on the exploitation of the energy sources available within the urban context, allowing to maximize the replicability and upscale potential of the decentralized solutions developed in the project. The REWARDHeat solutions can be implemented in cities across Europe.
Why should I use it?	The REWARDHeat solutions promote a cost efficient and technically viable decarbonization of the DHC sector. This new generation of DHC networks can satisfy at least 80% of the energy demand of the system with locally-available renewable energy and waste heat sources. The project will integrate the EU top-down energy and climate policy mechanisms with a bottom-up approach to promote the decarbonisation of the local DHC systems
Project size	There are 7 demonstrator networks located in 7 different countries.
Summary	The overall objective of REWARDHeat 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. These networks will be able to increase production and distribution efficiency by recovering, renewable and waste heat available at low temperature. REWARDHeat will promote punctual metering, thermal storage management, network smart control as means to enable and optimise the exploitation of renewable and waste heat in DHC networks. At the same time, this approach permits a change of paradigm with respect to the business models devised: thermal energy will

	not be seen as a commodity anymore, rather it will be sold as a service to the customers.
Project details	REWARDHeat networks will integrate effectively multiple low-grade urban energy sources where they are available along the network. DHC networks operated at low temperature can provide contemporarily heating and cooling from the same pipelines, by means of reversible heat pumps located at customer's buildings. Innovative technologies for flexible use of heat in DHC networks will be developed. Prefabrication, standardisation and modularity will be distinctive for the solutions of REWARDHeat. This is to remove design errors and reduce installation time. The project aims to demonstrate innovative pipeline solutions that will allow for reduced installation time and optimal operation. The project will demonstrate digitalisation, allowing to optimise the management of the DHC network. Control strategies and fault detection solutions will be assessed that assure a thermal balance of diffused heat generation, storage and utilization. Interaction between thermal and electric systems will be addressed both on the supply and demand side. Moreover, approaches will be elaborated allowing to manage thermal and electric energy purchase from different sources. Business models will be developed and financial schemes to enable large public and private investments will be mobilised by focusing on the green dimension of investments and developing appropriate business models . REWARDHeat will encourage a paradigm shift from heat being viewed as a commodity, to being sold as a service.
Demonstrator site description	There are 7 demonstrators located in 7 European countries, deploying the following technologies: low temperature networks, neutral temperature network, waste heat exploitation, heat pumps, renewables integration and thermal energy storage. More information on the demonstrators is available at https://www.rewardheat.eu/en/Demonstration-Networks
How can cities use the technology?	With the global trend to urbanization, an urban approach to supply heating and cooling is increasingly relevant. It is in urban areas that the demand for heating and cooling demand assumes highest density. At the same time a huge amount of low-grade waste heat is diffused within the urban texture, the largest amount being rejected by air conditioners, cooling systems in industrial processes and tertiary buildings (i.e. dry coolers and wet cooling towers), chillers of refrigeration systems and service facilities. Cities can use the solutions developed by the project to capture this locally available energy. Successful results will be transferred to city stakeholders in order trigger additional investment in the medium-term

	period. Additionally, 2 policy workshops targeting city stakeholders and focusing on RES integration will be organized. The demonstration actions in REWARDHeat will serve as an example for public and private institutions and early adopters will lay the foundations for the following successful implementations of the demonstrated concepts after the project timeframe.
Environmental impact	Milan: Gadio - Exploitation of 0.4 MW of waste heat will displace the consumption of natural gas Balilla Street: 1,500 MWh/year of thermal energy derived from a heat pump Hamburg: Yearly heat production of 9450MWh and yearly cold production of 1000MWh Toulon: 6.5 GWh/year of thermal energy from the source with a thermal capacity of 6.9 MW Albertslund: 220,000 MWh of thermal energy supplied in one year of operation to the end users Topusko: 35,7 TWh could potentially be exploited from the geothermal well in a year Helsingborg: the Öresundskraft DH network will supply 300 MWh industrial surplus heat and approximately 3 GWh to the new built area. 200 MWh micro grid cooling will also be supplied.
Project coordinator’s contact details	EURAC Research, Roberto Fedrizzi, roberto.fedrizzi@eurac.edu
Contact information for demo site or specific solutions	EURAC Research, Sara Giona, Sara.Giona@eurac.edu

3.58 RUGGEDISED

Project name	**RUGGEDISED**
Call identifier	H2020-SCC-2016
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	www.ruggedised.eu
Amount of EU funding (in EUR)	17,692,858.41
Other public or private project funding sources	1,800,000 EUR
Replication/implementation potential	4****
What is it?	In various ways, the RUGGEDISED project is working to implement Smart Thermal Grids in Umeå (SE), Glasgow (UK) and Rotterdam (NL). The work covers everything from aquifer well deep underground to contractual models for others to exploit.
When can I use it?	The solutions are being (and have been) actively deployed in the three Lighthouse Cities and some are ready for immediate upscaling while others are still undergoing final testing to assess how the solutions complement each other. The TRL level for the solutions in the project range from 7 to 9.
Where can I use it?	The solutions in the RUGGEDISED project are designed for urban areas, but the actual deployment range from large a large venue (in Rotterdam) to parts of a vast university campus (Umeå) or a local housing association (Glasgow). As such, there are few limitations, though it's important to emphasize the local aspect of all the solutions. An essential part of the smartness is the use of locally produced heat and/or cold.
Why should I use it?	Smart Thermal Grids carry the promise of using the energy produced in a much better way (peak load management etc.) and therefore allow cities and communities to lower their overall energy usage while raising the quality of life for the inhabitants in the smart city.
Project size	The size of the project is vast and covers three areas in its three Lighthouse Cities plus several buildings the Fellow Cities of Parma (IT), Brno(CZ) and Gdansk(PL).
Summary	RUGGEDISED is a smart city project funded under the European Union's Horizon 2020 research and innovation programme. It brings together three lighthouse cities: Rotterdam, Glasgow and Umeå and three fellow cities: Brno, Gdansk and Parma to test, implement and accelerate the smart city model across Europe. Working in partnership with businesses and research centres these six cities demonstrate how to combine ICT, e-mobility and energy solutions to design smart, resilient cities for all. This means improving the quality of life of citizens, reducing the environmental impact of activities and creating a

	stimulating environment for sustainable economic development. These goals are being achieved through the deployment of solutions in the fields of Smart Energy Management/ICT, Smart Thermal Grids and Smart Electricity Grids & e-Mobility.
Project details	The RUGGEDISED project has deployed a number of solutions related specifically to its work with Smart Thermal Grid. In Glasgow, the City has developed a business model that enables enable public sector buildings in Glasgow to sell excess-heat from/to one another and for private industry to sell heat to local customers, which in this case includes local housing, either directly or via an intermediary. The business model has resolved in a full contractual agreement template for such agreements. In Rotterdam, focussing on a Smart Thermal Grid connected to aquifers deep underground, the city has worked to connect various state-of-the-art heat pumps installed at large facilities – such as the venue Rotterdam Ahoy – to support the district Hart van Zuid in becoming more sustainable. The heat sources RUGGEDISED has gained experience with using in Rotterdam includes surface water (ponds etc.), asphalt, waste water from the large facilities as well as the energy already stored in the ground. Through the use of these highly advanced heat pumps, it's possible In Umea work has especially centred on a further development of its already advanced District Heating through the development of a full-circle business plan between the local energy company, university, jospital and businesses, supporting Umea in meeting its target of becoming CO2 Neutral. The work support the city in optimising its use of their geothermal facility which delivers 7GwH of heating energy yearly and 5GwH of cooling energy and is one of the 30 biggest in the world. The plan shows how different entities can connect – and share energy – with each other while all benefitting and saving energy. The partners in the RUGGEDISED project have also used buildings as heating storage to manage peak loads.
Demonstrator site description	Find the implementation report for Rotterdam's work here: https://ruggedised.eu/fileadmin/repository/Publications/Ruggedised-Implementation-Report-Rotterdam-final-www.pdf Find the factsheets on the individual solutions in Rotterdam's Hart van Zuid here: Geothermal heat-cold storage and heat pumps: https://ruggedised.eu/fileadmin/repository/Factsheets/Ruggedised-factsheet-R1-Rotterdam.pdf Thermal energy from waste and surface water: https://ruggedised.eu/fileadmin/repository/Factsheets/Ruggedised-factsheet-R2-R3-Rotterdam.pdf

	Thermal energy from pavements: https://ruggedised.eu/fileadmin/repository/Factsheets/Ruggedised-factsheet-R4-Rotterdam.pdf Find the implementation report from Umeå's Universtiy District here: https://ruggedised.eu/fileadmin/repository/Publications/Implementation_Report_Umea_in_RUGGEDISED.pdf Find the factsheets on the individual solutions here: Smart connection to renewable geothermal storage + exchange: https://ruggedised.eu/fileadmin/repository/Factsheets/Ruggedised-factsheet-U1-U3-Ume%C3%A5.pdf Peak load management with buildings: https://ruggedised.eu/fileadmin/repository/Factsheets/Ruggedised-factsheet-U2-Ume%C3%A5.pdf Glasgow implementation report: https://ruggedised.eu/fileadmin/repository/Publications/Implementation_Report_Glasgow_in_RUGGEDISED.pdf Find the Factsheet for Glasgow's innovative contractual agreements here: https://ruggedised.eu/fileadmin/repository/Factsheets/Ruggedised-factsheet-G1-Glasgow.pdf
How can cities use the technology?	The RUGGEDISED Project is sharing the key lessons learnt from the project through Implementation reports and unique reports on various topics, such as Innovation platforms, Urban Data Platforms and more. All are available on the project's website (https://ruggedised.eu/project/publications/) As the project matures, specific replication guides will also be made available through the website.
Environmental impact	The project's solutions are currently in the monitoring period, but by the beginning of the project the expectation was to support 182,000 m² of more energy efficient buildings providing a reduction in CO2 of 3,700 ton while the instalment of 4,700 new renewable capacity will provide 3a reductions of 3,800 tons of CO2 per year.
Project coordinator's contact details	Albert Engels, the City of Rotterdam please write to info@RUGGEDISED.eu

3.59 SDHp2m

Project name	**SDHp2m**
Call identifier	H2020-LCE-2015-3
Type of action	Cooperation and Support Action (CSA)
Project logo	SDH solar district heating
Project website	http://solar-district-heating.eu/
Amount of EU funding (in EUR)	1,919,297.75
Other public or private project funding sources	N/A
Replication/implementation potential	N/A
Summary	The project aims at developing and implementing advanced policies and support measures for the use of large-scale solar thermal plants combined with other RES in district heating and cooling systems. By involving 9 EU regions, the project aims at a direct mobilization of investments in Solar District Heating and a significant market rollout due to an improved policy, regulation and financing framework backed with embedded efficient market support and capacity building measures. The activities in the participating regions follow a process including: 1. Strategy and action planning based on a survey, best practices and stakeholder consultation 2. Implementation phase starting at an early project stage, and 3. Efficient dissemination of the project results at national and international level.
Project details	The direct expected outcome of SDHp2m is estimated to an installed or planned new RES DHC capacity and new SDH capacity directly triggered by the end of the project corresponding to a total investment of 350 Mio. € and leading to 1 420 GWh RES heat and cold production per year.
Project coordinator's contact details	Thomas PAUSCHINGER, pauschinger@solites.de

