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Low-carbon **Heating & Cooling**

Contents

Editorial

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Energy security and decarbonisation are the main energy goals of the European Union. The Low-carbon Economy Roadmap aims for a reduction in CO_2 emissions of 80% by 2050 and the Energy Security Strategy calls for a significant cutback in fossil fuel and uranium imports. These ambitious goals can only be achieved if the heating and cooling (H&C) sector is almost fully decarbonised, since it is the largest energy sector in Europe representing 50% of final energy demand.

Today only 18% of H&C demand is supplied by renewable energy sources (RES), while 75% is supplied by fossil fuels and 7% by nuclear power. In comparison, the RES share in electricity has already reached 27%, with a much stronger growth dynamic. Therefore a special effort is needed to stimulate the transformation of the H&C sector. The European Commission has recognised the need for stronger activities in the H&C sector and published its Strategy on Heating and Cooling in February 2016.

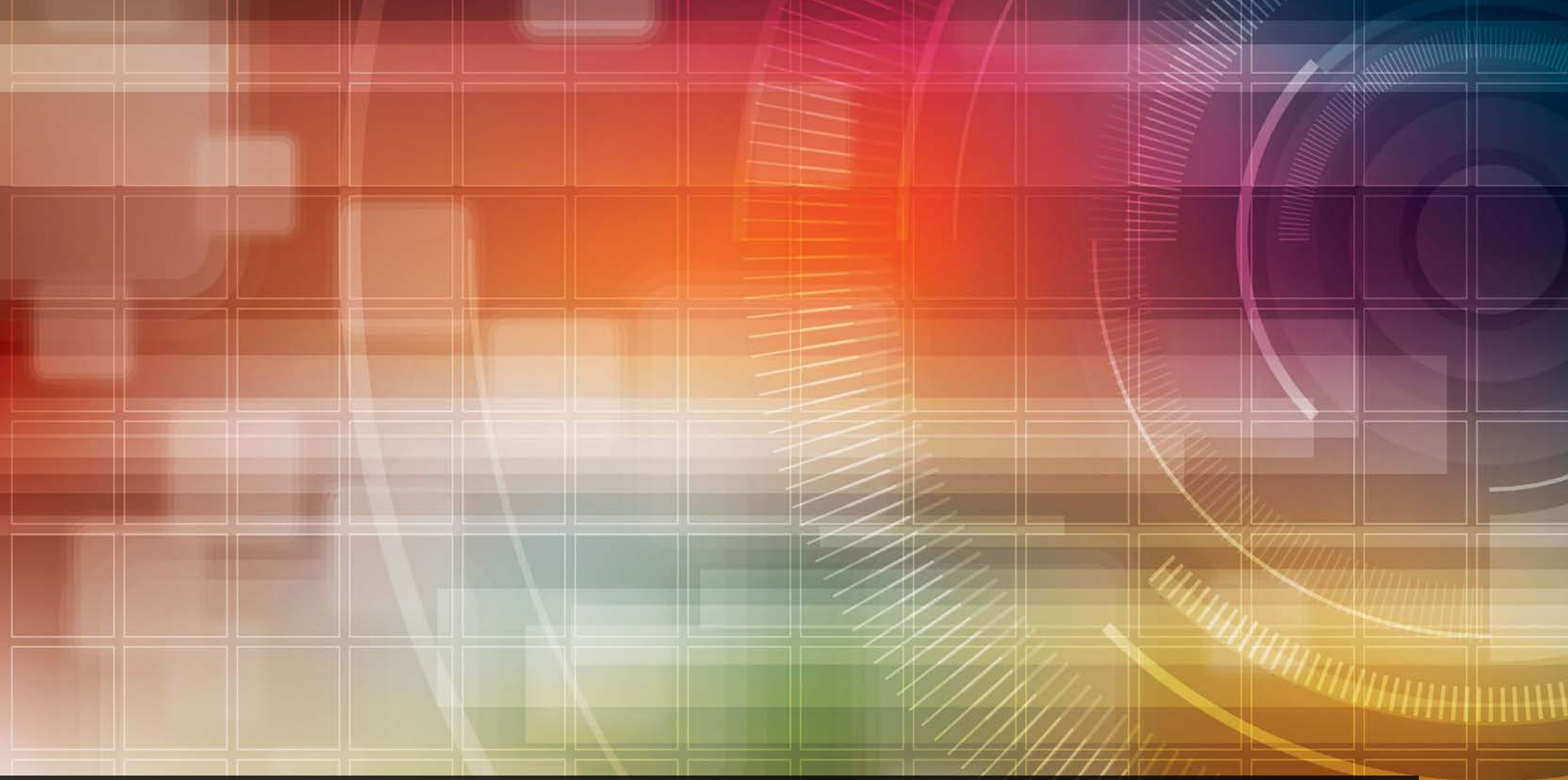
There are good reasons why the H&C sector has resisted decarbonisation up to now. At today's prices, heat generated from fossil fuels often costs less than heat generated by Renewable Heating and Cooling (RHC) technologies and RHC technologies often appear to be more complex than existing solutions in terms of design, installation and operation. In addition, the European RHC sector is very heterogeneous and does not have a unified infrastructure like the electrical grid. This situation leads to localised markets in the heating and cooling sector, which require decentralised, adapted support policies based on a good understanding of the H&C markets and their challenges.

In general, the transformation path for the H&C sector is clear. Efficiency must be significantly increased and a large share of the remaining H&C demand should be generated by RES, considering the ongoing debates in many Member States on the role of nuclear and carbon capture and storage in the future energy system. However, there are several uncertainties related to designing the future H&C system. Without a doubt, the level of energy efficiency, the share of district heating and the share of H&C generated by electricity from RES must be increased, but what is the optimal level at a given place?

The answers to these questions depend on local H&C market conditions and on the framework conditions, e.g. if cheap electricity from RES is definitely available during the heating season. This is the main reason why H&C systems should be optimised at city level as part of a smart city energy concept.

The role of RHC technological development should not be underestimated in implementing this transformation. Solar thermal and geothermal energy as well as biomass heating, heat pumps and cross cutting technologies like district heating, storage, cooling and hybrid systems have huge potential for technological development, which was neglected in recent decades. An analysis of the R&D projects funded by Horizon 2020 in 2014 and 2015 showed that, in full competition with RES electricity technologies, RHC technologies are rarely successful. Therefore, in order to unlock RHC potential and create a level playing field, a dedicated budget line for R&D on RHC technologies is necessary.

The need for action in the H&C sector is clearly recognised, and the technological scope of tasks to be implemented has been identified in the strategic research agendas and research roadmaps of the European Technology and Innovation Platform on Renewable Heating and Cooling (RHC-ETIP). Now is the time for policy-makers to focus on this sector and to take serious action.



SET-Plan Update

The European Strategic Energy Technology Plan (SET-Plan) aims to transform the way we produce and use energy in the EU with the goal of achieving EU leadership in the development of technological solutions capable of delivering 2020 and 2050 energy and climate targets.

The EU supports the development of heating and cooling (H&C) technologies through its Framework Programme for Research and Innovation and other mechanisms, and by creating the legislative and policy framework needed for these technologies to penetrate the market. The following is a chronological overview of some of the actions taken to support H&C research and the market uptake of H&C technologies in the EU, in addition to a more general look at recent actions in support of the SET-Plan.

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Heating & Cooling

- The European Heat Pump Association (EHPA) was set up in 2000. Its members comprise heat pump and component manufacturers, research institutes, universities, testing labs and energy agencies. Its key goal is to promote awareness and proper deployment of heat pump technology in the European market place for residential, commercial and industrial applications.
- The European Technology Platform on Renewable Heating and Cooling (RHC-Platform) was created in 2008, at the initiative of the European Commission, to bring together over 600 industry and research stakeholders representing all renewable energy technologies for heating and cooling. The Platform's mission is to provide a framework for stakeholders to define and implement a strategy to increase the use of renewable energy sources for heating and cooling, and to foster the growth and competitiveness of the relevant industries.
- In its 2009 Directive on the promotion of the use of energy from renewable sources (RES Directive, 2009/28/EC), the European Commission called on Member States to take steps to develop district heating infrastructure to accommodate the development of heating and cooling production from large biomass, solar and geothermal facilities.
- The European Energy Research Alliance Joint Programme on Bioenergy, launched at the end of 2010, contains a stationary bioenergy sub-programme, with work packages addressing energy, environmental and user aspects of small-scale domestic heating and cooling systems, including micro-CHP, and industrial and municipal combined heat, power and cooling. The overall objective of this sub-programme is to align pre-competitive

research activities to give a technical-scientific basis for the further development of biomass-based energy systems and to explore the possibilities for joint technology development.

- In December 2011, the European Commission published its Energy Roadmap 2050, in which it underlined that renewable heating and cooling are vital to decarbonisation. The Roadmap stresses that a shift in energy consumption towards low-carbon and locally produced energy sources (including heat pumps and storage heaters) and renewable energy (e.g. solar heating, geothermal, biogas, biomass), including through district heating systems, is needed.
- In 2012, the JRC published three reports related to heating and cooling. The first, a Background Report on EU-27 District Heating and Cooling Potentials, Barriers, Best Practice and Measures of Promotion, provided background information on potentials, barriers, best practices, the state-of-the-art and measures for the promotion of District Heating and Cooling to aid policy-making. The second report - Heat and cooling demand and market perspective - aimed to identify the existing and prospective demand for heat and cooling by sector. Finally, a report on the Best available technologies for the heat and cooling market in the European Union aimed to identify the current and future heat and cooling demand and the technologies employed in the domestic, commercial and industrial sectors of the EU.
- In 2014, the JRC published a review of factors affecting the environmental and economic life-cycle for electrically-driven heat pumps. The report presents an overview of the main factors characterising life-cycle cost methodologies for heat pump systems and identifies which factors have the greatest impact on the results. It also suggests methodological improvements to be employed in order to make life-cycle cost analyses more robust.
- In February 2015, the European Commission published its Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy, in which it noted that heating and cooling are the largest single source of energy demand in Europe and that, in order to capture huge efficiency gains, the Commission would propose a strategy to facilitate investment in heating and cooling by the end of 2015.
- On 25-27 February 2015, the Commission organised a conference on Heating and Cooling in the European Energy Transition, at which European and national policy-makers, representatives from industry, businesses and consumer associations, NGOs, local and national authorities, academia and research institutions met to discuss issues facing the heating and cooling sector.
- In February 2016, the Commission published a Communication on An EU Strategy on Heating and Cooling aimed at informing and providing inputs to the ongoing review of relevant EU legislation, which has an impact on the supply and use of heating and cooling, and on the assessment of the role and contribution of this sector in achieving the EU energy and climate goals.
- In March 2016, EASME, the Executive Agency for Small and Medium-sized Enterprises, published an Overview of the market uptake activities and projects they fund in support of the new Heating and Cooling strategy.
- The European Heat Pump Association (EHPA) held its Heat Pump Forum 2016 in Paris in May 18-20. Participants in the forum discussed successful European and national climate and energy policies and how they benefit from and affect heat pumps.
- The European Energy Efficiency Platform (E3P) was launched in April 2016 to deal with the scattered data and fragmented knowledge resulting from a rapidly growing energy efficiency market. This platform, currently in beta stage, is conceived as an interactive and collaborative online tool, and is expected to be both a one-stop shop for information retrieval and a meeting point for experts to exchange data and reduce redundant activities. Several of the 6 thematic areas potentially concern heating and cooling, for instance buildings, industry, urban areas, and energy generation and distribution.

