FLEXYNETS

Newsletter

FLEXYNETS is a Horizon 2020 European Project coordinated by EURAC, a scientific research centre based in Bolzano-Bozen (Italy). Traditionally, district Heating and Cooling (DHC) networks distribute energy from a centralized generation plant to a number of remote customers. As such, current DHC systems suffer from heat losses and fail to explore the potential of integrating other available energy sources into the network. FLEXYNETS will develop, demonstrate and deploy a new generation of intelligent DHC networks that reduce energy transportation losses by working at "neutral" (15-20°C) temperature levels. Reversible heat pumps will be used to exchange heat with the DHC network on the demand side to provide the necessary cooling and heating for the buildings.
Five other partners join EURAC on the project: Acciona (Spain), a large company with dedicated energy departments; zafh.net (Germany), a research centre at the "Hochschule für Technik" of Stuttgart; Solid Automation (Germany), a company specialized in control and monitoring design; PlanEnergi (Denmark), an engineering office specialized in district heating; and, Soltigua (Italy), a producer of concentrating solar collectors.

EDITORIAL

What is Innovation?
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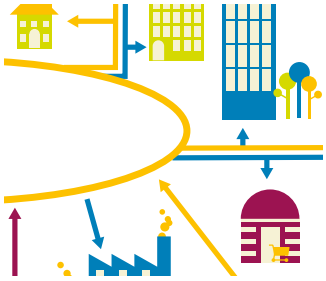
5th GENERATION DHC NETWORKS



Climate change is a fact: average temperatures have raised constantly in the last century and planet earth is suffering extreme condition, especially in the temperature **... read more**

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- **12th Heat Pump Conference** (15-18.05.2017, Rotterdam, Netherlands)
- **IEA-SHC Task 55 - Towards the Integration of Large SHC Systems into District Heating and Cooling (DHC) Network** (Billund, Denmark)

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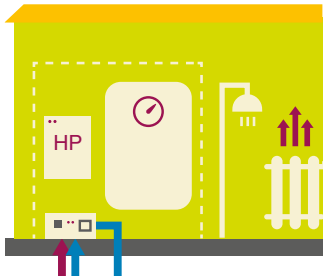
A TECHNICAL INSIGHT



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EDITORIAL

What is Innovation?

When we think of innovation, what first comes to someone's mind is the idea of a technology that will change our lives forever. Innovation is seen as a big step forward into the future, something that will change a paradigm, turning what was used before into something obsolete.
For example, one can say the biggest innovation in the last decades has been the internet. Moreover, if we think of the greatness of the system, we certainly can say that we experienced a revolution in the communication sector.
Carrier pigeons have been the most reliable and fast way to exchange information until the creation of the telegraph first, the radio and the telephone afterwards. They have been used until the end of the Second World War to carry strategic messages. Considering this, in the last half of a century we faced an incredible revolution in the way human beings reach each other.

This revolution has not been part of a single discovery, rather of an incremental and immense effort of illuminated minds that worked with the ideal of connecting people in order for them to communicate without boundaries.
We do not fully understand how human kind switched from carrier pigeons to smartphones, but it happened. This is exactly what I mean when I am thinking of innovation: a process.

Precisely, an incremental process citing Sir Isaak Newton: "If I have seen further it is by standing on the shoulders of Giants". We can define innovation as an original combination of already known and used (read reliable) technologies.
This is the strategic vision of FLEXYNETS, a project that will include and integrate a number of known technologies.
The main issue related to older generations district heating and cooling networks is that they work with high temperatures and have problems to limit heat losses. In order to minimize these, DHC networks pipelines need a thick isolation, which is part of the high investment costs. Even with insulation, thermal losses are still high.

Thereof, the main idea is: why do we have to warm water at 90°C in a centralized plant, when we could distribute water at a neutral, ground temperature and then heat it when it is necessary by using heat pumps?
Moreover, why could we not recover into the same network the waste heat from industrial processes – even at low temperature, 30°C –, supermarkets refrigeration, and also tertiary and residential buildings air-conditioned at summertime?
FLEXYNETS elaborates on the integration of heating & cooling technologies into substations that interact into a flexible and wisely operated network.