3.60 SecRHC-ETIP

Project name	**SecRHC ETIP**
Call identifier	H2020-LC-SC3-2018-Joint-Actions-3
Type of action	Cooperation and Support Action (CSA)
Project logo	
Project website	www.rhc-platform.org
Amount of EU funding (in EUR)	984,200.00
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	The European Technology and Innovation Platform on Renewable Heating & Cooling (RHC-ETIP) brings together 1000+ stakeholders from the biomass, geothermal, solar thermal, heat pump and district heating and cooling sectors to define a common strategy for increasing the use of renewable energy technologies for heating and cooling. The Platform includes a Technology Panel focusing on District Heating & Cooling and Thermal Energy Storage, as well as horizontal working groups dealing with horizontal topics such as districts and cities.
When can I use it?	The RHC-ETIP is operating continuously and works with its members leading the process towards the definition of a joint Vision and Strategic Research Agenda for the renewable heating and cooling sector.
Where can I use it?	The RHC-ETIP is open to join for members and stakeholders. More information: https://www.rhc-platform.org/member/register https://www.rhc-platform.org/about-us/structure/stakeholders/
Why should I use it?	Every year, almost 50% of the total energy consumed in Europe is used for the generation of heat for either domestic or industrial purposes. The vast majority of this energy is produced through the combustion of fossil fuels such as oil, gas and coal – with an impressive environmental impact in terms of greenhouse gas emissions. Today the social, natural and economic costs of climate change highlight the urgency of moving towards a new and more sustainable energy system. For all these reasons policy makers, investors and citizens are realising that the time for heating and cooling from renewable energy sources has come. The European Strategic Energy Technology (SET) Plan – proposed by the European Commission in order to accelerate the deployment of low-carbon energy technologies – recognises the essential role of renewable energy sources for heating and cooling as a part of the EU's strategy to improve

	the security of the energy supplies and to foster a competitive edge in the related highly innovative industries.
Project size	N/A
Summary	The RHC-Platform is recognized by the European Commission as one of the European Technology Platforms (ETP) and, since beginning 2016, has officially become a European Technology and Innovation Platform (ETIP). The RHC-ETIP's working groups address challenges facing the RHC sector: • Vision and research and innovation priorities for the heating and cooling sector • Enlargement of the RHC-ETIP and discussion with complementary sectors, and experts • Involvement of experts from several disciplines and sectors, complementary to the renewable heating and cooling sector, in order to ensure a multidisciplinary approach to the current and future challenges related to the energy sector, with a focus on renewable heating and cooling • Active participation to the definition of a stable and favourable research policy framework for the development of renewable heating and cooling technologies at EU level • Development of a financing strategy for the RHC-sector • Online database on projects' results for the RHC-sector
Project details	The RHC-ETIP operates via Technology Panels and Horizontal Working Groups (HWGs). HWGs bring together interested experts from different technology panels to work on common horizontal topics, defined on the basis of main challenges to be addressed by the RHC-sector. Each HWG defines its own programme in order to achieve its pre-defined goal. These technical HWGs are composed of experts from several renewable heating and cooling technologies, and are complemented by external expertise, such as socio-economic experts, experts from the traditional heating and cooling sector, from the building sector etc… The following publications have been developed recently: • Vision for the RHC sector towards 2050: https://www.rhc-platform.org/content/uploads/2019/10/RHC-VISION-2050-WEB.pdf • Districts Vision with case study examples: https://www.euroheat.org/publications/100-renewable-energy-districts-2050-vision/

	The RHC-ETIP also organizes a yearly event as well as national roundtables in different EU member states to further the discussion of R&I on heating and cooling.
Demonstrator site description	N/A
How can cities use the technology?	Cities can join the discussions by signing up as members or stakeholders and shape the R&I policies for Renewable Heating and Cooling.
Environmental impact	N/A
Project coordinator's contact details	Bioenergy Europe: info@rhc-platform.org
Contact information for demo site or specific solutions	Contact details for Technology Panel District Heating & Cooling and Thermal Storage and Horizontal Working Group Districts: dhcplus@euroheat.org

3.61 Sim4Blocks

Project name	**Sim4Blocks**
Call identifier	H2020-EE-2015-2-RIA
Type of action	Innovation Action (IA)
Project logo	
Project website	https://www.sim4blocks.eu/
Amount of EU funding (in EUR)	3,729,055.76
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	Sim4Blocks - Simulation Supported Real Time Energy Management in Building Blocks Demand Response and Demand Side management at three pilot sites in Germany, Spain and Switzerland. In Germany and Switzerland in the context of decentral heat pumps combined with cold district heating grids.
When can I use it?	The developed solutions can be assessed as TRL 7 and TRL 8. A roll out to additional demonstration sites will be needed as last step to get the technology market ready.
Where can I use it?	The technology can in theory be applied to all heat pump systems which provide the necessary interfaces.
Why should I use it?	The users will benefit from a reduction in electricity costs due to the participation in DR measures. In addition more profit is generated by an increase in self-consumption regarding on-site produced electricity (e.g. PV) when available.
Project size	17 project partners from various European countries and Switzerland, 3 pilot sites: Germany (17 smaller residential buildings with decentral heat pumps), Spain (three large office and residential buildings) and Switzerland (13 larger residential buildings with decentral heat pumps).
Summary	Sim4Blocks aim is to raise the energy flexibility of blocks of buildings to increase the utilisation of fluctuating renewable energy sources. This is archived by advanced prediction driven energy management systems (model based building demand calculation, model predictive control (MPC) and data driven approaches) as well as by measures to increase the user engagement and awareness in energy use at home by enabling energy cost savings for end users (e.g. by app based notifications).
Project details	Sim4Blocks develops new demand response (DR) services for smaller residential and commercial customers in blocks of buildings. Those services are implemented and tested in three pilot sites together with an aggregator company.

	In two out of the three pilot sites those services are developed for energy supply systems that are sourced by cold district heating grids in combination with geothermal applications. The pilot sites located in Spain, Germany, and Switzerland, all feature blocks of buildings that have efficient energy supply and distribution systems and an existing IT/monitoring infrastructure. These IT systems are accessed by the project to enable user activation strategies, to generate and modify demand profiles for different profiles (i.e. residential, public, commercial) and to optimise the flexible operation of renewables (e.g. biogas, heat-pumps, wind, PV and solar-thermal), cogeneration and storage (e.g. thermal and electrical) for DR. The main objectives of Sim4Blocks are to analyse and specify the technical characteristics of the demand flexibility that will enable dynamic demand response (DR). Thereby quantification of DR impacts especially for customers in the residential or small commerce sector is a challenge and is tackled by pilot site monitoring schemes and parametric simulation studies. To evaluate the optimal use of this DR capability in the context of the market tariffs, RES supply fluctuations and user interaction, innovative modelling and optimisation services combined with big data analytics are used to provide the best real time and strategic DR actions. The user interface development and user activation programs deliver feedback and guarantee high user acceptance levels. The pilot sites, St. Cugat in Spain, Wüstenrot in Germany and Naters in Switzerland, have been selected due to their innovative renewable energy integration concept (e.g. biogas, heat-pumps, wind, PV and solar thermal), available storage (e.g. thermal and electrical) in the context of DR activities, diverse demand profiles and available IT infrastructure for different types of buildings (i.e. residential, public, commercial) and high potential of user activation strategies. The implementation of automated DR strategies in the pilot sites serves as demonstration for the characterization and quantification of the flexibility and eases the transfer to market process.
Demonstrator site description	Germany: The German pilot site in the municipality of Wüstenrot addresses DR for the plus energy district „Vordere Viehweide". This district comprises 17 newly built residential buildings. The net zero energy supply concept combines low depth geothermal systems, heat-pumps and large PV systems. The low temperature energy source of the heat pumps is the central cold water heating grid which is connected to a large innovative surface near geothermal system. Each building is equipped with a controllable heat pump and six buildings are equipped with electricity storages.

	An intelligent load and storage management system in the buildings helps to increase the PV self-consumption and to reduce peak power feed in on a building level. The existing connection to a virtual power plant offers negative controlling power range to the transmission grid for the whole cluster of buildings. A cloud based data management system with weather forecast data and predictive simulation tools is used for the evaluation of externally usable loads, their timely availability and their clustering for the whole district. Switzerland: The low temperature district heating and cooling network “Krommen” in Naters has been in operation since 2013. The network connects 13 residential buildings to ground water wells, which act as a geothermal source. Heating and domestic hot water are produced by decentralized heat pumps, which are connected to the heating and cooling network. Waste heat deriving from cooling installations in the buildings (free-cooling) is used to balance the energy flow to the ground water reservoir. The heat pumps are equipped with a cheap hardware component capable of collecting, processing and exporting data from the heat pump’s controller to a cloud-based algorithm that calculates the pumps’ optimal control strategy and sends it back to the hardware for translation to the heat pump’s controller. The users are able to dynamically modify their comfort levels to allow DR actions to take place. This includes heating temperature setpoint bands and scheduling for DHW. Additionally, a self-learning software is used to identify and address the values/signals of the controller’s interface. Hence, reducing the set-up costs for connecting the conversation unit to the cloud. Spain: The Spanish pilot site consists of three adjacent building blocks that have complementary and contrasting use characteristics and electrical interconnection possibilities. The focus here is on implementing demand response solutions to reduce the impact multi-purpose blocks of buildings have on the energy grids. Due to the highly integrated management, the site is also able to actively reduce grid congestion by making use of CHP peak supply and adjusting solar trigeneration production as well as controllable demand accordingly. Also dynamic electricity tariffs are offered to the end customers within the residential part of the buildings. To shift peak power to heat load, the full range of set point temperatures is controlled in the offices and commercial sites. The pilot site demonstrates how renewable and non-renewable production, consumption and storage can be optimised in groups of buildings using one centralized system at building level and a cloud-based intelligent demand response IT solutions.
How can cities use the technology?	The solutions can help to reduce electricity grid stress, to tap waste heat potential and to increase the profit margin for end

	customers when utilizing renewable energy supply systems by software algorithms developed and cost effective of the shelve hardware components.
Environmental impact	The project increases the utilization of various DR measures, related to heat pumps and several other heating systems allowing to integrate more RES without increasing the electrical grid stress.
Project coordinator’s contact details	wolfram.mollenkopf@hft-stuttgart.de

3.62 SmartEnCity

Project name	**SmartEnCity**
Call identifier	H2020-SCC-2015
Type of action	Innovation Action (IA)
Project logo	
Project website	https://smartencity.eu/
Amount of EU funding (in EUR)	27,890,138.75
Other public or private project funding sources	N/A
Replication/implementation potential	5*****
What is it?	SmartEnCity's main objective is to develop a highly adaptable and replicable systemic approach for transforming European cities into sustainable, smart and resource-efficient urban environments. This is achieved though integrated urban demonstrators in three diverse EU cities.
When can I use it?	The district heating and district cooling solutions are already existing solutions in the market , the innovation of the project is achieved by the integration of these solutions with other ones like energy efficient retrofitting, mobility measures , ICT integration… TRLs of technologies implemented in urban setting range from TRL7 to TRL 9.
Where can I use it?	SmartEnCity project is focused mainly in medium-sized cities, but the solutions implemented can also be used in big and small cities. Lessons learnt are applicable to diverse stakeholders in urban transformation; while the project primarily addresses City administrations, large industry and SME, the academia and NGOs. The project aimas to cover the whole EU, with diverse scenarios in its three demonstrators (located in ES, DK and EE)
Why should I use it?	You should is if your aim is: To achieve a significant reduction in demand in the existing residential building stock, through cost-effective low energy retrofitting actions at district scale. To increase the Renewable Energy Sources' share of energy supply, through the use of locally available sources. To enhance the use of clean energy in urban mobility, both for citizens and goods, by means of extensive deployment of green vehicles and intelligent infrastructure.
Project size	The project includes three large urban demonstrators located in Vitoria-Gasteiz (ES), Tartu (EE) and Sonderborg (DK), including the deep energy retrofitting of several hundreds of residential units in the three cities, several actions on clean energy supply, Electric Vehicles for public transport and

	electric bike fleets, and the deployment of City information platforms. -In Vitoria-Gasteiz, the demo area is the neighbourhood of coronacion, next to the medieval center, roughly 1 km2, where 350 dwellings are being retrofitted and a new biomass DH network is being deployed. -In Tartu, the deom area (0,4 km2) is part of the centre of the city. 23 buildings /900 dwellings are being retrofitted and equipped with an intelligent “smart home system”. Additionally, a new heat and cool generation facility has been built by Fortum Tartu, the local Utility. -In Sonderborg, several housing associations in the city are part of the project, covering an area of around 4km2. 45 buildings (844 units) have been retrofitted and are being equipped with electricity generation and storage capabilities.
Summary	The project’s underlying concept is the Smart Zero Carbon City concept, where city carbon footprint and energy demand are kept to a minimum by using demand controlled technologies that save energy and promote raised awareness. At the same time, the energy supply is entirely renewable and clean and local energy resources are intelligently managed by aware citizens, as well as coordinated public and private stakeholders.
Project details	A detailed account of solutions in the three demonstration areas can be found at https://smartencity.eu/outcomes/city-solutions
Demonstrator site description	This approach will be firstly defined in detail, laid out and implemented in the three Lighthouse demonstrators (Vitoria-Gasteiz in Spain, Tartu in Estonia and Sonderborg in Denmark). The three cities develop a number of coordinated actions aimed at: • Significant demand reduction of the existing residential building stock through cost-effective low energy retrofitting actions at district scale. • Increase in RES share of energy supply, through extensive leveraging of local potentials. • Enhance the use of clean energy in urban mobility, both for citizens and goods, by means of extensive deployment of green vehicles and infrastructure. An extensive use of ICTs is planned to achieve integration and consistency in demo planning and implementation, and to enable further benefits and secure involvement of citizens. https://smartencity.eu/about/lighthouse-cities/vitoria-gasteiz-spain/ https://smartencity.eu/about/lighthouse-cities/tartu-estonia/ https://smartencity.eu/about/lighthouse-cities/sonderborg-denmark/ These actions will be aligned to city-specific Integrated Urban Plans (IUPs), and the process will be replicated in two Follower cities: Lecce, (Italy), and Asenovgrad (Bulgaria) to ensure adaptability and maximize the project impact. https://smartencity.eu/about/follower-cities/lecce-italy/ https://smartencity.eu/about/follower-cities/asenovgrad-bulgaria/