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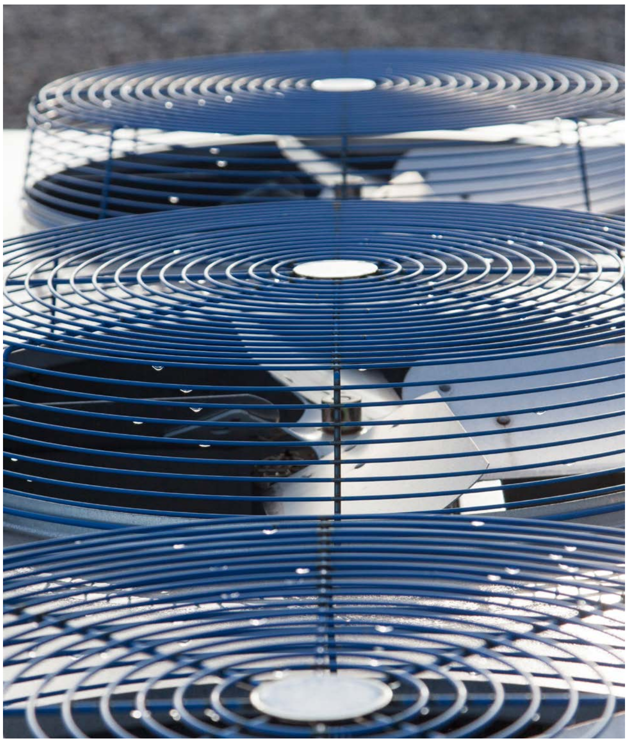
General SET-Plan related news and activities from JRC/SETIS

- The Joint Research Centre has published a number of reports in the first three months of 2016. The 2015 Geothermal Energy Status report presents the current status of the major geothermal energy technologies ranging from ground source heat pump systems and direct use facilities to geothermal power plants. Results from a second study - Energy Efficiency and GHG Emissions: Prospective Scenarios for the Aluminium Industry - show that, in 2050, the energy consumption and direct greenhouse gas (GHG) emissions of the European aluminium industry could be decreased by 21% and 66%, respectively, if the sector adopts innovative technological solutions instead of following a conservative technology deployment path. The JRC-EU-TIMES report Bioenergy potentials for EU and neighbouring countries is the first in a series on renewable energy potentials, and addresses the quantification of current and future biomass potentials for energy systems. The sets of data produced are input to the JRC-EU-TIMES model to analyse the main drivers of future biomass use within the energy systems.
- In February, the European Commission published a Consultation on A sustainable bioenergy policy for the period after 2020 to consult stakeholders and citizens on an updated EU policy on sustainable bioenergy for the period 2020-2030. The Consultation ran until 10 May 2016.
- The 24th European Biomass Conference and Exhibition took place in Amsterdam on 6-9 June. The event provided a unique overview of the state of play in the sector and a clearer view of the role biomass can play in achieving the transition to a low-carbon economy.
- EU Sustainable Energy Week 2016 was held in Brussels on 13-17 June. This event brought together public authorities, energy agencies, research organisations, NGOs, businesses, and private consumers to share best practices and inspire ideas on secure, clean and efficient energy. At the event the European Commission organised a session on the InnovFin Energy Demo Projects facility and how you can be part of it. The session presented the Energy Demo Projects Risk Finance Facility, the first projects to benefit under it and their experience with the due diligence process of the European Investment Bank (EIB).
- To facilitate the SET-Plan implementation organisations (universities, research institutes, companies, public institutions and associations) involved in research and innovation activities in the energy field are invited to register in the European energy R&I landscape database, which aims at facilitating partnerships and collaboration across Europe. Registration is open to stakeholders from the EU and H2020 associated countries. Organisations are able to indicate their area of activity according to the energy system challenges and themes, as identified in the SET-Plan process towards an Integrated Roadmap. The database is publicly available on the SETIS website.



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- The first two SET-Plan Steering Group meetings were held in Brussels on 20 January 2016 and on 15 March 2016. They dealt with SET-Plan Actions 3 and 4 addressing "the future smart EU energy system, with the consumer at the centre" and with Actions 5 and 6, which aim to "develop and strengthen energy-efficient systems" respectively. An additional SG meeting took place in Amsterdam on 13 April 2016 hosted under the Dutch presidency of the EU Council to discuss the Implementation Plan which follows the adoption of the Declarations of Intent. A number of meetings have been scheduled throughout the year to discuss the remaining SET-Plan Actions and their targets, to be set through the adoption of Declarations of Intent.
- The first agreements reached between representatives of the European Commission services, representatives of the EU Member States, Iceland, Norway, Turkey and Switzerland, (i.e. the SET-Plan Steering Group) and representatives of stakeholders, on the definition of strategic R&I targets took place during the first half of the year. The agreed Declarations of Intent concern the Actions 1 & 2 and 5 & 6 of the Integrated SET-Plan dedicated to Europe "Being n°1 in renewables" and "Developing and strengthening energy-efficient systems".
- The 9th SET-Plan Conference 'Energy Union: towards a transformed European energy system with the new, integrated Research, Innovation and Competitiveness Strategy' is to take place in Bratislava, Slovakia on 30 November - 2 December 2016.

Association of the European Heating Industry Secretary General

Federica Sabbati

TALKS TO SETIS

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What are the most pressing actions that need to be taken to create an efficient and decarbonised European market for heating and cooling?

The most pressing action is to modernise the stock of inefficient heaters which are currently installed in EU homes.

Heating and cooling today account for half of the EU's energy consumption, but a large part of this energy is wasted because 65% of the installed stock of heaters is old and inefficient. In addition, according to the recent European Commission Strategy for Heating and Cooling[1], both individual heating and district heating in Europe are largely based on fossil fuels. This means that the priority of a heating strategy should be to accelerate the replacement of the 80 million central space heaters with efficient and renewable heating technologies and to decarbonise district heating.

The heating industry has an important role in the modernisation process: replacing a domestic heating system with state-of-the-art available technology will provide an energy efficiency gain of a minimum of 25% compared to current levels. And there are many smart, efficient and renewable heating technologies available. How can we bring them into our homes?

1 COM (2016) 51 final: Staff Working Document accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: "An EU Strategy on Heating and Cooling", {SWD(2016) 24 final}, Brussels 16 February 2016, page 25.

The energy label, introduced only five months ago on heating appliances, can help: by increasing consumer awareness it can motivate them to replace their old appliances with more efficient ones. This, however, will only happen if the energy label promotes the best technologies, rather than downgrading them in the eyes of consumers as explained later.

How large a contribution does renewable heating currently make to Europe's heat supply, and what potential exists to increase this contribution.

Today renewable heating in Europe is still marginally deployed.

According to the European Commission, renewables accounted for 18% of primary energy supply for heating and cooling in 2012, whereas fossil fuels – mainly gas - accounted for the major share of 75%[2]. These shares take into consideration the type of energy used to produce electricity and district heating. Biomass is the most largely used renewable source for heating i.e. 90%; renewable-based electricity accounts to 5% and ambient heat 1%.

The energy supply composition for district heating is very country-specific. Fossil fuels, mainly natural gas and coal, cover a share of between 80% and 100% of the energy supply for district heating in Eastern European countries, while renewables such as biomass play a prominent role in Sweden (49%) as well as in Austria (41%) and Estonia (35%)[3].

2 Ibidem, page 26.
3 Ibidem, page 89-90.

Despite the low share of renewable use, renewable-based heating technologies exist and they are a proud innovation of European industry: solar thermal, heat pumps and biomass boilers are some examples.

The latest hybrid technologies have a great potential to increase the contribution of renewables in heating. Hybrids, for example those including a heat pump with a condensing boiler, smartly use two energy sources in order to improve overall system efficiency, reduce running costs and keep the high comfort levels expected by end-users.

A real political commitment to energy efficiency is needed to motivate the consumer towards the uptake of energy efficient solutions and behaviours. This is why energy efficiency should be an essential part of the transition towards the decarbonisation of buildings. Energy efficiency is of great value, especially in the short and medium run, because it reduces Europe's dependence on external supply as well as contributing to CO_2 reduction targets.

What do the latest heating technologies offer the European consumer in terms of efficiency and environmental benefits?

Today's heating technologies offer consumers at least 25% energy efficiency gains and reduce polluting CO_2 emissions, compared with the old and inefficient systems they should replace.

The benefits of modernising heating systems are all the more relevant due to the size of the sector. Indeed, space heating and hot water production represent about 85% of the energy used in an average European building, by far the largest share.

And today's heating technologies can bring these benefits to everybody. Why? Because there are very many heating technologies, each made to suit specific preferences of the user and each fit for specific building types. Simply substituting a traditional boiler with state-of-the-art, condensing technology would deliver at least 25% energy efficiency gains and can reduce CO_2 emissions by about 35%. This technology currently drives the modernisation of heaters, also due to its affordability. But other technologies, such as hybrids, heat pumps, solar thermal and biomass bring great energy savings and environmental benefits. For example, a solar thermal system installed in Belgium can provide two thirds of the hot water consumption of a household.

But heating technologies are not limited to heat generation. Heat should also be efficiently delivered to people. In this sense, the action of low-temperature radiators and surface heating, combined with modern temperature controls, further increases energy efficiency gains. For example, well installed, state-of-the-art radiators reduce a system's consumption by 9% to 13%.

What is the current focus of research in the European heating industry, and what do you see as priority areas for future research?