These are the features of what we called a fifth generation of district heating networks.
Innovation is also strictly linked with the concept of integration. A system that could integrate with older ones and coexist with them, improving their performance and reducing costs is a potential winner.

FLEXYNETS networks can be set up as a new system but it can also be integrated into older generation district heating networks. FLEXYNETS can be driven by means of the return flow of a conventional DH network. The performance of the existing network boosts and a larger amount of customers can be reached with limited additional investments for the energy utility.
Moreover, FLEXYNETS solutions integrate a range of heating and cooling technologies, being on the other hand "application agnostic": the solutions do not concentrate on any specific building category nor customer. This allows decision makers and network designers to identify the most suitable combinations for their specific cases.

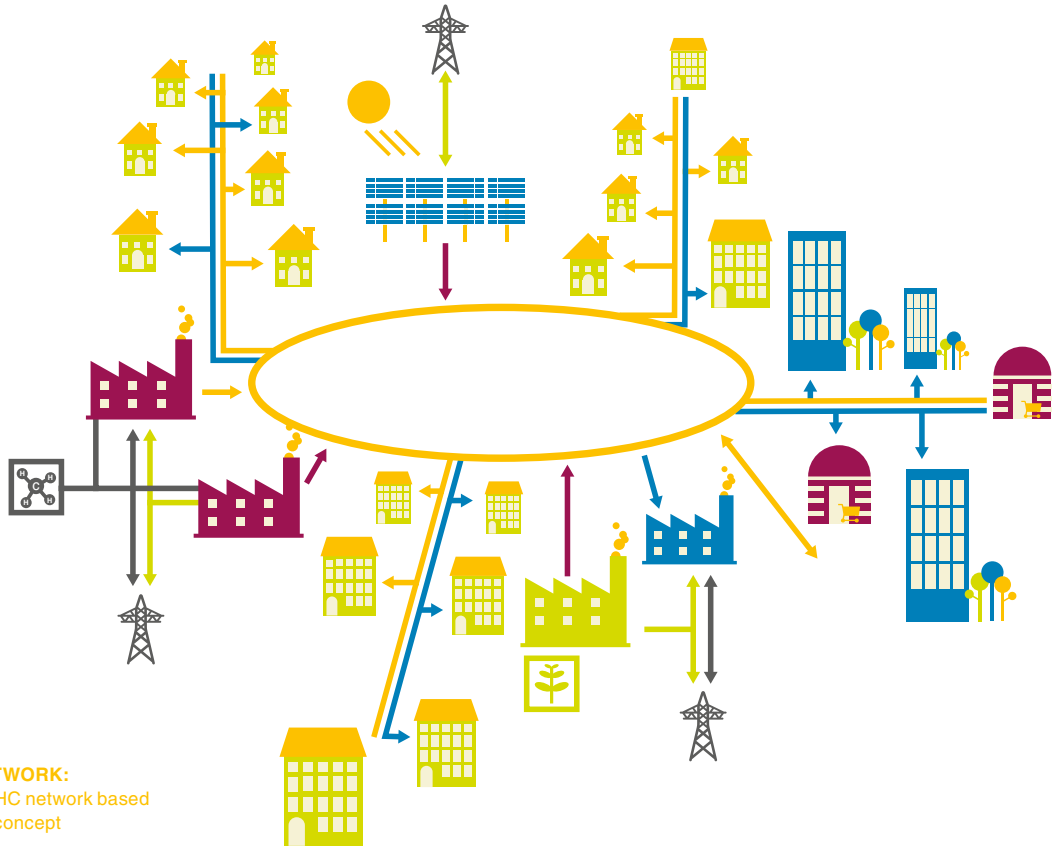
Overall, innovation is the word characterising the project consortium: all the members are real innovators in their respective fields of operation and their expertise and knowledge are crucial in order to find a concrete way to market of FLEXYNETS concepts.