	Additionally, a Smart Cities Network will be setup to support project replication at European scale. http://smartencitynetwork.eu/ https://smartencity.eu/about/follower-cities/lecce-italy/ https://smartencity.eu/about/follower-cities/asenovgrad-bulgaria/
How can cities use the technology?	In addition to helping cities in planning their Zero carbon transition strategies, through a methodology developed within the project, specific actions are to be replicated initially in Lighthouse cities and documented/disseminated. In addition, several actions addressing city administrations (From a "SmartEnCity Academy" as a series of webinars, to tailored support to cities in our "SmartEnCity Network" to develop their own city wide plan and to implement specific actions)
Environmental impact	The overall expected CO2 emission reduction to be achievd yearly amounts to 20.061 CO2 Ton distributed as follows: Vitoria 2.149 CO2 Ton Tartu 12.244 CO2 Ton Sonderborg 4.668 CO2 Ton
Project coordinator's contact details	Francisco Rodriguez Perez-Curiel Francisco.rodriguez@tecnalia.com
Contact information for demo site or specific solutions	Vitoria-Gasteiz : Alberto Ortiz de Elgea alberto.o@visesa.eus Tartu: Raimond Tamm Raimond.Tamm@tartu.ee Sonderborg : Peter Ratjhe peter.rathje@projectzero.dk

3.63 SMILE

Project name	SMILE
Call identifier	H2020-LCE-2016-SGS
Type of action	Innovation Action (IA)
Project logo	
Project website	https://www.h2020smile.eu/
Amount of EU funding (in EUR)	12,106,046.95
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	The overall scope of SMILE project is to demonstrate, in real-life operational conditions a set of both technological and non-technological solutions adapted to local circumstances targeting distribution grids to enable demand response schemes, smart grid functionalities, storage and energy system integration.
When can I use it?	The integrated solutions proposed by the project have been deployed in 3 demonstrators and the objective is to achieve the TRL 8 of these integrated systems by the end of the project and to reach TRL 9 in a period of 1-3 years from project end.
Where can I use it?	The project's main objective is to demonstrate the different innovative technological solutions in 3 large-scale smart grid demonstrators based in three island locations, namely the Orkneys (UK), Samsø (DK) and Madeira (PT). Each of the demonstrators brings a specific set of challenges, technology options and most importantly, energy market conditions. The sites are therefore effectively representative of the majority of the EU energy markets and offer excellent demonstration settings which will deliver maximum impact in terms of replicability.
Why should I use it?	Modularity and scalability of the proposed solutions and high replication potential. Actually SMILE is proposing a cross-functional, modular and integrated automation and control framework tested at the premises of the three demonstration sites towards making distribution in an electricity grid based on RES and storage more agile and competitive
Project size	The 3 demonstrators are based in 3 islands: the Orkneys (UK), Samsø (DK) and Madeira (PT)
Summary	The objective of SMILE is to demonstrate, in real-life operational conditions, a set of both technological and non-technological solutions targeting distribution grids to enable demand response schemes, smart grid functionalities, storage and energy system integration. To this end, three large-scale pilot projects are under implementation in three island locations in different regions of Europe with similar

	topographic characteristics but different policies, regulations and energy markets: Orkneys (UK), Samsø (DK) and Madeira (PT). The scope is to test the project solutions while establishing mutual learning processes and providing best practice guidance for replication in other regions. The 3 demonstrators in the islands are testing different combinations of technological solutions according to local specificities and conditions and the existing infrastructure and are involving all value chain actors needed to efficiently implement projects system-wide. The technological solutions vary from integration of different battery technologies, power to heat, power to fuel, electric vehicles, electricity stored on board of boats, installation of heat pumps in the district heating networks, aggregator approach to demand side management (DSM) and predictive algorithms. The 3 case studies are characterised by high penetration of renewable energy sources in the electricity grid. Each pilot aims to demonstrate stable and secure grid operation in the context of the implementation of solutions enabling demand response and intelligent control and automation of distribution networks to provide for smart management of the grid, as well as in the context of the adoption of energy storage solutions and the connection between the electricity network and other energy networks.
Project details	The project’s main objective is to demonstrate different innovative technological solutions in large-scale smart grid demonstration projects in three island locations, namely the Orkneys (UK), Samsø (DK) and Madeira (PT). The technological solutions vary from the integration of battery technology, power to heat, power to fuel, pumped hydro, electric vehicles, electricity stored on board of boats, installation of heat pumps in the district heating networks, an aggregator approach to demand side management (DSM) to predictive algorithms. During the first 36 months of SMILE, special attention has been paid to the development of the enabling technological solutions, in particular the Battery Energy Storage Systems -BESS (both the grid support BESS as well as the residential one), the PCM based thermal storage, the Energy Management System, the Load Controller and control equipment as well as the predictive algorithms. The integrated systems deployed in the 3 demonstrators have been obtained by combining these technological solutions. The choice of having solutions tested in island locations provides a fundamental advantage to the project that is the fact that island communities can be more easily engaged in the real-life testing of solutions aimed at solving important challenges impacting life on the island and therefore constitute ideal candidates for demonstration activities requiring societal engagement and active residents’ commitment. Special attention has been paid since the beginning of the project in the citizen engagement.

Demonstrator site description	During the first 36 months of the project, the 3 regional demonstrators in the 3 Islands (Orkneys (UK), Samsø (DK) and Madeira (PT)) were focused on the definition of requirements, on the design of the overall architectures, the selection of the most appropriate technologies and their development as well as their deployment. In the Orkneys, the architectural design of Demand Side Management (DSM) system including the domestic heating installations, the Electric Vehicle (EV) charging and as well as the industrial load was carried out and then reviewed according to the project evolution. The most suitable technologies have been assessed and chosen with technical interactions defined. Furthermore, special attention has been paid to the user engagement strategy in order to recruit the most suitable participants in the project area. The core of the Samsø Regional Demonstrator is the DSM system for the Ballen marina including a battery energy storage system (BESS). During the first 36 months of the project, the case study specification and assessment was carried out and the basic architecture was defined. The BESS was developed, released, installed and tested on the field. The heat pump covering 100% of the heating demand in the harbour master's office was installed as well as the PV panels. The development of the overall smart energy system control was one of the key objectives. Furthermore, In the Samsø demonstrator, special attention has been paid on the business and socioeconomic assessment of introducing Heat Pumps with Heat Storage in District Heating Systems. The district heating plant for the Ballen and Brundby villages (300 consumers) is fuelled by biomass (straw), but one future scenario is to replace it with a large heat pump, possibly with a 24-hour hot-water storage tank. This scenario was examined and published in a joint scientific article by partners Samso Energy Academy and Aalborg University (Østergaard, Poul Alberg, Jan Jantzen, Hannah Mareike Marczinkowski, and Michael Kristensen. 2019. "Business and Socioeconomic Assessment of Introducing Heat Pumps with Heat Storage in Small-Scale District Heating Systems." https://vbn.aau.dk/ws/portalfiles/portal/333603539/DOI10.1016_j.renene.2019.02.140.pdf) In Madeira, the following 5 pilots were defined: Pilot 1"Getting Started with BESS and DSM"; Pilot 2 "Moving forward with BESS and DSM"; Pilot 3 "Getting Started with EV and Smart Charging"; Pilot 4 "EV are our Future"; Pilot 5 "Voltage and Frequency Control Pilot". The first 2 pilots were related to the increase of self-consumption in micro-producers thanks to DSM services and BESS (pilot 1 targeting residential applications whereas pilot 2 devoted to commercial applications), pilot 3 and 4 were related to smart charging of EVs and pilot 5 deals with Voltage and frequency control. For each pilot, it was defined the

	architecture as well as the hardware and software requirements. Furthermore, special attention was paid to the end user engagement and to the deployment of the energy monitoring infrastructure as well as the installations of the project solutions in all the pilots. Links to reports/public deliverables: https://cordis.europa.eu/project/id/731249/results
How can cities use the technology?	While each of the SMILE demonstrator is testing solutions that are most appropriate for the local specificities, common lessons with crosscutting valence are derived from both the technical implementation of the intended solutions in the system-wide infrastructure and the definition of new services and the related business models for energy systems that combine distributed energy resources, self-consumption and storage with optimized utilisation of distribution networks. Each of the demonstrators is bringing a specific set of challenges, technology options and most importantly, energy market conditions. The sites are therefore effectively representative of the majority of the EU energy markets and offer excellent demonstration settings which will deliver maximum impact in terms of replicability.
Environmental impact	N/A
Project coordinator's contact details	Giannicola Loriga Rina Consulting S.p.A gianni.loriga@rina.org
Contact information for demo site or specific solutions	Samso demonstrator: Jan JANTZEN Samso Energy Academy jj@energiakademiet.dk