The European heating industry invests 700 million EUR / year in research, development and innovation in energy efficiency. Currently there are two broad trends of innovation: first, flexible energy integration, through hybrids, and secondly, the 'smart' or 'connected' home.

Responsible for the highest share of energy consumption in a building, heating and hot water production has a lot to contribute to global energy saving and to decarbonisation goals. This is why our industry has devised technologies which enable the flexible integration of two or more energy sources, and increase the system efficiency: these are hybrids.

How do they work? Think of a heating generator made of an electric heat pump supported by a condensing boiler, then linked to a photovoltaic or a solar thermal panel and a hot water storage tank resulting in a single, connected system. Monitoring the trends in the cost of energy and, via an intelligent control, the individual energy demand at different times of the day, a hybrid supplies heat from the more efficient source at any moment, either directly or with the support of hot water storage tanks. Hybrids are a new way to increase efficient electricity and renewables use in heating.

Individual energy management and, more generally, consumer empowerment trends have been the driver for the development of "smart home" appliances, including in the heating sector. Heating appliances are increasingly connected to other appliances in the house and to energy utilities, which can use this connection to stabilise the grid, when necessary. But this is not all: connectivity allows users to autonomously monitor and manage their energy consumption, the performance of their energy generators, including the effectiveness of their solar panel and all of this while at home via user-friendly and fun interfaces or remotely, simply using their smartphone.

What are the main challenges facing the heating industry in Europe and what needs to be done to overcome them?

From the regulatory point of view, the main challenge is to translate commitments for energy efficiency into practice. Conflicting legislation on energy efficiency should be avoided. The revision of the energy labelling legislation is a case in point.

In order to reach the ambitious energy efficiency goals of the EU for 2030 and beyond, Europe needs to tap into the potential that lies in modernising heating in buildings, which currently contribute to almost half of the EU energy consumption. The energy label can help, by increasing consumer awareness and motivate them to change their old appliances.

But just as Europe is set to introduce this label to boost the replacement of inefficient heaters, new plans to modify the Directive's defining feature, the energy scale, send a conflicting message to the market and threaten to slow down the modernisation process. "Rescaling" the energy label will place appliances such as the most efficient geothermal heat pump in class C, or state of the art condensing boiler technology in class F. But who would buy an F-graded product? Consumers will rather repair an old appliance and postpone their investment in energy efficient products.

This is why we believe that "rescaling" the label of heating products, introduced in the EU market only in September 2015, will not increase the energy efficiency of our buildings: perversely, it might stop this positive trend.

The solution, according to us, is to "rescale" when it is needed, that is, when the majority of products falls in the top classes of the energy scale, which would indicate that efficient heaters have penetrated the market. Until then, the energy label should do its job: to motivate consumers to become more efficient in the way they heat their homes.

Committing to "energy efficiency first" should also mean to look critically at the impact a policy will have on the uptake of energy efficiency in Europe.

How does the heating industry in Europe perform compared to other regions in the world? Are there lessons that can be learned from international experience?

The European heating industry is the world leader in highly efficient hydronic heating systems. These systems have established themselves as the solution of choice in terms of comfort and efficiency in distributing heat within a building. This is particularly important for areas with cold winters: today the European heating industry covers 90% of the European market and is an important exporter of heating technologies in many other parts of the world. This includes countries such as Russia, where we are market leader, Turkey where we represent half of the market, and even in China where we play an increasingly important role in the development and deployment of efficient heating.

The EU commitment to ambitious energy and climate goals has paved the way for the large presence of our energy efficient technologies. Today Europe has the highest standards in the world in terms of energy efficiency, strengthened recently by the introduction of Ecodesign criteria for the sale of heating products. From now on, the minimum standard for a new heating installation is represented by the very efficient boiler condensing technology. This move is bound to have a long-term positive effect for EU energy independence and climate protection, if accompanied by measures to support the renovation of the installed stock of heaters.

The lesson to be learnt is that the European industry can support ambitious energy efficiency policies, but it needs a full commitment to the goal of energy efficiency policy stability, as a signal to continue to invest in these highly successful technologies.

For more information: www.ehi.eu

Federica Sabbati

Federica Sabbati is Secretary General of the European Heating Industry association (EHI), which represents European manufacturers covering 90% of the European market for highly efficient heat and hot water generation and renewable heating systems, heating controls and heat emitters, as well as 75% of the hydronic heat pump market. Previously, Federica has held the position of Secretary General of the European Liberal Democrat and Reform Party (ELDR), Secretary General of the Liberal International, and European Affairs Manager of The Coca-Cola Company. Federica holds a university degree in International Relations from the University of Trieste and a Master's Degree in Russian and Post-Soviet Studies from the London School of Economics.

The EU strategy on heating and cooling

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In February 2016, the European Commission presented its newly established Heating and Cooling Strategy. This is the first EU initiative to comprehensively address the energy used for heating and cooling in buildings and industry, which accounts for 50% of the EU's annual energy consumption. By making this sector smarter, more efficient and sustainable, energy imports and the EU's dependency on them will fall, and both costs and CO_2 emissions will be reduced. The strategy is a key action of the Energy Union Framework Strategy and will contribute to improving the EU's energy security and to addressing the post-COP 21 climate agenda.

Currently, renewables are not widely used in the sector: Natural gas is the largest primary energy source for heating and cooling (46%), followed by coal (about 15%), biomass (about 11%), fuel oil (10%), nuclear energy (7%) and some renewable energy sources (wind, PV and hydro, about 5%). Other renewables like solar (thermal) energy, ambient heat and geothermal energy account for 1.5% altogether and other fossil fuels for 4%. Overall, renewable energy accounts for 18% of primary energy consumption in the heating and cooling sector and there is a significant potential to increase its share. Moreover, the amount of heat produced from industrial processes and wasted in the atmosphere or into water in the EU is estimated to be enough to cover the EU's entire heating needs in residential and tertiary buildings.

Given the EU's climate goals, the demand for heating and cooling should fall by 42% to 56% by 2050, with a commensurate reduction in CO_2 emissions. The EU Heating and Cooling Strategy identifies actions in the following areas:

1) Making it easier to renovate buildings;
2) Increasing the share of renewables;
3) Reuse of energy waste from industry;
4) Getting consumers and industries involved.

The implementation of the strategy will bring benefits to all, and more specifically:

- To EU citizens: who will benefit from better living conditions, comfort and health, a better environment, and reduced expenditure on heating.
- To workers: the manufacture and installation of equipment and materials that are energy efficient and based on renewable energy are labour-intensive activities that, on average, may create twice as many jobs as the manufacture and installation of conventional energy generation equipment.
- To industry: energy costs could be reduced by 4-10% with investments that can pay for themselves in less than 5 years.

In the long term, Europe wants to decarbonise its building stock by 2050: this means that Europe would save around EUR 40 billion on gas imports and EUR 4.7 billion on oil imports per year. The EU's CO_2 emissions would be reduced by 30% and citizens' expenditure on heating and cooling their homes and buildings would be lowered by 70%. Air pollution from heating and cooling would be reduced by more than 90%, eliminating related health problems. For example, the new EU Energy Label and Ecodesign Regulation for boilers, showing efficiency ratings for the first time, is estimated to save 600 TWh of energy and cut CO_2 emissions by 135 million tonnes by 2030.

Industry can move in the same direction by taking advantage of the economic case for efficiency and new technical solutions. It is estimated that industry could reduce its energy consumption by 4-5% in 2030 and 8-10% in 2050 just by implementing commercially viable and available solutions. The share of renewable energies would reach 30% and breakthrough technologies would help industries to decarbonise while making production processes 30-50% less energy intensive.

The transition towards a low-carbon heating and cooling system requires action from all actors involved. The strategy refers to various types of actions, including:

1. Legislative reviews of:

- The Energy Efficiency Directive, the Energy Performance of Buildings Directive and the Smart Financing for Smart Buildings Initiative in 2016;
- The New Electricity Market Design and the proposal for a Renewable Energy Framework in 2016.

2. A series of non-legislative actions including:

- Developing a toolbox of measures to facilitate renovation in multi-apartment buildings;
- Promoting proven energy efficiency models for publicly-owned educational buildings and hospitals;
- Extending the work of the BUILD UP skills campaign to improve training for building professionals, in particular through a new module for energy experts and architects.

Source:
European Commission - Fact Sheet - Towards a smart, efficient and sustainable heating and cooling sector http://europa.eu/rapid/press-release_MEMO-16-311_en.htm

More information:
Website DG Energy: https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-gas-and-heating-and-cooling-strategy

European Commission

This article was contributed by the European Commission's Directorate General for Energy, Energy Efficiency Unit (C3).

European Heat Pump Association Secretary General

Thomas Nowak

TALKS TO SETIS

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What are the main current trends on the heat pump market in Europe?

Heat pumps are an established technology for heating and cooling as well as hot water production in many EU countries. In some countries, like Norway, Sweden, and Finland heat pumps are the dominant heating technology. In others, like Denmark, Switzerland, France or Austria, heat pumps are aspiring to move into that position. In a third group, with Germany being the prime example, heat pump technology has achieved a significant share in the new build market segment.

This flashlight on sales numbers reflects the characteristics of heat pumps. The technology is mature and ready for most application areas. Technological progress has increased the range of possible applications. In countries with sufficient time for market development and/or proper framework conditions, heat pumps have become a key heating and cooling technology.

Looking at the technology itself, a few trends are visible:

1. The large majority of units (>80%) are using air as their heat source.
2. Sanitary hot water heat pumps show the fastest growth. They help introduce renewable energy into traditional boiler installations.
3. Connectivity is becoming more and more important. Improved interfaces integrate heat pumps into home energy management systems and connect them in particular to PV systems.
4. The number of large heat pumps is increasing. In buildings with a dual use for heating and cooling heat pumps offer the highest efficiency. Bespoke heat pump solutions are the de-facto standard.