Roberto Fedrizzi (EURAC), Project Coordinator

FLEXYNETS Geographic Connotation

Climate change is a fact: average temperatures have risen constantly in the last century and planet Earth is suffering extreme conditions, especially in the temperature peaks, that are increasing in both ends of the range. We are experiencing hotter summers and peaks of high temperatures, unusual at every latitude, particularly in the northern hemisphere.
Over the next decade, space-heating needs will decrease thanks to new energy efficiency measures in buildings, but we will most likely experience higher energy demands for cooling. Heating in buildings and in industry is by far the largest source of energy demand in Europe; however, cooling demand is growing rapidly, on the one hand as a result of the air-conditioning needs of the southern regions, and on the other hand, due to the growth of the food conservation market in northern countries.
Depending on the geographical location, the period of the year and the type of city (for example, a small village or a large city with industrial and commercial areas), heating loads can prevail over cooling needs, or vice versa. Therefore, heating and cooling loads coexist in the built environment, which offers the opportunity to partially balance one with the other.
FLEXYNETS assumes this as a simple fact, focusing on the need to recover the waste heat that technologies produce for cooling and refrigeration.

Generally speaking, older generations of district heating and cooling networks are designed to operate at higher water temperatures with cooling driving sorption chillers. This results in increased front-end costs and an inefficient carrier fluid distribution.
By using a carrier fluid that works at “neutral” temperature levels – between 10 and 25°C – heat pumps and chillers can simultaneously exchange heat and cold on the same DHC network pipeline. Therefore, any waste heat from chillers in the network can be effectively reused by heat pumps placed along the network and the loads will partially balance one another.
In southern European countries, where air conditioning is more common, rejected heat from residential buildings can essentially meet their domestic hot water needs during the summertime. This is extremely interesting if we think that waste heat from commercial and industrial applications can potentially also be added to this analysis.
This is a major change of paradigm, rendering DH technology attractive in climates where both heating and cooling is used. Moreover, the increased energy efficiency of the network means lower prices for users and higher profit margins for energy producers and providers.



FLEXYNETS NETWORK:
Hypothesis of a DHC network based on the water loop concept

FLEXYNETS CO_2 Emissions Reductions

Sustainability is a concept that has a powerful significance in FLEXYNETS: we think that contributing to lower the emissions of CO_2 related to the operation of our buildings is one of the primary ways to respond to the challenges of the climate change.
FLEXYNETS is a project that has the potential to address the southern markets, because of its high adaptability to such climates. However, the diffusion in the northern ones is also to be regarded, as a consequence of the increased cooling demand in the next years, mostly in the tertiary sector. By offering a systematic solution for providing both heating and cooling as one of the primary objectives, FLEXYNETS addresses highly unexplored markets in the southern countries, in addition to the usual ones. A huge market is offered for example by three large countries like Spain, Italy and France accounting for about 170 millions of citizens overall (35% of the total EU-28 population), 25% of the demand for heating and domestic hot water preparation (800 TWh/y only in the residential and office sectors) and 50% of the cooling demand (24 TWh/y again in the residential and office sectors) over Europe.

Extrapolating how much of this market can actually be addressed in the short-medium term is a hard task, since statistics are weak and only 5% to 7% of the population is served by district heating networks so far in the 3 countries mentioned. Assuming a Business as Usual scenario (5% growth rate per year), around 3% of the population (5 to 7 million people) could be reached by the FLEXYNETS solutions between 2020 and 2030.
This would results in Primary Energy savings for heating and cooling of 800 TWh/y * 3% * 50%, that is between 12 TWh/y. The cooling PE savings could be 24 TWh/y * 3% * 60%, resulting in 0.4 TWh/y. Note that the savings on the cooling demand are largely underestimated, since the calculation is made on today consumptions, whilst they are foreseen to grow between here and 2030. FLEXYNETS emissions reduction corresponds to space heating needs of three to five millions houses with a surface of 100 square meters, depending on their period of construction and insulation level.