3.64 SO WHAT

Project name	SO WHAT
Call identifier	H2020-LC-SC3-EE-2018
Type of action	Innovation Action (IA)
Project logo	
Project website	https://sowhatproject.eu/
Amount of EU funding (in EUR)	3,397,497.38
Other public or private project funding sources	N/A
Replication/implementation potential	4****
What is it?	SO WHAT's main objective is to develop and demonstrate an integrated software which will support industries and energy utilities in selecting, simulating and comparing alternative Waste Heat and Waste Cold (WH/C) exploitation technologies that could cost-effectively balance the local forecasted H&C demand also via renewable energy sources (RES) integration, including the surrounding communities.
When can I use it?	The SO WHAT tool is planned for completion in 2022, at the project's end, and it will be a near market solution, tested in the various demo sites and additional ones. The tool is being currently developed from various commercial and research tools and it is overall currently at TRL6.
Where can I use it?	One of the characteristics of SO WHAT tool will be its flexibility, the software will be data-based, therefore further expansions to include additional equipment, for example, will be possible. In principle, there are no geographical limitations, however the projects is taking advantage of EU databases, which precision outside the EU is yet to be verified.
Why should I use it?	There will be a Free Tool which will give the end user the possibility to provide a first estimation of the potential to recuperate waste heat or cold based on simple and pre-defined data. In case this first estimation gives positive feedback, the Tool is intended to be used in its complete version, which will be able to evaluate in a precise way the technical solutions that might be available as well as their potential. In addition, not only the technical part will be included but the economic/financing schemes would be tackled as well by the tool.
Project size	There are 11 different demo sites in Portugal, Belgium, Sweden, Spain, the United Kingdom, Romania and Italy. They represent extremely different industries and environment, including district heating providers and public authorities.
Summary	SO WHAT's main objective is to develop and demonstrate at TRL8 an integrated software which will support industries and energy utilities in selecting, simulating and comparing alternative Waste Heat and Waste Cold (WH/C) exploitation technologies that could cost-effectively balance the local

	forecasted H&C demand also via renewable energy sources integration. The SO WHAT integrated tool will be designed to support industries, and energy utilities in 1) auditing the industrial process to understand where WH/WC could be valorised 2) mapping the potential of locally available RES sources to be integrated with WH/WC potential 3) mapping the local forecasted demand for heating and cooling 4) define and simulate alternative cost-effective scenarios based on WH/WC technologies also leveraging TES introduction 5) evaluate the impacts (in terms of energetic, economic and environmental KPIs) that the adoption of the new scenarios will generate against the current situation (i.e., baseline) both at industrial and local level 6) promoting innovative contractual arrangements and financing models to guarantee economically viable solutions and less risky investments.
Project details	The project focus on the development of an integrated software tool: the tool will include various technological solutions but it will support the user in defining suitable business models according to the identified intervention and the actors involved.
Demonstrator site description	LIPOR Waste-to-Energy Plant in Maia, Portugal LIPOR is participating in SO WHAT through its waste to energy plant in Maia, Portugal, treating 380,000 tons of waste per year. ISVAG Waste to Energy Plant in Antwerp, Belgium ISVAG's role in SO WHAT is wide, they have an incineration plant running and they are planning the construction of a new one in parallel to a district heating network. Varberg Energi Pulp and Mill industry Waste Heat District Heating Network in Varberg, Sweden The demosite in Varberg is a community-based energy company providing district heating in the area. They are currently investigating the increase of waste heat injected in the network through actions both at heat exchanger level and at customer level, and to provide district cooling during summer via absorption chiller exploiting local waste heat. Materials Processing Institute (MPI)'s Steel Industry Research Pilot Plant in Middlesbrough, UK MPI represents the Steel Industry in SO WHAT, having a great experience in the related activities and processes deriving both from research activities and from the actual pilot plant operation. Göteborg Energi's multiple waste heat and district heating and cooling networks in Gothenburg, Sweden

	Göteborg Energi is acting as lighthouse partner for the SO WHAT project, but it also benefits from it for its next development forecasted activities expanding their cooling production and utilizing low temperature heat for district heating networks. Renovation of RADET District Heating Network in Constanta, Romania RADET Constanta aims at injecting heat from neighboring industries (petrochemical, manufacturing etc.) to become less fossil fuel dependent and to promote new business models. UMICORE Rare Material recycling and production centre in Olen, Belgium UMICORE is carrying out a pre-feasibility study to integrate a campus-wide heat network and there are already renewable installed on-site. IMERYS carbon black and graphite manufacturing centre in Willebroek, Belgium IMERYS Graphite & Carbon is situated on the industrial site of Willebroek Noord and in the direct vicinity of the industrial site of Puurs Pulaar and the municipality of Willebroek with its own residential development projects. This offers an opportunity to valorise IMERYS waste heat to industrial consumers, public buildings and residential consumers. Martini & Rossi's Distillery in Pessione, Italy Martini & Rossi's demosite has been identified as particularly relevant for the SO WHAT project as the stabilization of sparkling wines requires low temperatures, which are achieved via glycol-based refrigerators. In parallel, a solar thermal plant for industrial heat is being commissioned at the facility. ENCE Pulp Mill in Navia, Spain ENCE's biomass dryer in Navia is actually working with heat recovered from the bleaching stage. In the framework of SO WHAT, the heat from the bleaching stage and the effluent treatment stage will be analyzed in order to use it for the heating of the hospital and the town hall of Navia. ROMPETROL Refinery in Petromidia of Navodari, Romania As a refinery, Rompetrol presents a lot of waste heat potential, which is yet to be recovered. In parallel, the modelling of a refinery is a challenging task given the complexity of the plant itself.
How can cities use the technology?	The SO WHAT tool is key for an efficient management of Waste Heat and Cold Recovery and Reuse, which can boost sustainable urban development in the framework of the smart cities and regions paradigm and local climate and energy actions.

Environmental impact	SO WHAT will contribute to reduce the environmental impact of EU industrial activity as a consequence of increased energy intensity and reduced primary energy use. SO WHAT aims at unlocking the potential for waste heat recovery and RES share increase, thus not directly having an environmental impact but generating one. GHG emission reduction is directly estimated from the Primary Energy Savings triggered by the project by 2030. A conversion factor of 2 MtCO2/Mtoe = 0.172 MtCO2/TWh was used according to last IEA world statistics27. Then, 11440 GWh/yr × 10-3 TWh/GWh × 0.173 MtCO2/TWh = 1.98 MtCO2-eq/yr
Project coordinator's contact details	Francesco Peccianti francesco.peccianti@rina.org Nick Purshouse nick.purshouse@iesve.com

3.65 SPARCS

Project name	**SPARCS**
Call identifier	H2020-LC-SC3-2019-ES-SCC
Type of action	Innovation Action (IA)
Project logo	SPARCS
Project website	https://www.sparcs.info/
Amount of EU funding (in EUR)	19,701,216
Other public or private project funding sources	project partners' own public and/or private funding
Replication/implementation potential	5*****
What is it?	SPARCS - Sustainable energy Positive & zero cARbon CommunitieS - demonstrates and validates technically and socio-economically viable and replicable, innovative solutions for rolling out smart, integrated positive energy systems for the transition to a citizen centred zero carbon & resource efficient economy. Seven cities will demonstrate 100+ actions turning buildings, blocks, and districts into energy prosumers, creating VirtualPositiveEnergy communities as energy democratic playground (positive energy districts can exchange energy with energy entities located outside the district).
When can I use it?	Most of the demonstration actions are available and ready for utilisation (TRL 6-9), while some of the demonstations focus on the processes, governance, community engagement and system integration, which need to localized (TRL 5-8).
Where can I use it?	The low carbon urban development for blocks, districts and cities, in the fields of energy, buildings, transport, ICT, city governance.
Why should I use it?	Increasing energy efficiency and distributed RES production locally helps to miticate climate change through decarbonizing urban development.
Project size	2 lighthouse cities with 6 demonstration blocks and 5 fellow cities preparing their low carbon urban development. 31 partners around Europe.
Summary	The overall goal of SPARCs is to demonstrate, and validate, the technical and socio-economic viability, and impacts, of scalable, innovative solutions for planning, deploying and rolling out smart and integrated energy systems as an efficient mean for the urban transition into a citizen centered zero carbon ecosystem, enabling a high quality of life. The 7 SPARCs cities will promote the replication of the urban energy transition widely in Europe, by demonstrating the measurable evidence of the benefits of these integrated solutions, on a large scale, for developing blocks of buildings and districts into active energy ecosystems and pioneering business models tailored on interactions between the citizen, building and the urban energy systems.

Project details	SPARCs's overall objective is to achieve citizens' inclusive carbon-free urban community by integrating the following key factors: technologies for energy positivity in buildings and districts, citizen engagement, city planning and governance, flexible grid management and energy storage and; e-mobility as an energy system element. SPARCs targets to tackle the multifaceted challenges that cities are called to solve by creating the ecosystems necessary for the urban energy transformation in cities towards a citizens-inclusive Sustainable energy Positive & zero cARbon CommunitieS. The project wants to trigger the urban transformation while keeping a high quality of life for citizens. A top priority is to set up inclusive management and planning models, ecosystems and processes, involving companies, city planning & technical departments of cities, citizen and research organizations, creating an Information Society with citizens being at the centre of the decision process and aware of the city's activities. Establishing a robust and dynamic circular economic framework is another key element for creating citizens inclusive communities. Realizing such urban ecosystem implies having a long-term political commitment from cities, in-depth understanding of current city challenges, mastering "green city" business models as a whole with its social, environmental and economic implications to both local and global scale. In this context, advanced carbon neutral technological solutions become profitable for Public-Private-Partnership (PPP) investment. The cornerstones of SPARCs are two lighthouse cities: Espoo in Finland and Leipzig in Germany, and five fellow cities: Reykjavik in Iceland, Maia in Portugal, Lviv in Ukraine, Kifissia in Greece and Kladno in Czech Republic. Lighthouse cities aim to prove that the urban energy transformation of a city into a carbon neutral urban community is socially and economically viable. Fellow cities demonstrate the smooth transferability of this transformation model. SPARCs will set both large demonstrations activities in the lighthouse cities and hands-on feasibility studies in the fellow cities of carbon neutral solutions for energy positive blocks and districts. These will be supported with city and user centric business models, specifically tailored for SPARCs solutions, which identify bankable actions for generating a quick market uptake, leading to relevant impacts on an urban area scale. Furthermore, concrete wide scale demonstration actions allow drawing practical suggestions, for solving physical-virtual interoperability and integration issues, utilising big data management as an enabler of new services, and for regulatory and legal framework alterations, addressing sensitive issues of data security and protection, as well as gender and socio-economics impacts. The project aims to capitalize these aspects together with business models, innovative joint procurement procedures and citizen engaging mechanisms in an overarching city planning

	instrument, which is calibrated toward the City Vision for 2050.
Overall demonstrator site description	SPARCS deploys wide scale demonstration of innovative technologies for integrated, mixed-use, positive energy building blocks in the 2 lighthouse cities, Espoo and Leipzig, and selected feasibility tests in 5 fellow cities. Demonstrations include: - energy positive blocks and 5 districts in Espoo and Leipzig; - Hands on feasibility studies in fellow cities - Integrated smart energy solutions and systems including virtual power plant, integration options for renewables towards carbon neutral solutions, district level energy solutions such as district heating and cooling integration and thermal demand response, predictability and optimization of energy performance, large battery and storage applications, profitability and energy markets, emerging opportunities in the energy market; - Interoperable digitalization solutions including big data optimization and adaptation of blockchain technology; - Electro-mobility integration and technologies including the integration of EV-charging to the local grid and its impacts on the energy system, peak load monitoring and control, EV-charging economy and services, community and residential EV-parking solutions, EV as storage, city planning measures, electrification of the public transport and E-bus charging, Mobility as a Service (MaaS); - Energy positive urban district planning and governance models including new procurement and co-creation models, new mechanisms for networked urban development. Details of the demonstrations will be available in SPARCS deliverables D3.1 and D4.1. The demonstration districts represent common urban context throughout Europe. In Espoo, demonstration activities focus on mixed-use building blocks, consisting of both existing building stock and new-built, within fast growing districts along the multimodal public transport network, In Leipzig the activities are focus within districts located in partly historic and dense neighbourhood, which is a very common city layout of many European cities. SPARCS demonstrations focus on different levels, ranging from building block, district and macro level interventions. Building block interventions aim to equip buildings with innovative technologies demonstrating the integration of RES, energy storages and EVs in the site energy infrastructure, upgrading the building energy management with new operating functionalities of the virtual energy

	community with users as active players, and the financial viability of these. Increasing the sense of ownership and enabling the participation of alternative market (reserve, energy flexibility a nd capacity markets) are the main purposes of the business and financial models of the building block level interventions. District level interventions aim to upgrade the district energy infrastructure in order to exploit the energy-flexibility, coming from buildings (including users' behavioural patterns), district storage solutions and advanced control, and the surplus of energy produced at the different building sites through opening the district infrastructure to a bidirectional use and implementing predictive control of generation, consumption and storage units. These levels of interventions demonstrate the integration of building block and district energy storage solutions onto the district energy infrastructure as well as the multifaceted benefits of a peer-to-peer energy exchange approach from the profitability and user engagement points of views. These two levels are complemented with Macro level intervention which support the smooth deployment of actions at both levels from city planning, regulatory and financing aspects and set the replication actions for rolling out a wide deployment of the demonstrated solutions.
First demonstrator site description	A new Lippulaiva block in Espoo is currently under construction. The completely new shopping centre will be a state-of-the-art cross point with 20,000 daily customers and 10,000 daily commuters (3.5 million/year). The new underground metro line and station, and feeder line bus terminal, will be fully integrated. Residential housing of approximately 550 new apartments will be built on top. Lippulaiva is a large traffic hub, directly connected to public transport and right next to the Länsiväylä highway and extensive cycle paths. Leasable gross area of the shopping centre is 44,000m2, and additional 550 residential apartments and 120 apartmens for elderly. It will offer diverse, mixed-use services, such as a shopping mall, public services, a day care centre, residential apartment buildings, and underground parking facilities. The carbon footprint will be reduced significantly, as the building block is designed to meet the BREEAM Excellent certification,target, with sustainable energy production and environmentally friendly construction methods and materials, such as isolation, ventilation, and low carbon materials; wood, low carbon concrete, green roof, and led lighting. This site will demonstrate integrated RES solutions for Energy Positive Blocks using a combination of PV, regenerative geothermal and waste heat solutions, electricity, and heat&electricty trade strategies, e-mobility activities & optimisation and citizen engagement actions. The nZEB block will use the world's largest ground source heat pump (GSHP) unit in commercial buildings (4MW, totalling 50 km of bore holes), producing at least 90% of the heating and cooling demand (CO2 emission reduction of 95 %) of the Lippulaiva district.