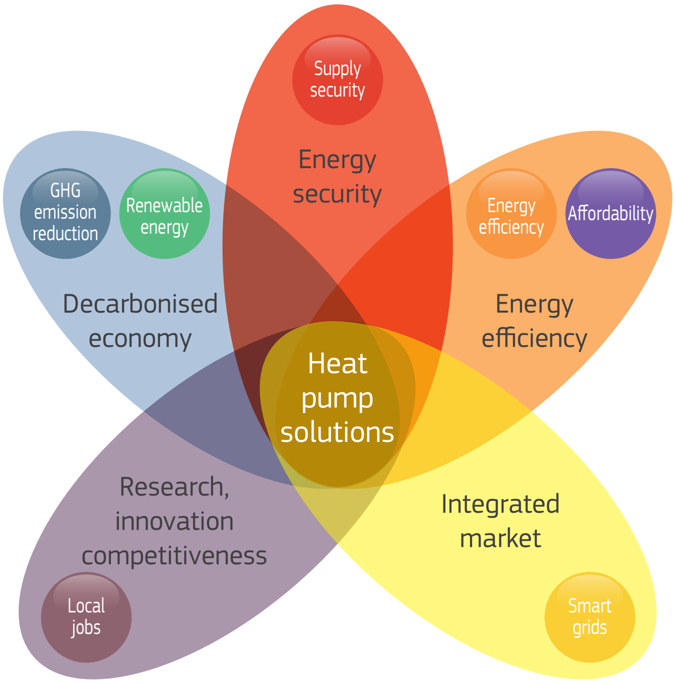
In terms of efficiency, the technology has made huge developments. Where, in the past, one could argue that achievable efficiencies of air source heat pumps were much lower than those of geothermal or hydrothermal units, this gap has been closed. The best air source heat pump systems perform as well as average geothermal or hydrothermal units with the latter on average still being the most efficient heat pump type in the market. However independent of energy source and application area, proper system design is key for efficient systems.

The EU presented a strategy for heating and cooling earlier this year. What role do you see heat pumps playing in this strategy?

With a 100% decarbonisation target in mind for 2050, heat pumps can be considered nothing less than essential to the heating and cooling strategy. They are unique in using renewables and increasing energy efficiency at the same time, thus reducing CO_2 emissions. On top, the technology enables a sector connection between electricity and heating. New business models make using the inherent demand response and storage potential of heat pumps feasible, contributing to stabilised high-res electric grids. Whenever heating and cooling services are needed in parallel, heat pumps are the most efficient technology.

Looking at the five dimensions of the European Energy Union, heat pumps contribute to all of them. In addition to the already men-

Figure 1: HP benefits to the Energy Union



tioned benefits, they are installed by local installers – thus providing employment and supporting SME's. For many segments, Europe is a market leader. The underlying skill set in the R&D department of companies and in university-based research should be supported further by public programs. Last but not least, heat pumps use locally available ambient energy and thus reduce import dependency, providing full supply security and avoiding spending on energy imports.

What do individual heat pumps have to offer the European consumer in terms of their environmental and economic performance compared to conventional heating solutions?

Heat pumps work – they provide efficient heating, cooling and hot water to the individual customer and thus ensure comfortable and healthy buildings. Heat pumps also help improving indoor and outdoor air quality.

With regards to the economic performance, the assessment depends very much on the national conditions. The constantly increasing efficiency requirements in national building codes make it more and more difficult to meet them for the construction of new buildings by installing a traditional boiler alone.

For this market segment, heat pump investment costs are very similar to heating systems combining fossil and renewable energy. In consequence, heat pumps have a significant, if not majority share of the new build market in many EU countries.

For the replacement market, the comparatively low cost of a traditional boiler needs to be compared with the investment cost of a modern system – which are still higher. While the renovation market is the largest and thus most promising market segment, it needs improved solutions at a lower price point and skilled installers / planners to copy heat pump success in this market.

With NZEB (nearly zero-energy building) requirements soon becoming mandatory in public and private buildings and with an extension of efficiency requirements also to the renovation segment, the field of possible heat pump installations is bound to increase.

This and the outstanding performance of current hybrid heat pumps should fuel the market uptake of the technology.

Has R&D funding in Europe been sufficient to allow heat pumps reach their potential as a bridging technology between electricity and heat, facilitating the integration of more renewables into the grid? What are the research priorities in this regard?

The latest trends in funding for R&D in Europe have shown that both at EU and national level, policy-makers have started to recognize the importance of heat pump technology for a decarbonised building sector and for the use of more renewables in electricity and heating and cooling production.

This development needs to continue. The industry will require a constant and predictable funding level. Funding should no longer focus on components and products but on systems optimisation and integration connecting heating and the electricity sector.

Heat pumps using 100% renewable electricity provide emission-free heating and cooling today. With appropriate design, heat pump systems can store surplus electricity and overcome peaks for hours or even days, thus providing meaningful peak shaving to the grid.

While this potential is available in principle, only a minority of systems are designed to make use of it in the most optimal way. We do observe a mismatch between technical and realised potential. This could be overcome in two ways:

Using heat pumps for sector connection should be made subject to research projects in Horizon 2020 and beyond, focusing on systems integration including improved controls, interfaces and storage technology.

Updating the electricity market design to encourage utilities to offer cost flexible pricing to end-users and aggregators. Providing an economic benefit in exchange for the grid stabilisation services of heat pumps will make designing such systems attractive.

Heat pump systems that are optimised in this way can also increase the on-site use of auto produced electricity, for example from a PV generator.

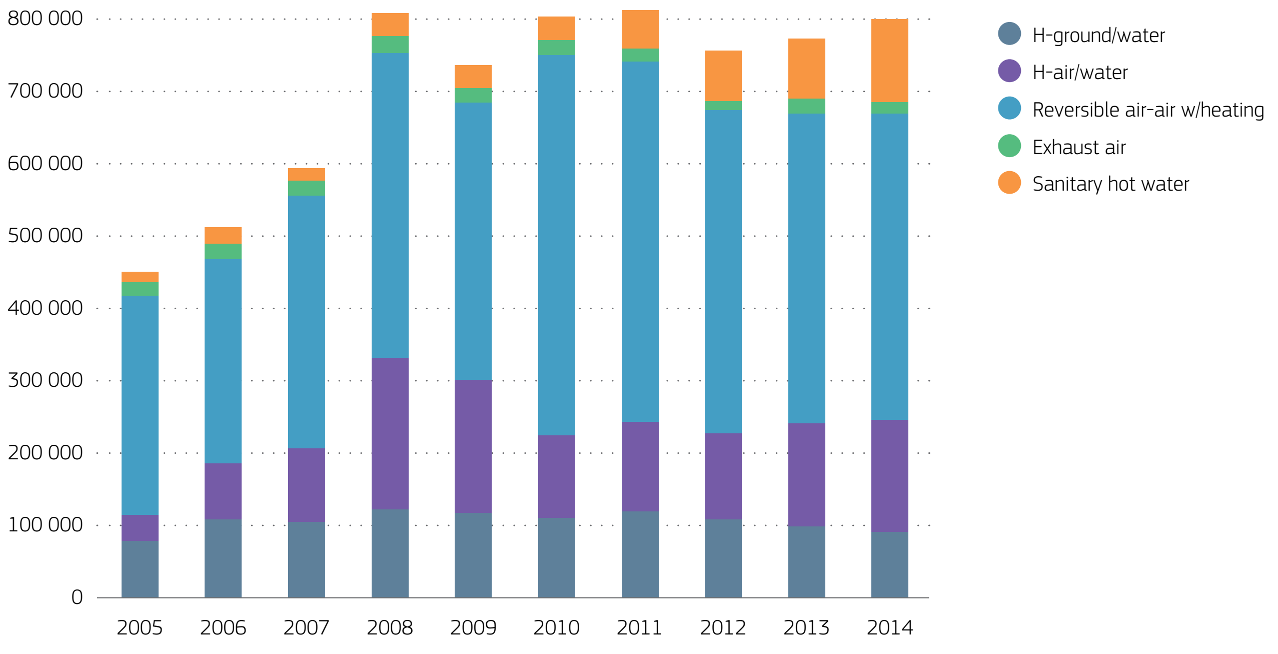
In terms of research priorities EHPA believes that R&D should prioritise funds for:

- The development of easy replacement options for the renovation segment.
- Efficient solutions for heating and cooling in industrial processes and commercial applications.
- Home systems with the integration of HP and PV power plants for (near) 100% green heating and cooling solutions.

R&D funding programs should focus on helping Europe realise the necessary fuel switch towards renewable energy. Technologies are available, but often still face non-technical deployment barriers. Overcoming these obstacles should be a key pillar of Europe's R&D programs.

How do national heat pump markets compare across Europe? Are there frontrunners from which policy lessons can be learned that might be applied to the European market in general?

Figure 2: Heat pump sales in 21 European countries



As touched upon in the first question, the EU markets have quite a heterogeneous development status and speed. 10 EU markets represent 90% of all heat pumps sold in Europe.

The highest market penetration per 1000 households is found in the Nordic countries. Heat pump markets have benefitted from:

- A lack of extensive gas distribution grids;
- A forward looking ban of the use of heating oil;
- The acceptance of (efficient) use of electricity for heating purposes.

A new challenge will be the large share of wind and PV electricity in the electric grids. Simulations for countries like Denmark, with a planned wind share in the power mix exceeding 50%, show that heat pumps will become essential for grid stability.

The biggest market with the strongest growth rate is France. Efficient heat pumps are part of the national heat strategy. As they multiply the efficiency of every kilowatt-hour of electricity by a factor of 3-4, they are a fast track solution towards reducing France's electricity demand.

There are many takeaways that can be transferred from these markets to the rest of Europe. It will however be essential for governments that want to make heat pumps a success in their markets to correct market imperfections (if not failures) in the heating market to make the technology economically attractive to end-users and investors.

Is enough being done to promote heat pumps as a mature and efficient heating solution, and to ensure that the construction industry has the necessary skills to meet market demand

An 80-95% decarbonisation of the energy system is foreseen for 2050. Considering, that this will be difficult in a number of sectors, it should result in much stronger efforts in those, where solutions are readily available – the heating and cooling sector being one.

The strictest efficiency requirements and a minimum RES share should be set in residential and non-residential buildings, the use of fossil energy carriers in systems with primary energy efficiency below 100% should no longer be allowed, let alone be subsidised.

Energy efficiency, the use of waste heat and renewable sources should become state of the art in planning and renovation action in industry.

Many European governments could take more swift and decisive action to accelerate the decarbonisation of their respective heating and cooling sectors. Focusing on heat pumps would fast-track this development, make achieving current RES, EE and CO_2 emission reduction targets easy and would make more ambitious targets realistic.

With regards to the skill set of the construction industry we do observe potential here. A heat pump market share of approx. 10% of annual boiler sales indicates that a large number of skilled planners and installers is helping the industry to grow today.

Heat pump market development would clearly benefit from an up-skilling of the vast majority of planners, architects and installers not yet conveniently familiar with the technology. This is a tremendous, but not impossible challenge.

Clear messages by policy makers on the importance of heat pumps for the energy system would help industry to make investment decisions, young people to take decisions on their careers (in heating and cooling) and end-consumers as well as industry to recognize and decide in favour of the technology.