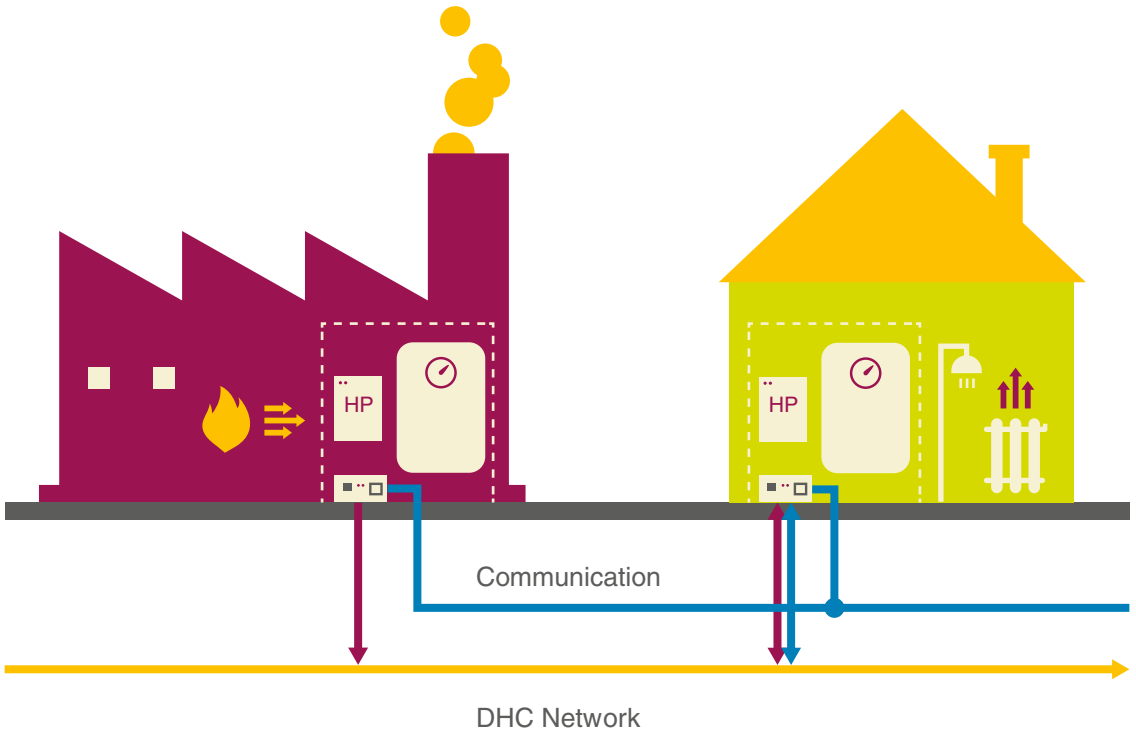
FLEXYNETS Economic Considerations

The FLEXYNETS concept reduces investment costs, since cheap, easy-to-install, plastic pipes can be used to distribute the carrier fluid. Moreover, the integration of multiple heat sources and heat sinks all over the network path increments the profitability per unit length of pipe installed. For example, moving from pre-insulated pipes (PE-Xa with surrounding polyurethane foam, presently used for water up to 95 °C) to standard water pipes in PEX would decrease the cost of piping – which is of the order of 25-35 % of total DHC installation costs – by almost 80 %. Assuming that pipes costs cover around 50% of the overall pipelines installation, that results in roughly 40% reduction of the upfront cost for the network setup.
Moreover, the scalability of FLEXYNETS solutions – from serving a small cluster of buildings up to an entire city – makes them suitable for single city quarters; they do not require large infrastructural investments and complex political decisions that involve the entire urban environment.
Finally, besides the environmental benefits, the energy savings correspond to lower expenses for energy bills for users. In addition, FLEXYNETS creates a broad range of profit opportunities on a newly setup heating market for heat producers and suppliers and for single customers, increasing their contractual strength
Taking only Spain, Italy and France as examples, and bearing in mind the current prices of gas and electricity, savings in the range of 1.5 B€/y and 4 B€/y can be obtained for heating in the residential and office sector. Between 30 M€/y and 80 M€/y can be saved with respect to the cooling demand.
We must also account for profits related to the sale of heat from waste and Renewable Energy Sources. Actual sale prices of waste heat range between 10 and 40 €/MWh. Assuming frozen prices until 2030 and minimum 50% of waste or renewable heat entering the DHC networks, a “heat stock market” ranging between 150 and 400 M€/y can be foreseen. These profits are largely shifted from gas providers to the European industry. Furthermore, this will result in new highly qualified jobs.