	Leppävaara is one of the fastest growing areas in Espoo and Sello Center is the local Energy hub of Leppävaara. Sello multipurpose centre has an area if 102 000 m2 including shops, a library, concert hall, movie theatre. Sello center has 2900 parking lots that includes tens of EV charging station. Sello gets 23 million yearly visitors. A new plan of Sello Center extension is under development. Sello demonstration includes an advanced smart energy system with a large integrated electricity storage (2,4 MW; 2MW) and on-site PV (553 kWp), which enable virtual power plant operation, and participation to the Fingrid's frequency controlled disturbance services with a total load of 3.6 MW to be controlled. Energy performance will be optimised in real time. Also e-mobility charging for public transport is in place and its optimisation is studied in connection with the energy system of the Sello block. Kera district in Espoo acts as a testbed for co-creation and infrastructure building towards a resilient, sustainable and smart, energy positive area. Infra solutions will include a bidirectional electricity grid, 5G platform, emissionfree energy, and open district heating system (heating energy consumers acting as prosumers).
Second demonstrator site description	In Leipzig, the demo districts are two areas in the western part of the city: one former industrial areas (Baumwollspinnerei , a former cotton mill and Leipzig-West, which includes the housing area of the Duncker Neighbourhood) and a Virtual Positive Energy community. The first two have defined physical boundaries, while the third has not, but virtually connects generating, storing and consuming entities. Generation and storage assets physically located in the first two districts can also contribute to the energy flows of the Virtual Positive Energy community accordingly with the contracted share of energy. Demonstration in the Baumwollspinnerei premises focuses on an intelligent micro grid with active positive energy community. The aim of this demo is to address:1) the technical integration of additional RES and power energy storages into the district network (e.g. the type and mix of second-life battery accumulators); 2) bidirectional energy management (intelligent multiuse) involving cooperation between local microgrid and public network; and commercialization of the district power system including the network, power generation assets and storages (e.g. the design of equitable energy tariffs and supporting policies). Buildings heating demand (space heating and DHW) is covered by renewable energy produced locally by bio-CHP and by solar energy produced in by a Solar Thermal Plant in Leipzig-West (Virtual Positive Energy Community demo district). The Smart Social Housing Block is in the Duncker Neighbourhood of the district of Leipzig-West. The municipal

	housing company owns about 1.000 apartments in the area. The districts consists mostly of buildings from 1950ies, some housing blocks were built in the 1970ies, which have a district heating connection (ca. 300 apartments). Additionally a new social housing block will be built (constructions started in 2020). It consists of a floor area about 24 000 m2 with about 250 apartment. Several smart social housing solutions will be tested in the area. The aim of the demo is: 1) to integrate RES and advanced storage solutions into the district heating network, set up for Virtual positive energy community operations, 2) to demonstrate the viability and effectiveness of the proposed user centric control, by means of a dedicated platform for an active involvement of citizens, for optimizing energy flows. Within the district, a novel solution for optimizing thermal energy consumption through the implementation of human-centric thermal demand response programmes (implicit demand response) operated by one project partner will be demonstrated
How can cities use the technology?	One of the main aims of SPARCS is to replicate demonstrated smart and integrated lighthouse city solutions in fellow cities and lay the foundations for European wide adoption and upscaling. SPARCs boosts remarkable technological and deployment progress, as suggested by the SET plan, by supporting systematic adaptation, replication and upscaling of integrated lighthouse city solutions for energy positive districts in 5 fellow cities and Europe. To reach efficient replication SPARCs will: - Develop structured, inclusive and targeted Fellow City Implementation Plans in all 5 Fellow Cities - Collect all implemented Lighthouse City Use Cases in a structured format (incl. financing model, practical lessons learned and many more) to be communicated to Fellow Cities and freely accessible on the internet (https://www.bable-smartcities.eu/explore/use-cases/?L=0) - Educate certified Smart City Managers (focus on energy) in each Fellow City to enable effective and efficient implementation during and beyond the project scope - Develop and execute robust and structured knowledge transfer mechanisms - Prepare the implementation and upscaling of positive energy block solutions; - Identify opportunities for further transferability, large scale replication and implementation of demonstrated solutions across Europe and globally; - Pilot Joint Cross Border Procurement of Innovation with at least 2 cities
Environmental impact	SPARCS has ambitious environmental targets, including increasing energy efficiency in demonstrations from 10 to 35%, and reducing carbon emissions from 50-95%, depending on the demonstration activity and local conditions. For example, Lippulaiva ground source heat pump reduces

	heating and cooling emissions 95% in the block. Leipzig demos are reducing the CO2 emissions -50-70%.
Project coordinator's contact details	Mr., Dr. Francesco REDA, VTT Technical Research Centre of Finland Ltd. francesco.reda(a)vtt.fi
Contact information for demo site or specific solutions	Lighthouse city Espoo, Finland: Elina Wanne, elina.wanne(a)espoo.fi Lighthouse city Leipzig, Germany: Nadja Riedel nadja.riedel(a)leipzig.de; David Bausch David.bausch(a)leipzig.de

3.66 STARDUST

Project name	**STARDUST**
Call identifier	H2020-SCC-01-2017
Type of action	Research and Innovation Action (RIA)
Project logo	STARDUST
Project website	https://stardustproject.eu/
Amount of EU funding (in EUR)	17,940,000
Other public or private project funding sources	761M€ of total investment, 21 M€ eligible costs
Replication/implementation potential	5*****
What is it?	STARDUST serves as smart connector bringing together advanced European cities and citizens of Pamplona (ES), Tampere (FI) and Trento (IT) - with the associated follower cities of Cluj-Napola (RU), Derry (UK), Kozani (GR) and Litomerice (CZ). A partnership composed of public bodies and relevant industrial partners, supported by academia and research organisations, will demonstrate three lighthouse cities, deploy intelligent integration measures, test and validate technical solutions and innovative business models, and deliver blueprints for replication throughout Europe and abroad
When can I use it?	All technologies to be integrated in the smart solutions are advanced: already in the market or very near to the fully commercial exploitation (TRL:7-9). STARDUST does not develop new technologies, processes or systems. The innovation rely in the smart integration of novel, but existing, technologies, exploiting the multiple synergies found in the cross – sectorial collaboration between ICT, energy, mobility and other urban infrastructures, and reaching the adequate scale of intervention (district scale)
Where can I use it?	Smart Cities, applying to three main areas: nZEBs, energy infrastructures and electro mobility.
Why should I use it?	N/A
Project size	98,300 m2 nZEB refurbishment 133,770 m2 nZEB new buildings Roll out of EVs (786) & Charging Points (410) 63% GHG REDUCTION
Summary	The objective of STARDUST project is to pave the way towards low carbon, high efficient, intelligent and citizen oriented cities, fully aligned with the Clean Energy for All Europeans strategy, by developing urban solutions and innovative business models, integrating the domains of buildings, mobility and efficient energy through ICT. The aim is to test and validate these solutions, enabling their fast roll out in the market. The STARDUST project will demonstrate that the smart integration of these actions, together with other accompanying non-technological measures can provide a platform for citizens and community engagement. The smart cooperation among each other will increase the quality of life of the citizens while driving the local

	economies forward by means of a novel productive model based on eco-innovation technologies
Project details	Energy: The high energy consumption observed among urbanised cities can be reduced by introducing smarter technology, methods and materials into their districts and buildings. Retrofitting and innovative heating and cooling systems will be introduced to already existing buildings and districts to increase their energy efficiency while providing comfort to local residents. By developing efficient energy management protocols, user-designed interfaces of smart grids and storage systems and open sharing of data between users and other stakeholders, energy usage can be monitored and managed by the buildings' inhabitants and by the energy provider. ICT: Information and Communication Technology (ICT) unlocks the potential of different cities by allowing them to connect and integrate with their operational processes. Its transformative nature amplifies the impacts of other innovations piloted in the city by enabling their scalability, preventing technology and vendor lock-in situations and facilitating collaboration and innovation between stakeholders. The latest generation of the ICT smart city platform, the open access strategy, data centres and infrastructures, and user-driven and demand-oriented city infrastructures will be introduced to reduce greenhouse emissions and to promote social innovation and co-creation of ideas between stakeholders. http://stardustproject.eu/news/
First demonstrator site description	PAMPLONA ENERGY: nZEB (renovation works & new construction), HEMs and BEMs in several neighbourhoods; Installation of Active Roofs: Plug & Play; Biomass District heating in Txantrea; Microgrid in public building ; Heat recovery in the municipal Data Center; Heat recovery at urban scale: monitor and analysis of the potential use of water & waste water networks to integrate heat exchanger to provide heating & DHW through heat pumps; ICT: An Open City Platform with a holistic approach that will integrate all the urban elements presented above. INNOVATION ECOSYSTEM AND BUSINESS MODELS: Validation of Smart Business Models (PPP, Energy Performance Contr., Innovative Public Procurement, etc); A Green Public Utility: promoting and aggregating the supply and commercialization of locally generated RES; Exploitation of North district heating system; Promotion of the development of innovative start-ups.

	STAKEHOLDERS AND CITIZEN ENGAGEMENT: Citizens' acceptance and consensus building, through Citizen information activities, localised citizen engagement activities, "JOIN STARDUST" program linked with e-participation tools etc. Sustainable Behaviour Change Gaming Tool
Second demonstrator site description	TAMPERE Ilokkaanpuisto: A new concept will be tested, where the residents in the area will own a photovoltaic power station located in a rural part of Tampere. Härmälänranta: The energy efficiency of the buildings will be improved through the use of smart technical building systems, as well as by utilizing renewable energy sources. Also, indoor air quality and apartment-specific controllability will be improved, which will lead to increased comfort of living. Smart District Heating and Cooling: A demand response service will be developed together with the electric utility's customers. Also, the possibility to open up the district heating network for the renewable small-scale production will be explored, the energy efficiency of the district cooling network will be maximized, and the possibility to produce cooling from district heat will be researched. An open and common IoT platform, where all the data for example from different pilots and experiments will be brought, will be purchased for the city.
Third demonstrator site description	TRENTO ICT Installation of a sensor network to collect data on the environment, energy, mobility, safety and waste collection. The data will be processed and made available in real time to the administration and citizens through a dashboard and used to create advanced online services. Creation of a participation portal where citizens can actively contribute to the smart evolution of the city. Installation of some smart points: advanced information points that will make the data collected by the sensors be usable and will provide other services such as the intelligent public lighting system. ENERGY EFFICIENCY Energy refurbishment and upgrading of the technological systems of three towers in the northern part of the complex (164 apartments for a total amount of 15,000 square meters). Among the main interventions: the realization of photovoltaic systems, a heat pump based on geothermal heat pumps, an innovative ventilated façade and an advanced system for monitoring consumption. The interventions require an investment of over 10 million euros, and they aim to reduce the total energy needs of buildings by 50%.