I am optimistic that a future energy system will largely be based on heat pumps integrating renewable energy and leading to the necessary no-emissions future in heating and cooling.

Thomas Nowak

Thomas Nowak has more than 15 years of experience in the field of renewable energy. Currently, he is responsible for the management and development of the Brussels-based European Heat Pump Association (EHPA), an industry lobby group with more than 110 members. He is also a board member of the EU Renewable Heating and Cooling Platform and a contributor to scientific publications including the IEA energy technology perspectives and the REN21 Renewables Global Status Report. Thomas holds a degree in business administration from the University of Paderborn, Germany.

Valorisation of waste heat in industrial processes – Results from the SILC I projects

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In a context of strong global competition and ambitious EU energy and climate policies, Sustainable Industry Low Carbon (SILC) is a EU grant scheme that aims at identifying, developing and deploying technological innovation measures allowing to improve the competitiveness and reduce the carbon intensity of energy-intensive industries. SILC is being implemented in two phases, each with its specific objectives: SILC I (2011-2013) and SILC II (2014 onwards).

SILC II is a Horizon 2020 initiative that funds large-scale demonstrators for low-carbon technologies that require demonstration and validation before implementation. It looks at breakthrough solutions that can bring significant greenhouse gas emission reduction (35% compared to current 'best available techniques') and that have a high potential technology transfer within and across sectors[4].

The SILC I programme instead focused on measures that can be implemented in the shorter term (3-year horizon) without prior demonstration/validation. Through three rounds of calls for proposals in 2011-2013, eight projects have been selected for funding, covering the following sectors: iron and steel, ferroalloys, cement, glass, ceramics, and pulp and paper. To date, five of the projects have been finalised. Most of the solutions are designed to be integrated into existing production lines, which might increase their potential for implementation in the specific industrial sector as well as other energy-intensive industries. Out of these eight projects, five are centred on waste heat recovery while the others focus on energy efficiency measures. The five projects focusing on waste heat recovery are described below:

A) Ceramics industry: Reduction of CO_2 emissions in the ceramic manufacturing process (REDUCER) (complete)

The objective of this project is to identify and implement energy savings in elements of the ceramic tile manufacturing process characterised by high thermal energy consumption such as kiln and dry units. Thermal energy in the target industrial facility is obtained through combustion of natural gas. As much as 50% of energy wasted in the kiln through hot flue gases has been reported. First, energy-related process variables were optimised using a process simulation approach. Afterwards, a new energy recovery system was designed and installed, by which the hot gasses from the kiln cooling stack are recovered into vertical dryers. The reported savings amount to 2.16 kWh and 0.44 kg CO_2 per m^2 of material produced, which represents about 10% of the energy and CO_2 emissions associated with the process. This could potentially save, if expanded to the whole EU-27, 520 000 tons of CO_2 per year.

4 See http://ec.europa.eu/growth/industry/sustainability/low-carbon-economy/silc-programmes/index_en.htm and http://ec.europa.eu/programmes/horizon2020/en

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B) Ferro-Alloy industry: Emission Reduction in Manufacturing and Process industries (ER>ER) (complete)

This project consisted of the development and dissemination of a Waste Heat Recovery Best Practice Framework and the implementation of an open online community platform to reach and engage with interested stakeholders, based on the experience gained by the industrial partner, which in 2012 and independently of the SILC scheme, started to operate a waste heat recovery system to produce electricity (340 GWh per year) using the off-gases (at 800 °C) of the electric furnace. The electricity generated is consumed on-site and covers 35% of the plant's electricity needs. A boiler able to produce up to 125 GWh per year of process heat was also installed.

The project made it possible to develop the HeatREcovery+ mobile app in which the user can make simple choices regarding waste heat recovery technology and local conditions of a hypothetical industrial plant and, as a result, the app returns the energy recovery system with the highest potential. The project identified economic risk and financial regulations as the most decisive aspects in the feasibility of a particular heat recovery system.

C) Glass industry 1: Fume Heat Recovery System (FHRS) (ongoing)

The FHRS project aims at energy recovery in the melting processes in the glass industry. The system comprises a two-step waste fume energy recovery system to preheat both the oxidizer and the combustible supplying an oxy-combustion furnace. A CO_2 saving of about 9% is expected, to be confirmed after system optimisation. A cost benefit analysis including the impact on industrial competitiveness will be carried out. Furthermore, the final results will also include an evaluation of the potential implementation of the new technology in similar industrial sectors such as the production of steel and cement.

D) Steel sector - Waste heat valorisation for sustainable energy intensive industries (WHAVES) (ongoing)

This project builds on results obtained in two previous LIFE+ projects[5] in which a solution based on electric arc furnaces (EAF) and Organic Rankine Cycle (ORC) was implemented in a steel demo plant. The project explores methods to replicate the solution in other steelworks and energy intensive industries such as cement, glass, non-ferrous metals and oil & gas. Data from an existing EAF coupled to an ORC unit combined with other waste heat recovery, along with data from a cement plant and a glass plant are collected and analysed. It has been possible to define a standardised solution for an ORC-based heat valorisation system integrated in the water-cooled piping component of the cooling fume treatment system in the iron and steel industry. The project claims that one of the advantages of using ORC is that its design allows it to operate efficiently under the variable operating conditions typical of the iron and steel melting process (variation in exhaust gas temperature and flow). A 4.6% increase in energy efficiency has been observed, which could potentially lead to savings of 2.2 million tonnes CO_2 per year at European level for the whole sector. In a similar manner it is estimated that 1.9 million tonnes CO_2 could be saved in the cement industry, and 225 000 tonnes in the glass sector.

E) Glass industry 2: CO_2 reduction in the ETS glass industry (CO_2-Glass) – ongoing

The project started by evaluating the potential use of waste heat in a glass container production plant in Sofia. In particular, a heat exchanger for enhanced batch preheating will be designed and installed. This technology is applicable to fuel/air fired oxy-fuel furnaces and batches with cullet content of over 50%. It can be applied at existing glass production chains without the need for major modifications to the process. The project will also evaluate the potential implementation of the proposed technology in four additional glass facilities. A batch pre-heating process simulation tool was developed and an energy-mass balance analysis was carried out. Several concepts for the glass industry, dealing with fuel reduction, electric boosting reduction and increased pull were examined. The results showed that energy consumption under full load operation could be reduced between 12.3% and 16.2% and CO_2 emissions by between 3.4% and 10.7%. It is expected that the project results could be potentially reproduced in small, medium or large glass industrial sites.

5 H-REII (www.hreii.eu) and H-REII DEMO (www.hreii.eu/demo)

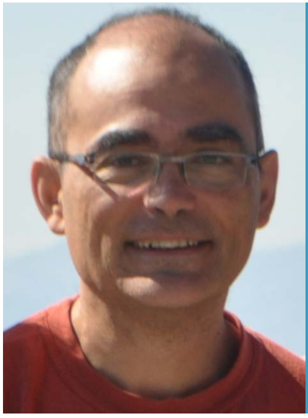
Conclusion

Industry accounts for 25% of the EU's entire final energy consumption, 73% of which is provided in the form of heating and cooling[6].

Primary sources of waste heat in industry can be single process units or whole systems that release heat into the environment. In terms of sectors, the largest amounts are usually found in basic metals, chemical industry, non-metallic minerals, pulp and paper and food.

Although considerable effort has been made to optimise industrial processes, there is still a large amount of recoverable heat that is wasted, either in individual facilities or industrial hubs. Five out of the eight SILC I projects are exploring technical solutions that can be used to recover this heat. Based on the partial results obtained to date, the considered solutions could deliver between 4% and 16% energy savings and up to 10% CO_2 savings, depending on the sector and the production process.

6 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, An EU Strategy on Heating and Cooling, Brussels, 16.2.2016 COM(2016) 51 final.



Jose A. Moya

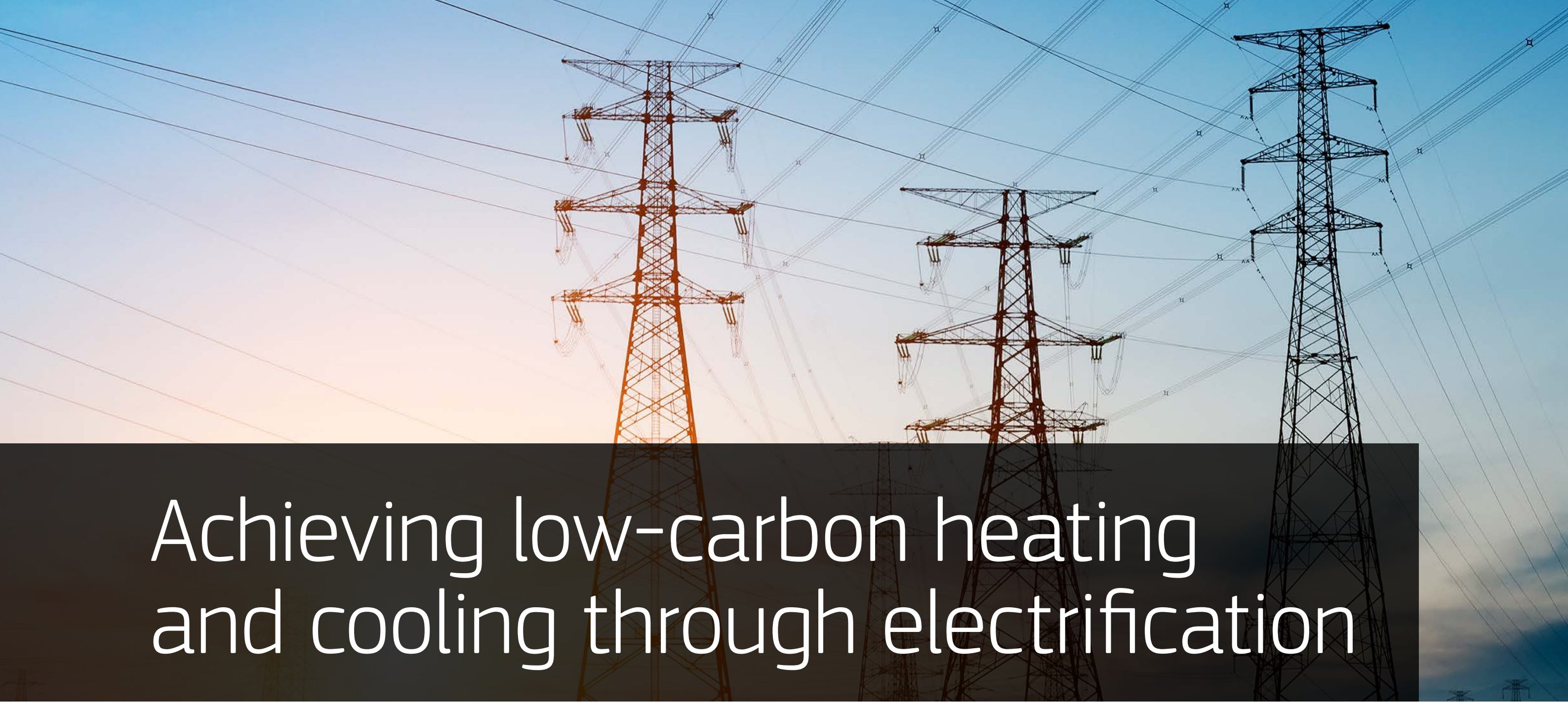
Jose A. Moya graduated in mining engineering from the Universidad Politécnica de Madrid. He worked as a researcher for 6 years in probabilistic safety assessments of nuclear repositories and for 10 years in INDRA, a Spanish consultancy firm in which he provided significant support to an electricity distribution company on regulatory issues. In 2009 he joined the Joint Research Centre, where he has worked assessing the role of technology innovation in energy-intensive industries to improve energy efficiency and reduce GHG emissions.