FLEXYNETS Substations

While a neutral temperature network is FLEXYNETS' cornerstone, the interaction with the built environment is guaranteed through substations.
Despite the clear advantages related to multiple players providing thermal energy to the network, the practical achievement of this objective poses relevant practical challenges.
This is due first to the fact that, engineering offices, factories' and buildings' energy managers do not know which are the opportunities, technical needs and performance of systems possibly used to exchange energy with a DHC network.
By elaborating Production and Utilization Substations, FLEXYNETS aims to develop and demonstrate a set of units capable of generating, storing providing and/or drawing energy to/from the DHC network. Since a wide range of devices (i.e. ORC engines, heat pumps, sorption chillers, storages, etc.) are nowadays market available, the elaboration will concentrate on the integration of such devices.
From the energy production point of view, indications will be provided on the sizing, control and utilization of each Substation based on the application (e.g. industrial process waste heat) and its energy availability and the energy needs of the network. Flexible solutions will be studied that grant effective operation even in case such parameters are modified with time. Local storages will be key in this design, since Production Substations are foreseen to exchange thermal energy on request of the utility company managing the whole network.
From the prosumers' side, Utilization Substations move from actual hydronic units entailing a small domestic hot water storage already developed by big players in the heating and cooling market. In addition to this concept, the use of invertible heat pumps will be considered as already mentioned, both drawing and providing waste energy to be reused elsewhere: hence consumers turns into prosumers, by selling energy to the network. Nowadays, on-the-shelf heat pump solutions can be retrieved producing warm water up to 65°C. In case this temperature is not sufficient to feed radiators, hybrid solutions using the installed gas boiler to cover peak loads will be considered.

FLEXYNETS SUBSTATIONS
Examples of substations exchanging heat with the DHC network



FLEXYNETS-Planning

The innovative idea of FLEXYNETS needs to be validate and for this reason, the project will simulate different networks, substations, buildings, climates and latitudes. FLEXYNETS will investigate different configurations of a District Heating and Cooling network, where heating and cooling supply can be as distributed as the consumers. In this way, it will be able to provide recommendations for the replication of such systems depending on the boundary conditions. The investigation aims to consider the following:

- Locations (weather conditions throughout the year)
- Distribution of energy demands for heating, cooling,domestic hot water and electricity
- Distribution of temperature requirements for heating, cooling and domestic hot water at prosumers' side

Recommendable configurations of the following parameters will be provided:

- Size, type and number of the energy (heating, cooling and electricity) generation units along the network and supply temperature levels
- Size, number and type of the storages used
- Temperature set points of the thermal carrier fluid in the DHC network and insulation thickness of pipes
- Size, topology and pathway of the DHC network through the built environment.

FLEXYNETS-PLANNING integration solutions will be assessed as a deliverable of the project, disclosing how multiple energy generation sources have to be included into a DHC network. The principles of BALANCING the thermal fluxes and improving FLEXIBILITY in terms of types and number of loads covered by DISTRIBUTING energy supply and use along the network will guide the planning.
As already stated, research projects are in progress demonstrating the possible integration of multiple energy sources into a DH network at temperatures down to 40-50°C, or multiple sinks exploiting energy sources with temperatures down to 0°C. Besides, the effort is almost completely devoted to develop solutions for heating and domestic hot water preparation.
However, all the work done until now only solves part of the puzzle. The integration of sources and sinks, supplying and exploiting thermal energy at temperatures from 250°C to 10°C, by means of a network based on a water loop topology allowing contemporary utilization of the same pipelines for heating and cooling purposes, is far from being understood: work starting from the conceptual stage is needed.
Therefore, FLEXYNETS-PLANNING solutions will move from the concept to the preliminary planning (sizing of the components), through the energy performance assessment by means of simulation work, to the validation in the emulated environment for a number of climates and built environments, in a dedicated pilot laboratory.