How can cities use the technology?	STARDUST has a clear strategy and roadmaps for replicating measures in its follower cities Cluj, Derry, Kozani, and Litoměřice. The empirical analysis of demonstration results of the lighthouse cities will be transferred via the replication plans, including: •The establishment of a favourable environment for the raise of a new eco-technological economy, based on the most innovative ICT tools, connecting the new requirements of smart citizens with the new market actors. •To accelerate the rate of growth of sustainable technology solutions by improving and spreading the knowledge on good practices regarding institutional and technological innovation. •To provide insights on social responses along the chain from awareness, attitude formation, uptake of knowledge, establishment of personal ambitions towards the efficient use of energy and to the integration of new energy technologies. •To launch, establish and implement city platforms as a hub in close cooperation with our lighthouse partners and to showcase suitable project results and recommendations. •To validate and assess demonstrative innovative sustainability-oriented solutions of three smart district hotspots (Pamplona, Tampere and Trento) through the SCIS KPIs for Smart Cities , to be then replicated in the follower cities from 2018 onwards keen to learn and implement themselves novel integration measures and related business models they get from first hand. •To mitigate barriers for integrating affordable energy measures and to up-take intensive dialogues on replication strategies by considering necessary on-site partner constellations, case study analyses able to cover and explore all important contextual factors and conditions, and the financing of the future reference projects by using a robust mixture of private business plans and public financial support •To use envisaged dissemination and promotion activities that will consolidate the main outputs into single packages in a format that is attractive for the target groups and the civil society as a whole.
Environmental impact	63% GHG REDUCTION 6.400 NEW LOCAL JOBS 115 INNOVATIVE SOLUTIONS
Project coordinator's contact details	fmanteca@cener.com
Contact information for demo site or specific solutions	communication@stardustproject.eu

3.67 STORM

Project name	**STORM**
Call identifier	H2020 EE-13-2014
Type of action	Research and Innovation Action (RIA)
Project logo	STORM DISTRICT ENERGY CONTROLLER
Project website	http://storm-dhc.eu/
Amount of EU funding (in EUR)	1,972,126
Other public or private project funding sources	N/A
Replication/implementation potential	N/A
Summary	Develop, demonstrate and deploy an advanced self-learning controller for district heating and cooling (DHC) networks. The controller has been demonstrated in two sites: Mijnwater in Heerlen (the Netherlands) and Växjö (Sweden).
Project details	The project is expected to result in the following: • Developing an innovative controller for district heating & cooling (DHC) networks • Balancing supply and demand in a cluster of heat/cold producers and consumers • Integrating multiple efficient generation sources (renewable energy sources, waste heat and storage systems) • Including three control strategies in the controller (peak shaving, market interaction, and cell balancing). • Present generic applicability by demonstration on two demo-sites • Developing innovative business models needed for the large-scale roll-out of the controller at reduced costs • Designing a scalable and performing self-learning control approach requiring limited external experts • Increasing awareness on the need to control DHC networks in a smart way
Project coordinator's contact details	Johan Desmedt, johan.desmedt@vito.be

3.68 TEMPO

Project name	**TEMPO**
Call identifier	H2020-EE-2017-RIA-IA
Type of action	Research and Innovation Action (RIA)
Project logo	
Project website	https://www.tempo-dhc.eu/
Amount of EU funding (in EUR)	3,130,869.18
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	Tempo demonstrates the applicability of low temperature district heating through a comprehensive solution Package including technological innovations on the network and building side, consumer empowerment enabled by digital solutions and innovative business models for EU replication
When can I use it?	TEMPO envisages several technical solutions, each of them with different TRL and level of deployment. In particular: - A supervision ICT platform for detection and diagnosis of faults in DH substations: TRL 8 expected - Visualisation tools for expert and non-expert users: TRL 8 expected - Smart DH network controller, to balance supply and demand and minimize the return temperature: TRL 8 - Innovative pipe system: TRL7: The integrated 3-4 pipe solution in a single casing for all application cases, is simulated and optimal dimensions are determined. - Decentralised buffers: TRL8 - Optimisation of the building installation: TRL7: Integrated algorithms will be able to analyse data from the actual demo site satisfyingly, focusing on temperature optimisation
Where can I use it?	The strength of TEMPO lies in the combination of different individual innovations into solution packages for different application areas, since the innovations strengthen each other. TEMPO solution packages are tested on two kind of networks: existing high temperature urban networks and new rural low temperature networks.
Why should I use it?	TEMPO aims to reduce DH network system temperatures to achieve improved network efficiency, costs competitiveness and capability of integrating sustainable energy sources like renewable and residual heat.
Project size	Windsbach: 5 multi-family-houses and 100 single family houses Brescia: network size 25,000 MWh
Summary	The TEMPO ('TEMPerature Optimisation') project will serve to lower the temperature levels of the network, so that heat losses can be reduced and will thereby enable the use of a higher share of sustainable sources to meet heat demand. In

	doing so, TEMPO will significantly contribute to steering DH networks towards a more sustainable and economically viable future. To achieve this goal, the project relies on the demonstration of cost-effective technological innovations that will contribute to minimising the temperature level in DH networks and enable the cost-efficient implementation of low temperature networks. Additionally, innovative approaches towards consumer empowerment and new business models for LT DH networks will guarantee a successful outcome of TEMPO. These innovations will also safeguard sustainable and economically viable DH networks, even in challenging situations e.g. a combination of low-energy buildings and less dense areas.
Project details	TEMPO project partners have individually developed multiple technological innovations in various previous R&D projects that are currently between TRL 5 and 6. Within TEMPO, these innovations will be further developed to reach TRL 7-8 whilst being integrated into 3 TEMPO solution packages that cover major challenges associated with the application of LT DH networks. In function of the 3 defined TEMPO solution packages, 2 suitable demonstration sites were selected to demonstrate the technical and economic viability of the LT DH networks. The following technological innovations are included in the TEMPO solution package: - A supervision ICT platform for detection and diagnosis of faults in DH substations - Visualisation tools for expert and non-expert users - Smart DH network controller, to balance supply and demand and minimize the return temperature - Innovative piping system - Optimisation of the building installation - Decentralised buffers
Demonstrator site description	Two demonstration sites are included in the TEMPO project. The selected demonstration sites provide a well-balanced combination of new built and existing networks, in combination with new low-energy buildings and existing buildings in less dense areas. 1. Windsbach (Germany): The municipality of Windsbach (6,000 inhabitants, located 35 km south west of Nuremberg) has planned a new residential housing project, developed in rural area and heated by DH. In phase 1, 5 multi-family-houses and 50 single family houses will be built and connected to the network. In phase 2, 50 single family houses will additionally be added to the network. Possibly, also an industrial area will be connected to the scheme, however no timing is - known yet for this connection. The network has in total an estimated heat demand of 1000 MWh (800 kW peak load, without industrial area). There is an existing biogas plant about 800m far away from the

	proposed energy center location, where in summer there is approximately 400 kW of waste heat available, and in winter 100 kW. This waste heat will be utilized to cover the base load in the new built DH network. The rest will be supplied by two new CHP plants. 2. Brescia (Italy): The network of A2A in Brescia is a rather old network, connecting buildings from the 1950s in a low-building density area. The network is currently operating at temperature levels of 120/60°C. The network is heated by a waste-to-energy plant (~50% coverage), in combination with a CHP, waste heat recovery from industries and peak load boilers. The total network has a heat load of about 25 000 MWh. The goal in TEMPO is to lower the supply temperature in one branch in the network by mixing the supply water - with the return water from the branch, by means of a shunt installation. In a first phase, this will be done on a trial-and-error basis, involving the costumers. Then the TEMPO innovations will be installed, and the additional - temperature reduction is quantified. The goal of implementing several TEMPO innovations is to verify the effects of these innovations in an operational setting and to develop a solution that is easily replicable over low density parts of the networks. End customers will be involved and required equipment will be installed.
How can cities use the technology?	The project in Windsbach is a typical for hundreds of projects which could be realized in Germany within the next years. Germany is facing a massive housing shortage, estimated at about 800.000 dwellings. New developing areas like these will be a main part of the solution. Also in other parts of Europe similar housing concepts will be developed. The demo site in Windsbach will demonstrate how an efficient low temperature DH network can be installed and operated in rural areas with a low heat density. As for the second demo site, Brescia, This demo site is added to the project since it is representative for so many networks throughout Europe, and as such, there is a large replication potential for the measures taken in this project
Environmental impact	Windsbach: Primary energy saving: from 2.469 MWh to 1.566 MWh (the demo site is already 100% renewable) Brescia: Primary Energy Savings: from 21.649 MWh to 14.693 MWh GHG Emissions: from 1.998 ton to 1.341 ton
Project coordinator's contact details	Six Daan daan.six@vito.be

Contact information for demo site or specific solutions	Windsbach: Markus Euring Markus.euring@enerpipe.de Brescia: Marini Ilaria ilaria.marini@a2a.eu

3.69 THERMOS

Project name	**THERMOS**
Call identifier	H2020-EE-2016-RIA-IA
Type of action	Research and Innovation Action (RIA)
Project logo	THERMOS
Project website	https://www.thermos-project.eu/home/
Amount of EU funding (in EUR)	2,902,480.00
Other public or private project funding sources	N/A
Replication/implementation potential	3***
What is it?	THERMOS - Thermal Energy Resource Modelling and Optimisation System - developed a web-based software designed to optimise local district energy network planning processes and support sustainable energy master planning. In offering instant high-resolution address-level mapping, built-in energy demand estimations and network optimisation online, the software provides the methods, data, and tools to enable public authorities and other stakeholders to undertake more sophisticated thermal energy system planning far more rapidly and cheaply.
When can I use it?	Currently available for use via the project website or directly at: https://tool.thermos-project.eu/
Where can I use it?	Currently available for use by anyone/anywhere but is expected to be used mainly by consultants or local authority officers undertaking heat mapping, energy masterplanning or heat network prefeasibility work. Geographically unlimited but depends on OpenStreetMap coverage (or user can upload local data).
Why should I use it?	THERMOS is an open-source software using OpenStreetMap or local energy demand data. The software offers a rapid generation of local heat density maps and has a team option so that different users can work on the same project at the same time in different locations. THERMOS allows to model heating and cooling networks and includes an advanced facility to optimise network supply – e.g. by taking into account energy output or cost over time through varying demand profiles and different tariffs. THERMOS is particularly good for conducting in-house pre-feasibility analyses thereby saving on expense consultancy costs, and has been successfully trialed with local authorities and validated with industry experts. The flexible. THERMOS's network optimisation model can be adapted to user-specific network criteria to identify cost-optimal solutions taking into account factors such as capital costs for plant, pipes and connection and setting them against revenues from heat sales and monetised greenhouse gases (GHG) emissions. Being web-based technical updates are introduced directly. Benefiting from EU project funding users can rely on support materials and user help pages available for free on the THERMOS project website and the software's user forum.