Carmen Moles

Carmen Moles is a chemical engineer with a PhD in Optimisation Techniques from the Spanish National Research Council (CSIC). After holding a postdoctoral position at R&D Unilever, she worked at ABB AS and the Norwegian University of Science and Technology (NTNU). Since she joined the Joint Research Centre (JRC) in 2013, Carmen has been involved in heating and cooling technology and low-carbon solutions for energy-intensive industry.

Ronald Piers de Raveschoot

Ronald is a mechanical engineer with an MSc in Environmental Management (Imperial College). After working in energy-related industries for seven years he moved to the public sector, first in the Brussels Capital Region administration for environment and energy, where he headed the energy sub-division, and then in Joint Research Centre of the European Commission (JRC). At the JRC, he has been in charge of providing scientific support to the Covenant of Mayors initiative and to the Environmental Technology Verification (ETV) pilot programme. Since 2014 he has also been involved in projects and studies related to efficient heating and cooling.



Achieving low-carbon heating and cooling through electrification

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.With discussions well underway in the EU on establishing an Energy Union and on its climate and energy framework, European policy-makers are taking important steps in setting European energy policy on track towards a nearly carbon neutral economy in 2050. Heating and cooling in buildings and industry constitutes 50% of the EU's energy consumption. Together with the 32% contributed by the transport sector, these represent the largest shares of energy demand across Europe. Due to its decentralised nature and its dependence on regional climate and infrastructure, decarbonising the heating and cooling sector is a major challenge. Currently, 85% of heating in Europe is produced from fossil fuels. This means that decarbonising heating and cooling is key to achieving Europe's climate goals and decarbonising our society as a whole.

The electricity industry is ready to take a leading role in achieving these objectives. Electricity today is increasingly generated from renewable sources. As a result, the carbon intensity of electricity as an energy carrier is falling – and we expect it to decrease even further as the sector steps up its use of low-carbon power generation sources. The sector is actually committed to achieving carbon neutral power supply by 2050[7]. In fact, the Energy Roadmap 2050 recognises that *"electricity will have to play a much greater role than now [...] and will have to contribute to the decarbonisation of transport and heating/cooling"*.

Electrification will mean replacing fossil fuels with low-carbon electricity in meeting our daily energy needs for heating, cooling and transport. As these sectors are currently based in great part on fossil fuel technologies (such as gas or oil for heating and combustion engines for vehicles) electric solutions will enable their decarbonisation. This fuel switch can also help increase energy efficiency, reduce primary energy needs and allow an increase in renewable energy penetration. The benefits are therefore multiple: greenhouse gas mitigation, energy security, customer empowerment, potential reduction in primary energy usage, as well as various other environmental and health benefits.

A variety of clean and energy-efficient electric solutions can play a part in this process. The technologies to enable electrification already exist on the market or are getting ready for mass deployment. New technologies, such as smart heat storage systems, enable electric heating/cooling to act as decentralised storage. These open up more options in making our energy systems cleaner, more efficient and more flexible.

One of the most important technologies to unlock the benefits of electrification is heat pump technology. These use an electric compressor that "pumps" heat from one location to another. By pumping heat from outdoor air, soil or groundwater into a building, such as an apartment block, each kW of electricity consumed by a heat pump, generates about 4kW of thermal energy, depending on the circumstances - this corresponds to 300% efficiency[8].

Today, equipping a new single family home with a heat pump instead of an oil burner can save up to 40% in annual primary energy consumption. The potential contribution to the EU's energy strategy is impressive: more than 70 million heat pumps could be installed by 2020, which would lead to a reduction in final energy consumption of more than 900 TWh[9], thereby contributing almost 20% to the EU's energy efficiency target for 2020.

Electrifying heating, cooling and transport with power from decarbonised sources reveals a wide range of benefits which are critical in the transition to a sustainable economy in Europe. One of the key benefits of electrification is that when combined with low-carbon energy technologies, it helps meet the world's energy needs with less carbon. Using electricity for local heating in buildings and cities

7 http://www.eurelectric.org/CEO/CEODeclaration.asp

8 http://www.ehpa.org/technology/key-facts-on-heat-pumps/

9 http://www.ehpa.org/uploads/media/EHPA_Action_Plan.pdf

would not only reduce greenhouse gas emissions, but it would also cap the emissions of the heating sector by de facto bringing them under the EU Emissions Trading System.

Currently, there is widespread perception that improving energy efficiency implies reducing electricity consumption. However, recent technological developments have completely reshaped the comparative efficiency of electricity use versus the use of other energy vectors such as gasoline, natural gas or oil. The use of more electricity can therefore actually result in increased energy efficiency, thanks to technologies like efficient heat pumps, modern water boilers with thermal storage, smart heating solutions which take power from the grid when it is sustainable and/or cheap.

Not burning fossil fuels in cars and houses has further advantages. In urban areas in particular, electrification can have significant environmental and health benefits. Electricity in transport and heating can reduce air pollution in our cities, especially when it comes to local pollutants such as particulates, NOx, SOx, VOCs and ozone. The use of electric buses, trains and light trains can drastically improve air quality, traffic congestion and noise pollution. Furthermore, electricity can also replace fossil fuels in small and medium enterprises. This will make it possible to concentrate the energy-related emissions to those remaining electricity producing plants with more efficient pollution abatement systems that will primarily be used as back-up for carbon-neutral power generation. In this way, switching from direct use of fossil fuels to electricity could enable energy users to meet more of their energy needs through zero-emission energy.

Switching to electricity in sectors which currently do not use it will of course change the demand profile, and will require intelligent solutions in order get the maximum out of our infrastructure and changing generation mix. Increasing numbers of electric vehicles can disturb the power system in a major way, adding additional peaks to the variable renewable peaks already observed. One solution to this challenge is smart charging - charging EVs in a way that avoids excessive and costly spikes in power demand and also, in the years to come, using car batteries as storage to deliver valuable services to the electricity system, as well as maximising local integration of renewable energy sources (RES). By optimising grid utilisation (i.e. by making sure the demand does not exceed grid capacity), smart charging will help to avoid grid reinforcements costs.

Since power can be produced from many different sources, electrification allows greater flexibility and, in return, this will further strengthen the security of supply. We are also seeing that electrifying final energy consumption could increase energy storage opportunities. The use of electric vehicle batteries or electric appliances (e.g. water heaters) as flexible demand and decentralised energy storage will allow higher renewable penetration and increase the reliability of electricity supply. Linking the systems for heating and transport with the electricity system will unlock important benefits on both sides. Finally, all electrification benefits have direct positive impacts on the consumer. The use of electric vehicle batteries or electric appliances means that customers will no longer rely on fossil fuels and their volatile prices. Moreover, the development of demand response options makes electric solutions highly valuable for consumers: electrification empowers the final consumers by giving them the opportunity to increasingly influence their energy bills and be in control of their consumption.

Decarbonising Europe's power production and, at the same time, increasingly electrifying our energy use is key on the path towards creating a carbon-neutral and energy efficient economy in the EU as it removes the need to burn fossil fuels in our buildings and in our means of transportation. This also helps decrease the amount of oil and gas we need to import to the EU for our energy needs, thereby increasing security of supply. With the technologies to trigger this already on the market, the challenge we now face is to create a policy landscape which unlocks the potential of electrification and ensures the uptake of the technologies that enable it.

Hans ten Berge

Born in Eindhoven in 1951, Hans ten Berge holds a Degree in Chemistry from the Rijksuniversiteit in Utrecht and also graduated from the University of Delft in business administration. Following posts in a number of international enterprises, including Exxon Chemie and Kemira Agro, he joined ENECO Energie in November 1998 as Managing Director of Energiehandelsbedrijf, subsequently serving as a member of the ENECO Energie Board of Management from November 1999 until January 2006. He served for several years as Chairman of the EURELECTRIC Markets Committee, before taking on the full-time post of Secretary-General in 2007.

Euroheat & Power Managing Director

Paul Voss

TALKS TO SETIS

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What is the potential contribution of sustainable heating and cooling to energy transition in Europe?

Well, as a point of departure, let's bear in mind that heating and cooling account for more than half of the energy used in the EU today. Moreover, as the recently published EU Heating and Cooling Strategy made clear, they will remain the dominant source of demand through 2050 and beyond. With that in mind, it becomes clear that this sector is more than a potential contributor to the energy transition. It is an indispensable and non-negotiable element. There can be no energy transition without a fundamental shift in the way we heat and cool our buildings. One only needs to look outside the window of an office in Brussels to understand the problem. Nearly every building has a chimney at the top spitting out CO_2 from an oil or gas boiler downstairs. We cannot credibly talk about 80-95% decarbonisation without a serious plan to replace these boilers with alternative solutions that do not generate GHG emissions. The good news is, there are plenty of technically and economically feasible low-carbon solutions available today and district energy networks can be an efficient means to deliver energy from these low-carbon sources to the end-users. If the European energy transition of the nature and speed required is really going to take place, these solutions will need to become the rule rather than the exception.

What are the main challenges that need to be overcome for district heating and cooling to reach its full potential?