Recommendations for Optimal Configurations

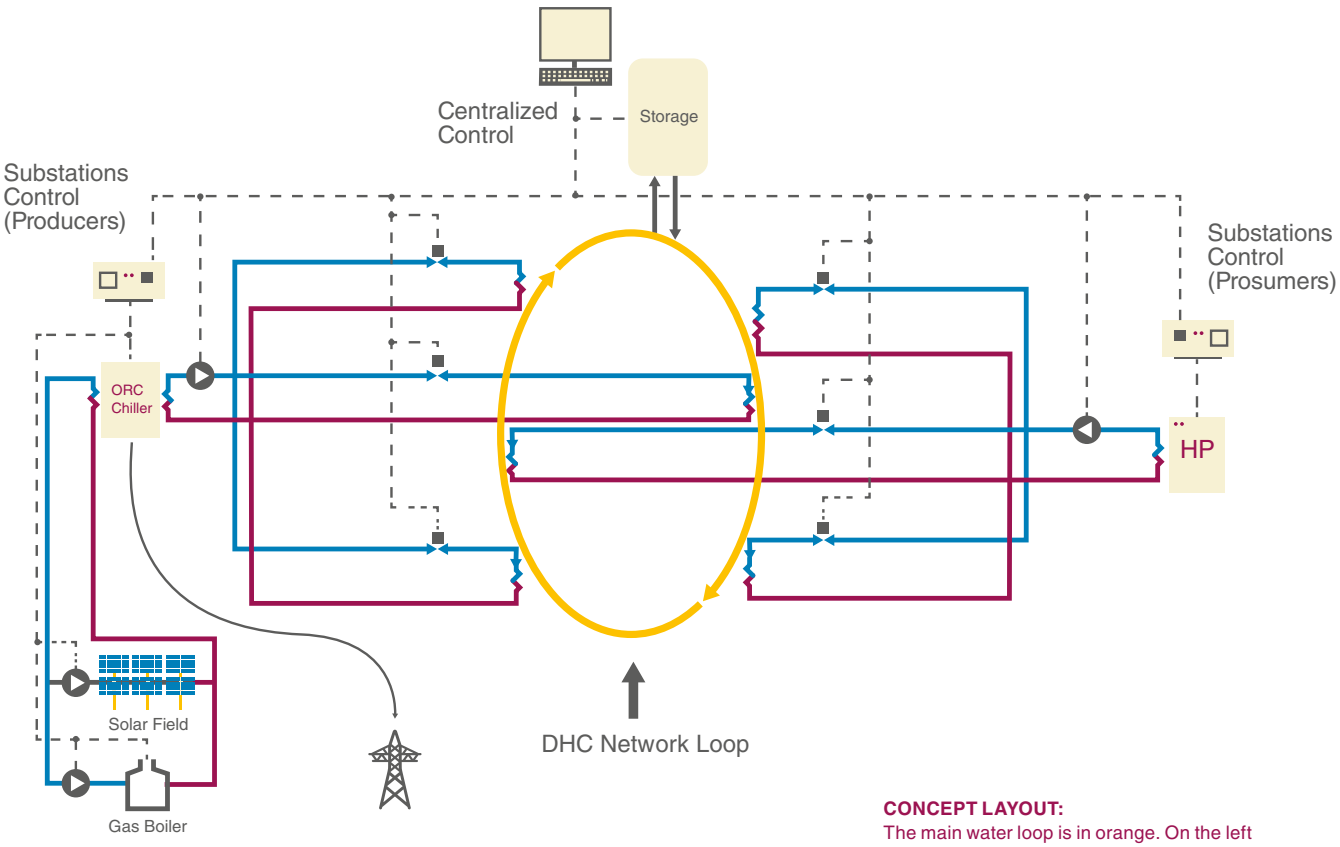
The work done in FLEXYNETS will be analyzed and filtered in order to extract simple but reliable, practical results to be presented to urban planners and heating and cooling engineers. This will provide crucial content to be moved from research to real life, exploiting the possibilities shown in the project.
A database of planning solutions will be generated and the results will be used to develop a software tool to support the pre-design of low-temperature DHC networks. The tool will be made available online on the project website by the end of the project.