Project size	THERMOS is working with 7 partner cities (London, Jelgava, Granollers, Warsaw, Cascais, Alba Iulia and Berlin) in developing the software, but as the tool is freely available online there are now many more users within the EU and the rest of the world.
Summary	Running from October 2016 to March 2021, THERMOS is developing the methods, data, and tools to enable public authorities and other stakeholders to undertake more sophisticated thermal energy system planning far more rapidly and cheaply than they can today. This will amplify and accelerate the development of new low carbon heating and cooling systems across Europe, and enable faster upgrade, refurbishment and expansion of existing systems. These outcomes are being achieved through: a) Development of address-level heating and cooling energy supply and demand maps, initially for the four Pilot Cities, and subsequently for the four Replication partners - establishing a standard method and schema for high resolution European energy mapping, incorporating a wide range of additional spatial data needed for modelling and planning of thermal energy systems, and their interactions with electrical and transport energy systems; b) Design and implementation of fast algorithms for modelling and optimising thermal systems, incorporating realworld cost, benefit and performance data, and operating both in wide area search, and local system optimisation contexts; c) Development of a free, open-source software application integrating the spatial datasets with the search and system optimisation algorithms (trialled and tested through the public authorities representing four Pilot Cities); d) Supporting implementation of the energy system mapping methodology, and subsequently the use of the THERMOS software, with a further four Replication Cities/Regions, from three more EU Member States; e) Comprehensive dissemination of mapping outputs and free software tools, targeting public authorities and wider stakeholders across Europe.
Project details	Ultimately, THERMOS will provide accessible sophisticated new energy system mapping methodologies, software and associated modelling tools that empower and enable public authorities and other stakeholders to plan for heating and cooling systems significantly more quickly, efficiently and cost effectively. This will result in multiple environmental and socio-economic benefits at the local citywide level whilst contributing to strategic sustainable energy targets at the broader national/international level. The innovative open-source software solution being developed is surpassing the tools that are currently offered in this field, including commercial energy system mapping and modelling applications. THERMOS incorporates novel algorithms for identifying optimal thermal energy system configurations and produces state-of-the-art thermal energy

	maps using address-level demand/supply modelling with consistent geospatial data structures to facilitate cross-border use. Its ambition is to set a new state-of-the-art European standard which can be widely adopted by energy planners. The project also includes an extensive trial and testing phase of the tool through a series of 'Agile' workshops with technical experts and local authority representatives from the THERMOS cities to ensure their needs and the practicalities of implementation are properly addressed. An innovative city 'twinning' process between the Pilot and Replication Cities is resulting in peer-to-peer sharing of experiences in adopting THERMOS, including the embedding of THERMOS within municipal energy system planning processes. This has been facilitated by the establishment of Local Stakeholder Liaison Groups for each city to gain the support and views of wider stakeholders. Additionally, a City Interest and Ambassador Group has been established and a series of Train-the-Trainer programmes with participant certification is being rolled out thus ensuring a robust dissemination phase and capacity-building within public authorities and wider stakeholders across Europe. The THERMOS tool allows users to create their own local energy demand maps which can be supplemented with local data if available via the tool's data upload facility. Once the map is generated, the user can select groups of buildings and interconnecting routes to create a network 'problem' which the optimiser then attempts to solve according to user-set objectives (NPV, emissions, etc). Thus, pre-feasiblitiy work on potential networks can be undertaken in a fraction of the time and cost of that normally incurred through external consultancy work. The THERMOS software code will also be open-sourced before the end of the project. Now in it's final year, THERMOS is focusing on enhancing the user-interface and validation of the energy demand and network optimisation models to demonstrate it is fit-for-purpose and can be used with confidence. Final activities also include developing a comprehensive exploitation/business plan and sustainable adoption roadmap in order to maximise impacts within key target groups. These will help to ensure that the project's ambitions are realised and that sufficient momentum is achieved to leave a lasting legacy beyond the end of the project in March 2021.
Demonstrator site description	The THERMOS software has been developed with 7 European cities (comprising 4 pilot and 4 replication local authorites): Granollers (Spain), Cascais (Portugal), Islington (London, UK), GLA (London, UK), Jelgava (Latvia), Alba Iulia (Romania), Warsaw (Poland), Berlin (via dena, Germany). The extensive knowledge of the challenges facing thermal

	network planners of pilot cities has been used to develop the software reflecting these real world needs. Replication cities have been crucial for testing and using the THERMOS planning methodology and software and ensuring they are fit-for-purpose to quickly assess where to place new networks, and how best to refurbish existing ones.
How can cities use the technology?	THERMOS helps local authorities to identify climate mitigation actions by providing valuable information on district energy solutions which can reduce local GHG emissions and support cities in meeting their energy and climate reduction targets. It is freely available and web-based so can be used with standard 'office specification' computers. It is expected that users will most likely be local authority officers already familiar with their local area energy system, or by expert consultancies/agencies on their behalf.
Environmental impact	Not yet quantified
Project coordinator's contact details	Martin Holley martin.holley@cse.org.uk

3.70 Upgrade DH

Project name	**Upgrade DH**
Call identifier	2020-EE-2017-CSA-PPI
Type of action	Cooperation and Support Action (CSA)
Project logo	upgrade DH
Project website	www.upgrade-dh.eu
Amount of EU funding (in EUR)	1,999,667.50
Other public or private project funding sources	N/A
Replication/implementation potential	2**
What is it?	The overall objective of the Upgrade DH project is to improve the performance of inefficient district heating networks in Europe by supporting selected demonstration cases for upgrading, which can be replicated in Europe.
When can I use it?	It is a market uptake measure at TRL 8-9
Where can I use it?	On existing district heating networks
Why should I use it?	To save money in the long-term and to speed the energy transition up by improving the efficiency of existing district heating networks and introducing more renewable heat sources.
Project size	8 demo sites and replication cases in Bosnia-Herzegovina, Croatia, Denmark, Germany, Italy, Lithuania, the Netherlands and Poland
Summary	The EU project Upgrade DH supports the upgrading and retrofitting process of DH systems in different climate regions of Europe, covering various countries. The target countries of the Upgrade DH project are: Bosnia-Herzegovina, Denmark, Croatia, Germany, Italy, Lithuania, Poland, and The Netherlands. In each of the target countries, the upgrading process is initiated for concrete DH systems of the so-called Upgrade DH demonstration cases (demo cases). The gained knowledge and experiences are replicated to other European countries and DH systems in order to leverage the impact.
Project details	Core activities of the Upgrade DH project include the collection of the best upgrading measures and tools (see document here), the elaboration of a Handbook on the technical and non-technical approaches in DH upgrading processes (available in English and 6 other languages: Bosnian, Croatian, Danish, Italian, Lithuanian, and Polish), the support of the upgrading process for selected district heating networks, the organisation of capacity building measures about DH upgrading, financing and business models, as well as the development of national and regional action plans. In addition, an image raising campaign for modern DH networks is being carried out in the Upgrade DH project.
Demonstrator site description	Tuzla, Bosnia and Herzegovina – more details here: https://www.upgrade-dh.eu/en/tuzla-bosnia-and-herzegovina/ Middelfart, Denmark – more details here:

	https://www.upgrade-dh.eu/en/middelfart-denmark/ Sisak, Croatia – more details here: https://www.upgrade-dh.eu/en/sisak-croatia/ Marburg, Germany – more details here: https://www.upgrade-dh.eu/en/marburg-germany/ Ferrara and Bologna, Italy – more details here: https://www.upgrade-dh.eu/en/ferrara-and-bologna-italy/ Salcininkai, Lithuania – more details here: https://www.upgrade-dh.eu/en/salcininkai-lithuania/ Grudziadz, Poland – more details here: https://www.upgrade-dh.eu/en/grudziadz-poland/ Purmerend, the Netherlands – more details here: https://www.upgrade-dh.eu/en/purmerend-the-netherlands/
How can cities use the technology?	Upgrading measures can be replicated by any city with existing district heating network. The implementation can be facilitated through the handbook “Upgrading the performance of district heating networks” that outlines the upgrading process, non-technical aspects as well as technical upgrading options.
Environmental impact	Energy savings triggered by the project within its duration: 190 GWh/year efficiency savings which is about 13% efficiency increase Renewable Energy production triggered by the project within its duration: 291 GWh/year additional renewables integrated Use of residual/waste heat: 111 GWh/year waste heat integrated GHG emission reductions: 77,012 t CO2equiv/year
Project coordinator’s contact details	WIP Renewable Energies (DE), Dominik Rutz, dominik.rutz@wip-munich.de

3.71 WEDISTRICT

Project name	**WEDISTRICT**
Call identifier	H2020-LC-SC3-2018-2019-2020
Type of action	Innovation Action (IA)
Project logo	W.E. DISTRICT Heating & cooling solutions
Project website	www.wedistrict.eu
Amount of EU funding (in EUR)	14,972,852.64
Other public or private project funding sources	N/A
Replication/implementation potential	4****
What is it?	District Heating and Cooling decarbonization. Smart and local renewable energy district heating and cooling solutions for sustainable living.
When can I use it?	Some of the technologies will be ready for deployment after the project and other might need further minor study. Similarly, after the project, some demo sites will be ready for real use and others might require further development. Next table summarizes the current and expected TRL related to each technology and demo site:

TRL CURRENT POSITIONING (WEDISTRICT Technologies & Demo sites)	Start TRL	Expected TRL
Low cost parabolic trough collectors	5	7
Concentrated Fresnel based solar collector system with high efficiency	5	7
Advanced tracking concentrator for fixed solar thermal collectors	5	7
Low-pollution biomass boilers combining Selective Catalytic Reduction (SCR) and Non-Catalytic Reduction (SNCR)	5	7
Hybrid geothermal-solar DH system	6	7
Data Center Waste Recovery (DCWR) using a system based on solid oxide fuel cells (SOFC) technology	2	6
Molten Salts-based thermal energy storage (MS-TES)	5	7
Advanced absorption chiller with internal heat recovery	5	7
Advanced RES fuelled air cooling unit	5	7
Self-Correcting Intelligent District Heating and Cooling Management System (SCI-DHCMS)	5	7
Seamless integration of multiple RES sources and storage in DHC	**5**	**6-9**

	Alcalá demosite: TRL 7 Bucharest demosite: TRL 8 Kuznia-Raciborska demosite: TRL 9 Lulea demosite: TRL 6
Where can I use it?	One of the main objectives of the project is to optimize local renewable source, therefore such RES availability would be the first limitation (we are working with solar, biomass and geothermal systems mainly). It might be implemented in both urban or industrial areas (for solar systems, available free area should be needed). In general, since the project develops and integrates a set of different renewable solutions, it could be concluded that its application is practically suitable for any new or existing district heating and/or cooling network. WEDISTRICT project is flexible enough to be exploited in the different geographical regions in Europe.
Why should I use it?	Responding to the EU's Heating and Cooling Strategy (2016), WEDISTRICT proposes the development of clean, smart and flexible district and cooling systems as a tool for reaching the EU climate goals. The wide range of proposed technologies, covering a broad set of potential RES and consumer combinations, enables a significant reduction in the dependency on fossil fuels almost in any district heating and cooling scenario. There are many benefits of the project solution, some of them would be: - Drastic reduction of fossil-fuels dependence - Greenhouse and air pollutants emissions are clearly reduced - Better valorization of local resources, like renewable and waste heat - Improvement of DHC energy efficiency - Confident renewable energy dispatchability - Flexibility to combinate different renewable solutions for heating and cooling needs as well as prosumer model integration - Ease of replicability and scaling of the system - Operators and users might benefit from lower installation and running costs thanks to the enhanced technologies and new business models. - Improvement of the attractiveness of renewable district heating and cooling systems
Project size	Alcalá demo site (New District heating and cooling network): - R&D CEPSA Technological center connected (13,523 m2 according to Cadastral data, distributed in laboratories, auditorium, offices and dinning hall). There are 77 employees working at this building. - The power plant will be constructed at 300 meters from CEPSA building composed of two lands with a total surface of 4,442 m2.

	Bucharest demo site (Extension of existing district heating network) - Renewable Energy Sources laboratory as target building (549.3 m2). - Regarding the building uses, the main part of the ground floor is dedicated to the experimental installations and equipment. In addition, we can also find at the ground floor a meeting room, a kitchenette, and a restroom. The first floor is occupied by 3 offices. Finally, the basement in the underground is partially used as warehouse. - The building is used for both teaching and research activities. The constant occupants, implied in research activities, is 6. The number of students implied in laboratory activities in the building is variable, therefore we considered a mean total value (both researchers and students) of 10 occupants throughout the calculations. Kuznia Raciborska demo site (Existing District heating retrofitting) - 20 buildings are currently connected to the district heating network (1 school, 1 commercial building and 18 residential buildings) with a trench length of 1400 m. The plan goes beyond WEDISTRICT project and foresees additional sources, WEDISTRICT will contribute with 1.3 MW (around half of total consumption) of combined renewable sources. Lulea demo site (Waste heat recovery from Data center to existing district heating) - 1 Data center with 15-30 kW solid oxide fuel cell
Summary	WEDISTRICT main ambition is to demonstrate the viability of renewable based DHC implementation at large-scale in Europe, through a number of success stories or demonstration projects distributed across Europe, as the best possible tool for raising investor and customer confidence, and facilitating the more widespread use of renewable district energy. The targe 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 9 upgraded renewable energies solutions for DHCs generation 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 citizens engagement.