In some ways, district heating and cooling (DHC) is quite typical in so far as the usual set of barriers (lack of long-term regulatory support/visibility, failure to internalise external costs such as CO_2 emissions and insecurity of supply, financing) can be observed. Where the sector is rather unusual among sustainable energy technologies is that examples of more or less fully developed national markets already exist and can serve as models for other countries looking to carry out their own energy transitions. In the Nordic countries, DHC already supplies the overwhelming majority of citizens in cities, with Copenhagen, Stockholm and Helsinki being just a few examples. In all 3 cases, the successful development of these networks was the result of (1) a genuine commitment on the part of policy-makers to establish a sustainable means of supplying heating and cooling to the urban environment and (2) a thoughtful planning process aimed at delivering this vision in practice. There is well-documented potential for the use of district heating and cooling in cities and regions across the EU, including in countries such as the UK and the Netherlands, both of which currently rely almost entirely on the combustion of oil and gas for heating. The main challenge for the coming years is to consolidate the emerging political will to carry out this transition and to bring citizens/consumers on board by informing and involving citizens/consumers in the process.

Euroheat & Power joined an international collaboration initiative with Korea, China and Mongolia in 2015. How can the European heating and cooling market benefit from international cooperation and/or experience?

Yes, it is always an honour and a pleasure to work with colleagues and governments around the world to share ideas and identify solutions to our common challenges. First of all, given that we share a planet, we certainly have a common interest in ensuring that the climate problem is effectively addressed. Rather more selfishly, from a European point of view, the development of DHC on a global scale is a tremendous opportunity. DHC is one field where Europe retains unquestioned global leadership. Having previously worked for a leading Danish green tech company, I can tell you that there is an enormous appetite around the world for access to European companies' knowledge in this area. By exporting our know-how and products to energy hungry markets around the world, we can simultaneously contribute to the emergence of a more sustainable energy system and keep money and jobs, particularly in key areas such as engineering and manufacturing, in Europe. With all this in mind, Euroheat & Power will certainly continue to cooperate with cities, governments and international institutions around the world to help ensure that the potential of DHC is understood and exploited wherever possible.

The European Commission proposed an EU heating and cooling strategy at the start of 2016. What impact will this have on the heating and cooling landscape in Europe?

The only thing that is certain for now is that the publication of this strategy was a vital and long overdue step forward. As set out above, heating and cooling is and will remain the single largest chunk of Europe's energy consumption. The absence of a European perspective on this issue had been seriously undermining the credibility of the EU's plans for the energy transition. With the strategy, we have a clear message from the Commission that there is a need for fundamental change. Crucially, this view has received strong support from the majority of Member States. This means there is a real opportunity to take action.

The challenge now is to translate the sound principles set out in the strategy into practice, not least through public policy. If this is done properly, a number of positive developments should follow. We know that demand for heating and cooling can be significantly reduced through cost-effective measures aimed at improving the quality of the building stock. In parallel, the strategy highlights the need to replace 'obsolete fossil-fuel boilers' with efficient, low-carbon

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alternatives. In cities, where the density of demand lends itself to the use of collective solutions, DHC networks are the ideal means of bringing locally available (renewable or recoverable heat from industrial processes, data centres, and even metro stations!) heating and cooling into a dense urban environment. We are hopeful that the publication of the heating and cooling strategy will be not an end in itself but rather the beginning of a process which will see Europe's heating and cooling landscape completely transformed.

At the level of policy and regulation, is enough being done to create an enabling environment for DHC to flourish in Europe?

Of course it depends entirely where we're talking about. As mentioned above, in the Nordic regions, such an environment has been in place for some time. In many other parts of Europe, it's probably fair to say that this process remains at a fairly early stage. What is extremely exciting and encouraging at the moment is to see how quickly things are progressing, particularly in countries without a rich history of DHC. Primarily, though not exclusively, on environmental grounds, countries such as France and the UK (among others) have established clear and highly ambitious visions for the emergence of DHC as the principle means of delivering low-carbon heating and cooling to their cities. There are currently over 180 ongoing initiatives in the UK alone. This would have been nearly impossible to imagine just a few short years ago, but today it's a reality.

Ensuring that this development continues at the speed and scale that the energy transition requires will indeed require a constructive and predictable regulatory environment. At the most basic level, this simply means a commitment across the various levels of governance (EU, national and local) to driving the energy transition by promoting energy efficiency and renewables over more conventional alternatives. At the level of the EU, it is essential that the concepts set out in the heating and cooling strategy are reflected in the forthcoming wave of new legislation in key areas such as the energy performance of buildings, renewables, energy market design, etc. Obviously, there is much that remains to be done but it's difficult not to feel optimistic about the prospects for the development of district heating and cooling within the European energy transition.

Paul Voss

Paul Voss joined Euroheat & Power at the beginning of November 2013 from Danfoss District Energy, a global leader in District Heating and Cooling (DHC) technology. As Head of Public and Industrial Affairs, he led the company's efforts to engage with policy-makers at global, EU, national and local level. Prior to that, he was responsible for relations with EU institutions in the fields of energy and environment policy at the European LPG Association. He has also worked for CLAN Public Affairs as a public policy analyst.

Geothermal – unlimited heating and cooling under our feet

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A quick glance at the stark figures for heating and cooling in Europe is enough to make clear the need and the potential to improve our energy system by tackling this sector. Heating and cooling represents half of the final energy consumption in Europe whilst 70% of the thermal energy used in buildings comes from burning natural gas, meaning expensive imports, vulnerability to price changes, and the environmental and social dangers inherent in fossil fuel use. In 2013, just 16.5% of the EU'S thermal energy demand was covered by renewables- although this represented 51.5% of the total renewable energy consumed.

Whilst the amount of thermal energy supplied by renewables is small compared to fossil fuels, the potential is much greater. It is feasible that by 2020, 25% of thermal demand could be covered by renewables. That would mean that the number of jobs, already 470,000 in 2013, would more than double, and EUR 21.6 billion would be saved annually in imports compared to 2012[10].

10 Common Implementation Roadmap for Renewable Heating and Cooling Technologies, RHC-ETP

Geothermal energy can provide heating and cooling in many different ways. Shallow geothermal energy harnesses the constant underground temperatures from about one metre underground onwards, with efficient heat pumps used to adjust the temperature to that required in the building. Underground Thermal Energy Storage (UTES) means that thermal energy, at temperatures ranging from 90°C to 5°C, can be stored underground until it is needed. Both shallow and deep resources can be used in district heating networks which can be small, in the range of 0.5MWth- 2MWth or large, with capacities of around 50MWth. Deep resources which are used to produce electricity often also produce heat, in Combined Heat and Power (CHP) plants.

Shallow geothermal all over Europe.

Shallow geothermal energy is by far the most exploited in Europe, with more than 1.4 million heat pumps installed, providing more

than 19,000MWth in 2014. It has, however, been difficult to effectively evaluate the number of installations and energy produced as reporting has not been uniform. This has recently been clarified by the Commission (decision 2013/114/EU) and new data is expected soon.

Most of the installed geothermal heat pump systems (also known as Ground Source Heat pumps, GSHP) are in Sweden, Germany, France, Switzerland, and Norway. However in Central and Eastern Europe an interesting pattern is emerging: although sales numbers are low in absolute terms, the rate of growth is exponential and the market is increasing much more rapidly than in the rest of Europe.

The industry received a boost in September 2015 when new energy labelling and eco-design rules came into force in Europe. These rules concern nearly all boilers, combi boilers and water heaters with rated heat output of less than 400 kW as well as for hot water storage tanks with a storage volume of less than 2,000 litres, labelling them according to efficiency. Geothermal heat pumps are amongst the few to be placed in the highest category, A++ until 2019, after which A+++. GSHP fall into this category as the Seasonal Performance Factor (SPF), the ratio of the heat delivered to the total electrical energy supplied over the year, is today above 4 (benchmark standard), and is heading towards 5 in the near future[11].

11 See RHC-ETP Strategic Research Priorities for Geothermal Technology and Geothermal Technology Roadmap

Shallow geothermal energy is being used in one of Europe's largest passive tertiary buildings which opened in Brussels in 2015. The Brussels Environment building has 16,700M^2 of floor space with thermal energy provided by two 80m boreholes connected to thermo-active floor slabs. It is an exemplary building, demonstrating the use of geothermal in synergy with other renewables like solar as well as energy efficiency measures. The smart grid concept can also be applied to shallow geothermal as it is in the Ümraniye Meydan Shopping centre, Istanbul. One of the largest shallow systems in Europe, 208 Bore Hole Heat Exchangers (BHE) were installed at an average depth of 88m and connected to a hot water loop, using individual heat pumps to direct the thermal energy to where it is needed and providing seasonal thermal storage. In total, the project saves the emission of 350 tonnes of CO_2 per year.

Geothermal district heating (GeoDH) is an ongoing European success story.

The rate at which new GeoDH capacity is installed has been increasing every year for the last five years; an additional 93.3MWth was installed 2012 and 50 MWth in 2015. Growth is happening in three directions: countries with a history of geothermal district heating systems, such as France and Hungary, are continuing to develop their resources in new ways; the Central and Eastern European market, which has a good but under exploited resource, is beginning to develop - Serbia will have the 6th highest number of systems by 2019; and new markets such as the Netherlands are building on lessons learnt elsewhere to develop new and innovative systems. New systems are being built, and existing, fossil fuel systems are being retrofitted to run on geothermal energy.

At the end of 2015, there were in Europe 257 district heating plants operating with geothermal energy, with a total installed capacity of 4701.7MWth. Of these plants, 177 with a total capacity of 1551.8 MWth were in the EU. The countries with the highest capacity are diverse, with Iceland leading the way followed by Turkey, France, Hungary, and Germany. The sector is growing, but remains a fraction of what it could be: there are 5,000 district heating systems in Europe and 25% of the EU population lives in areas directly suitable for Geothermal District Heating.

The development of smart thermal grids, where geothermal is integrated into a flexible, intelligent grid system, is key to future GeoDH development. In smart grids, geothermal resources can be used for base load district heating and (through absorption chillers) district cooling, whilst CHP plants can adapt the share of heat or power produced depending on demand. Shallow geothermal can also be used, with thermal energy storage (UTES) stabilising the grid, and heat pumps providing thermal energy and storage at an individual level.

An excellent example of innovative behaviour in new markets can be found in Heerlen, a former coal mining town in the Netherlands. After their closure, the local mines flooded with groundwater, creating a geothermal resource. In 2005 the town began to investigate using this thermal energy for heating and cooling with a project supported by the European Interreg IIIB programme and the 6th Framework Programme. The concept was proved and now Mijnwater B.V. is an expanding municipally-owned private company which is continuing to diversify and develop.