A TECHNICAL INSIGHT

The Laboratory Infrastructure is on the Way!

In March 2016, the FLEXYNETS team has appointed the company that will build the new laboratory infrastructure. The construction works of the laboratory will be completed within the summer.
The infrastructure – co-financed by the Province of Bolzano (Italy) and the European Commission – is expected to be operative since autumn 2016.
The laboratory will be installed in the new area of the technology park located in the industrial zone of Bolzano http://noi.bz.it/en
The laboratory infrastructure, reproducing a small-scale District Heating and Cooling network, will help the researchers to reach the goal of solving technical and technological issues related to the operation of the innovative district heating and cooling concept developed. In fact, the concept has to be validated under controlled real-like conditions after the numerical analysis finishes.

The infrastructure will include a water loop designed to distribute water at temperatures from 5 to 95°C. Besides the piping, the laboratory will include a small tri-generation system driven by a gas boiler and a solar thermal collector field, and reversible heat pumps simulating the network users.
The laboratory will allow to emulate different load/generation profiles: it will hence be possible to analyze supply-demand and thermal storage relationships in the network, thereby evaluating the dynamics between users, prosumers and producers.
It is foreseen that the both the numerical analysis and the experiments will provide useful information to energy utility companies and city planners interested in developing DHC networks more efficient compared to the actual standards.



CONCEPT LAYOUT:
The main water loop is in orange. On the left side there is a tri-generation system (solar field and boiler, ORC motor, chiller), while on the right side there is a system based on heat pumps for the simulation of reversible users.

RELATED NEWS

4th International Solar District Heating Conference

The fourth edition of the International Solar District Heating Conference will take place on 21 and 22 September 2016 in Europe's No.1 SDH market in Denmark. The Conference will focus on sharing the international experience on system concepts and technologies for large-scale solar heating plants and their integration into district heating networks. Market actors and policy makers from countries with new and developed markets will share their know-how and lessons learned regarding market preparation and support instruments. Moreover, experienced Danish operators will be available as SDH ambassadors and advisors during the whole event and will lead technical visits to one of the most modern Danish SDH plants in Gram.

For more information:
http://solar-district-heating.eu/NewsEvents/SDHConference2016.aspx

12th Heat Pump Conference

From 15th – 18th of May 2017 the International Energy Agency organizes its 12th Heat Pump Conference at the World Trade Centre in Rotterdam. A conference where the latest development and prospects in technology, applications and markets are shared with applied professionals.
The goal of the Conference goes beyond the traditional topics of energy efficiency, renewables and environment. It will focus on the main solutions and choices that has to be made not only on economics, but on the expectations on future energy situations where energy infrastructure is becoming more and more independent from insecure suppliers. This conference will highlight that Heat Pumping Technologies is one of the key technical solutions available.

For more information:
http://hpc2017.org/

IEA-SHC Task 55 - Towards the Integration of Large SHC Systems into District Heating and Cooling (DHC) Network

Solar District Heating (SDH) is in the early market development stage. Large solar thermal plants feeding into district heating networks represent only about 1% of the installed capacity of solar thermal systems, despite the fact that competitive prices lower than 40 €/MWh can be reached. In the long run, solar district heating could represent 4-15% of the total technical potential of solar thermal energy.
Today, the commercial application of Solar District Heating is spreading to several countries. In particular in Denmark, where SDH is operated at feasible heat costs and the building of plants is booming. SDH activities are also well underway in Austria and in the implementation phase in Germany, Italy, France, Spain and Norway.
This Task aims to develop technical and economic requirements for the commercial market introduction of solar district heating and cooling (DHC) for a broad range of countries. The activities aim to improve technological know-how, market know-how and understanding of the boundary conditions as well as to provide expert know-how for project initiation and implementation and for training. A key element will be the direct cooperation of SDH experts with associations and companies in the district heating sector as a means to bridge the gap between these sectors.

For more information:
http://task55.iea-shc.org/

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