In order to be at the forefront of the race to renewable heating and cooling, WEDISTRICT builds over series of beyond the state of the art initiatives:

- Combination of multiple renewable energies and thermal storage into one single DHC system to guarantee a secure, balanced, 100% renewable supply, dispatched when needed.
- Smart technologies integration to orchestrate efficiently between production, storage and demand and to go ahead peak demand thanks to the inclusion of accurate weather forecast and prediction skills with machine learning models.
- Deployment of a number of innovative renewable generation technologies, exploiting a comprehensive set of renewable sources (solar, geothermal, biomass, waste heat), progressing towards higher efficiencies at lowers cost to promote fast large replication in Europe.

Project details

RES Technology	Approach
Parabolic trough Collector	Different technologies of large-scale collectors and advanced hydraulic concepts, which are especially designed for huge collector arrays, to demonstrate solar thermal as a cost-effective solution
Fresnel panel	
Tracking concentrator for fixed solar thermal collector	
Low pollution-biomass boiler	The improvements will focus on reducing pollutants, both, GHG emissions due to higher combustion efficiencies and selective use of biomass sources; and NO_x removal through Selective Non-Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR) techniques.
Hybrid solar geothermal DH system	The result is a system in which outputs of each technology are highly complementary to one another and carry the potential to increase energy efficiency and cost effectiveness of individual components.
RES air cooling unit	Innovative and versatile free cooling technology, to install in building, able to produce cooled air using diverse sources of renewable heat and easy to make compatible with any kind district heating system to complement DH with cooling application.
Advanced absorption chiller with internal heat recovery	The focus is to enhance the performance of the current absorption chiller system. The ultimate goal is to validate a technology that allows the combination of District Heating and Cooling in a single infrastructure development, yielding to higher efficiency, and viable for large-scale implementation.
Recovery of low temperature waste	The strategy here is to valorise residual data center energy through the utilization

heat from data centers with fuel cells	of cutting-edge technology based on the integration of fuel cells. The key advantage of FC is that can boost the low-T waste heat from the Data center to higher temperatures than the heat pump. In addition, the integration of FC allows for cogeneration, since FC produce electricity (that will be used to power the data center) and heat (to be supplied to the DH grid).
Molten Salts-based thermal energy storage	The integration of a TES system based on molten salts (widely used in thermal solar plants producing electricity) into a DHC system can represent a technically and economically viable approach, taking advantage of two premises: - Massive storage density of Molten salts allows to design tanks up to 20 times smaller when compared to other storage technologies such as water-based. - MS-tank can act as a boiler itself, avoiding the use of fossil fuel boilers to cover demand peaks.
Self-Correcting Intelligent District Heating and Cooling Management System	ICT structure will be the brain of the energy management system, providing the optimal integration of all the DHC components. Technological progress will focus on trialing for the first time in DHC sector IT features such as machine learning for demand prediction, artificial intelligence for management support, SmartSCADA with GIS maps and automatization of procedures.

The overall WEDISTRICT business modeling approach will implement some of the key principles and guidelines from the DHC+ Technology platform Digital Roadmap for District Heating & Cooling (2018). The coupling of RES with DHC infrastructures will bring the following key benefits and value-propositions (VP):

- VP1 : Better prices and quality of service for DHC customers
- VP2: Relocated energy production and optimized investments for local communities
- VP3: Enabled global energy transition and new services for the larger community

Besides this, RES-integration in DHCs business models are also affected by political context)

- Countries with extensive DHC infrastructure fossil-based and old building stock (they need retrofitting in buildings + DHC)(e.g. Romania, Poland, Hungary)
- New comers to DHC networks or with a small number of installations (e.g. Spain, Portugal)

	• More experienced countries in RES integration (e.g. Scandinavian, Germany, Austria) WEDISTRICT will engage with citizens and listen to their concerns of heating and cooling to make them aware about the issue and personal benefits of the new approach of WEDISTRICT in order to eventually gain their support for its technology and implementation. To foster the dialogue with these end-users, an awareness campaign will be conducted in the local languages to secure maximum reach and acceptance.
First demonstrator site description	Four demosites will be implemented in the project: **Alcalá:** The city of Alcalá suits perfectly with 100% Renewable supply of heating and cooling. The sustainability is at the heart of this DHC, so the "localness" of the resources is a key parameter. Spain is one of the most attractive countries with regard to the development of solar energy, as it has the greatest amount of available sunshine of any country in Europe. The Direct Normal Irradiation in Alcalá de Henares is about 1800 kWh/m2/year, which makes the concentrated solar technology a promising solution to match effectively with the heating demand of buildings, and to cover the cooling demand through absorption chillers. Furthermore, the biomass is available on regional scale and WEDISTRICT will firmly value the pruning of the trees, being a model project of a circular economy. The CEPSA Research Center was selected as a representative building for the WEDISTRICT project in Alcalá de Henares. Currently, only this building is envisaged to be supplied by the proposed energy concept, however it would in principle possible to connect more buildings to the network in the future. This is why the system will be referred to as a District Heating and Cooling system. The building was constructed in 2008, with a total area of about 13,500 m^2, distributed in laboratories, an auditorium, offices and a dining hall. The current energy sources are gas and electricity, and the current installations include: • **3 Natural gas boilers of 378 kW each one (in total 1137 kW).** • **2 chillers of 646 kW each one (in total 1292 kW).** The site will have different technologies each of them proposing novel approaches to optimize in costs and effectiveness the DHC solution. Alcalá Demo site will incorporate: • **Concentrated Fresnel collectors delivering heat at 250 ºC (0.18 MWth)** • **Parabolic collectors around 220 ºC (0.25 MWth)** • Tracking Concentrator for Fixed Tilt Collector **delivering heat at around 100 ºC. (0.25 MWth)** • **Biomass boiler with selective scrutiny of biomass sources and catalytic and non-catalytic**

	depolluting technologies. Heat is expected to be delivered at about 215 °C. (1MW) • **Renewable air-cooling unit (RACU), using a desiccant indirect evaporative cycle (10kWth)** • **Advanced absorption chiller (100 kWth)** • **Conventional absorption chiller (700 kWth)** The system will also count on two Thermal Energy Storages (TES). A molten salt energy storage system (30 m3) will count on state-of-the-art design, accompanied with innovative salts compositions. A water storage tank will be designed to reduce the heat losses and optimize its volume. The project is expected to demonstrate that renewable sources are capable of satisfying 100% necessities of cooling and heating demand in a District Heating and Cooling project.
Second demonstrator site description	**Bucharest:** The demonstration project will be performed at the University Politehnica of Bucharest. In particular, the Renewable Energy sources Laboratory will be used as target building for the case study, consisting on the validation of a new heat supply based on renewable energy. The UPB campus is spread over 60 hectares while the electricity and heat demand for all buildings is currently assured by a CHP plant. The target building was chosen as a case study because it represents an example of an inappropriate supplied consumer. The current system has several challenges namely, consumers at the end of branches do not have the full supply temperature. The situation was worsened by new consumers added in recent years. Moreover, it is envisaged to expand the current campus district heating network. In order to eliminate the deficiencies in the thermal energy supply of the target building and to ensure the thermal comfort conditions, an optimal combination of two solutions (geothermal and solar) based on renewable energy in a hybrid scheme is proposed. The expected peak demands for the entire building are 60 kW for heating and 43 kW for cooling. The proposed system will be based on locally available renewable energy: • Geothermal energy: **which** will be built around a geothermal heat pump system, estimated to deliver up to 60 kW of heat**. A water storage system will be integrated.** • Solar energy**: PV (around 220 m2) modules for electricity generation and PVT (around 4.5 m2) modules for thermal generation oriented to satisfy DHW needs and electricity generation which will complement the PV installation. This power generation unit will be based on a (estimated) 20-30 kW photovoltaic array. The**

	energy produced will be stored in a battery storage system. In order to increase the energy efficiency of the system, the cooling of the building will be provided by a passive cooling system. By implementing the proposed WEDISTRICT solution, at the target building level, an estimated reduction of over 80% of energy produced from fossil fuel will be realized. A proportional reduction of CO_2 emissions will be also recorded. The aim of the Demo Project is to: • generate three forms (electricity, heating and cooling) of energy based on renewable energy sources, in which the electricity produced will cover the consumption of entire demo; • fully cover the heat and cooling demand for the target **building;** • inject the overproduction of energy (power and heat) into local grid and local heating network; • develop a modular concept that will ease the process of replication and scaling.
Third demonstrator site description	**Kuznia-Raciborska:** Kuźnia Raciborska is a town in Southwest Poland of 31.75 km^2, with a population of 5,359 inhabitants and a District Heating system with 3.96 MW installed (coal-based) heating capacity. The heating sources consist of one 360 kW coal boiler working for the domestic hot water production and two 1,8 MW coal boilers working for heat production. 20 buildings are currently connected to the district heating network (1 school, 1 commercial building and 18 residential buildings) with a trench length of 1400 m. The plan goes beyond WEDISTRICT project and foresees additional sources, WEDISTRICT will contribute with 1.3 MW of combined renewable sources (biomass and solar). Within WEDISTRICT phase, more than 50% of RES share will be implemented. The main challenges in the system are high CO_2-emissions and air pollution. The system needs to comply with the requirements of Directive (EU) 2015/2193 - the Medium Combustion Plant Directive (MCPD). Moreover, by connecting other users to the network the system could support decreasing the pollution from individual energy sources. The design of WEDISTRICT new heat source will include two biomass boilers 2x500 kW to provide flexibility and cover the energy demand. Additionally, the integration of PV panels (up to 100 kW_e) cooperating with a, air-to-water heat pump (up to 300 kW_{th}) is also considered, mainly for DHW purposes in Summer period. Extraordinary electricity surplus would be directed directly to the external power grid if necessary, when particularly favourable weather conditions, fulfilling the prosumer concept. The project will be a good example for other small networks using fossil fuel which are facing similar challenges across

	whole Europe. The replication scale could be very significant, as for example in Poland about 87.5 % (463 out of 529) district heating systems do not achieve the status of an efficient district heating and cooling system.
Fourth demonstrator site description	**Lulea**: Luleå holds an extensive and mature district heating network which is heating over 31000 households, where the main part is generated from burning excess gas form the local iron ore and steel plant with a maximum heating power output of about 200 MW. The Luleå demo site is an innovative set-up to harvest the excess heat from a fuel cell powered data center using a renewable source of energy that is converted into thermal energy both at the production of electricity in the fuel cell and the provision of digital services from the IT systems. The demo site is to be constructed from new. Since this project has the intention to use the waste heat from the fuel cells to provide heat to a district heating system operating in the design temperature range of 70 – 120°C, the solution requires the fuel cells to operate at high temperature, as Solide Oxide Fuel cell. The aim is to operate the data center primarily on power generated by the fuel cells and transfer excess heat into the district heating system. This will be achieved using a CO2 neutral biogas, “green” energy that will replace fossil-based fuels to co-generate heating and electricity, while undertaking digital processing. With 30kW of electrical power produced by the fuel cells, the thermal recovery for the demonstrator is estimated to produce a maximum of 15.5 kW of thermal power at a temperature range between 74°C and 115°C. To overcome challenges of deploying small data centres in urban areas, the proposed demonstration will provide a solution with low noise, small energy conversion losses, minor electrical grid demand (as most electricity is produced by the fuel cell) and little contributions to the urban heat island (most thermal energy will be captured for supply to the district heating network).
How can cities use the technology?	WEDISTRICT real implementation depends on local regulations in the terms on licenses, building works, utilities connection, etc., following the same steps than a conventional district heating and/or cooling installation.
Environmental impact	Depending on the current status and boundary conditions, WEDISTRICT project is able to reduce energy consumption and CO2 emissions from 50% to 100% (considering that WEDISTRICT technologies are 100% renewable-based). In particular, Alcalá demosite will reduced 100% of the focused building needs, Bucharest at around 85% and Kuznia-Demosite at around 50% considering the whole district heating consumption.
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