In its first stage, from 2008-2013, the low temperature resource was delivered to clusters of buildings in a grid, with heat pumps used to adjust the temperature, resulting in a CO_2 emission reduction of 35%. In the second stage, the mine water was used and a reservoir as well as a source, making sure that the resource is not depleted. The grid was expanded and users continued to be grouped into clusters, with energy exchanges both within and between clusters and surplus energy transferred back to the reservoir for storage. Whilst most thermal grids have a top-down structure with a heat plant at the top, the Mijnwater network is based on equal connections in a decentralised system. By 2014, CO_2 emissions had been reduced by 65%. The project, now in its third stage, is changing into a responsive system where supply is altered based on a number of demand-side factors, including the weather and customer demand, and which works in synergy with other renewables.

The future for geothermal heating and cooling

The potential for geothermal is clear but in the next few years some developments must be made. This includes increasing the rate of installation retrofits and refurbishments by making systems easier to install, developing technology which can be used in low-temperature district heating systems, improving the market conditions to make renewables competitive compared to classical alternatives like fossil fuels, and expanding the roll out of Enhanced Geothermal Systems (EGS), a European breakthrough technology which is creating potential for deep geothermal where none existed before.

Alexandra Latham

Alexandra Latham is in charge of communication at the European Geothermal Energy Council, working to facilitate growth in the sector by increasing awareness and improving access to information.

SETIS feature article

EnE-HVAC – a comprehensive approach to HVAC system efficiency

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Heating and cooling for buildings and industry accounts for 50% of the European Union's annual energy consumption. More specifically, heating and cooling accounts for 13% of oil consumption and 59% of total EU gas consumption (direct use only) – which equates to 68% of all gas imports.[12] Although most of the energy currently consumed for these purposes is accounted for by heating, demand for cooling solutions is on the increase.

The calculated total EU space heating load is 2823 TWh, of which 1702 TWh (60.3%) is in the residential sector, 677 TWh (24%) is in the tertiary sector and 443 TWh (15.7%) in the industrial sector.[13] The space heating load in the EU is expected to remain more or less stable, as growth in demand is offset by improved insulation, optimised ventilation (with heat recovery), increased urbanisation (heat islands) and global warming. However, space cooling demand is expected to continue to rise. According to Ecodesign Impact Accounting[14] projections, space cooling demand is expected to rise to 305 TWh (+38%) in 2020 and 379 TWh in 2030, with residential air conditioners expected to account for most of this growth. To reduce overall energy consumption in the heating and cooling sector, the European Commission has identified a compelling need to seek new and innovative technologies and to fund projects developing efficient heating and cooling systems.

One such project is EnE-HVAC (Energy efficient heat exchangers for HVAC applications). This project, funded under the European Commission's Seventh Framework Programme (FP7), aims to achieve significant energy savings in future HVAC systems by using new and innovative technologies that achieve a far better heat transfer efficiency in heat exchangers, with energy savings of up to 50% on the total energy consumption in an HVAC system compared to current conventional commercially-available systems.

In a comment to SETIS, EnE-HVAC Project Coordinator Dr Jacob Ask Hansen stressed that, to minimise energy consumption, it is vital to secure new and innovative technological solutions that significantly improve the energy efficiency of current state-of-the-art HVAC sys-

12 http://europa.eu/rapid/press-release_MEMO-16-311_en.ht
13 https://ec.europa.eu/energy/sites/ener/files/documents/2014_final_report_eu_building_heat_demand.pdf
14 https://ec.europa.eu/energy/sites/ener/files/documents/2014_06_ecodesign_impact_accounting_part1.pdf

tems. He said that new technologies would be brought into play in order to achieve a far more efficient heat transfer in heat exchangers. This will significantly reduce the energy consumed in modern heat exchangers for cooling and ventilation.

The EnE-HVAC project brings three novel technological approaches into play to improve heat transfer and transport throughout a HVAC system, thereby enhancing its overall energy efficiency. Nano-technological coatings limit the formation of ice on HVAC systems, nano-structured surfaces increase the heat transfer in refrigeration systems and nano-fluids increase the efficiency of brine systems. These three technological approaches contribute to the overall efficiency of the system, bringing it closer to its goal of a 50% energy saving.

"This very ambitious goal can be realised only by tackling the efficiencies in all parts of the HVAC systems. The technologies used will address efficiency on both the air- and liquid side of heat exchangers such as condensers/evaporators, and on heat recovery systems. Furthermore, this project will address the heat transport system to ensure high efficiency throughout the HVAC system. To achieve these large energy savings, it does put up large requirements on the refrigerants used; to ensure the largest possible environmental effects, throughout the project there will be a significant focus on the use of "green" refrigerants avoiding HFC and CFC gasses," Hansen said.

Nano-structured coatings and surface treatments, such as Sol-gels and PVD[15] coatings improve heat transfer in HVAC systems. Sol-gel functional coating technology can be used to make thin and transparent coatings with tailor-made functionalities. Sol-gel coatings are applied by standard methods such as spray-coating and are widely used due to their excellent adhesion to metals and their high chemical and wear resistance. Typical film thicknesses reach from a few nm to a few µm. This low thickness makes them extremely interesting for enhancing heat exchangers where good heat transfer is required in combination with other properties such as low adhesion of ice, improved bubble formation, antifouling, etc.

The project's work with nano-fluids is aimed at developing fluids that improve transfer across heat exchanging surfaces. Nano-fluids are nanoscale colloidal suspensions containing condensed nanomaterial in a fluid. The project has investigated the potential of doping refrigerants with nanoparticles to increase the heat transfer from a heat exchanger surface to the refrigerant. Modifications to the particle surface were found to enable their suspension in the refrigerant but no significant effects were observed for the boiling behaviour. Likewise, nanoparticle doped brine systems were investigated but were found to have no significant effect on the heat transfer.

15 Physical vapour deposition: A material is vaporised and deposited on a base material, with which it bonds on a molecular level.

Frost formation on the surface of heat exchangers is a great challenge for energy efficiency. Periodic defrosting by heating is required, which consumes energy. Approximately 13% of a heat pump's total energy consumption is spent on periodic defrosting at ambient temperatures below +7°C. To counteract this, EnE-HVAC has developed super hydrophobic coating systems to slow the formation of ice on cooled surfaces. Even if frost formation is not prevented completely, longer cycles between de-icing result in significant energy savings. Testing of these surfaces in full-scale heat exchanger systems has shown a significant delay of ice formation, with an associated reduction in energy consumption for defrosting.

In order to test the heat transfer improvement of the structured surfaces, a test setup simulating pool boiling has been developed. Furthermore, a large scale heat transfer setup simulating flow boiling is being built and will be used to test the most promising structured surfaces. A well-orchestrated synergy between simulation and experimental tests helps reduce the number of physical experiments required by the project.

By reducing the energy consumption of HVAC systems, nano-technology will help to ensure that future systems are more efficient, thereby reducing the overall heating and cooling load in Europe and enabling the EU to meet the anticipated increase in demand for cooling without an associated increase in energy consumption.

For more information:
http://www.ene-hvac.eu/

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COGEN EUROPE Managing Director

Roberto Francia

TALKS TO SETIS

How is CHP contributing to Europe's policy objectives regarding energy efficiency and the decarbonisation of the European energy sector?

Combined Heat and Power (CHP) is a valuable principle within Europe's energy efficiency and decarbonisation policy toolkit. CHP integrates the production of usable heat and power (electricity) in one single, highly-efficient process. As a consequence heat which would have otherwise been lost can be used to satisfy heat demand directly. Saving primary energy involves significant reductions in CO_2 emissions.

Today, 11.7% of Europe's electricity and 15% of its heat comes from CHP, providing a minimum of 35 Mtoe of primary energy savings and saving Europe around 200 million tonnes of CO_2 per year. The EU's total thermal energy demand consumes 60% of the primary energy resources in the EU and accounts for around 46% of its final energy use. A well designed CHP plant can reach up to 90% overall efficiency[16] in suitable applications. Savings of around 20% can typically be achieved – depending on the individual plants and the reference case[17]. It contributes to decarbonisation targets by significantly improving the efficiency of fossil fuel based technologies, and contributing to the stability of intermittent renewable energy generation and supply. At the same time as a fuel neutral concept, the cogeneration principle can be applied to all energy sources whether renewable or carbon-based, making them more efficient and thereby competitive.

16 Up to 90%, or even higher if flue gas condensation is installed
17 Commission Staff Working Document: Review of available information on an EU Strategy for Heating and Cooling pp 44-45.

It is also a principle that gives heat customers capabilities for electricity self-production, which can support the power system and the functioning of the grid. A significant fraction of the CHP fleet, where heat buffer capabilities can be installed, can be turned to balance the intermittency of supply from renewable sources such as wind and solar.

What potential exists for increasing the proportion of cogeneration in Europe's heat supply?

The Cogeneration Observatory and Dissemination in Europe Project (CODE 2), which was co-funded by the EU via its Intelligent Energy Europe programme, was aimed at identifying the potential for CHP across Europe by the development of 27 National Cogeneration Roadmaps. It found that in 2030 CHP could highly efficiently generate 20% of the EU's electricity and 25% of its heat, on a range of increasingly renewable fuels. The roadmaps, revealed that, in 2030, new and upgraded CHP capacity could be saving Europe 870 TWh of primary energy per annum, representing more than the total gross inland energy consumption of the Czech Republic, Slovakia and Slovenia together. These primary energy savings are equivalent to 350 MT of CO_2 savings representing 16% of CO_2 emissions in the energy sector.

However for this potential to be reached, substantive policy measures need to be put in place on EU and national level. There are a number of market and non-market barriers that necessitate the development of policy frameworks which provide investor certainty, and which internalise the positive externalities that the capture of primary energy creates.

What are the main barriers to CHP deployment and what needs to be done to unlock these barriers to ensure it reaches its full potential?

Overcoming the barriers to CHP deployment requires an energy system paradigm shift on the policy level that can act as an enzyme to precipitate a similar shift in the market. In existing energy market structures, savings at the system level remain a "public good". The fundamental barrier is that there is no market value for the primary energy savings of CHP at the system level. This significantly limits the economic incentive of market actors to invest in CHP solutions. A lack of revenue due to low wholesale electricity prices has also led to a contraction in the production of CHP. If price signals sufficiently reflected the value of primary energy within the infrastructure of the energy market, then this barrier could be sufficiently offset.

For larger CHP installations approaches which lower the operating risk of CHP rather than capital are preferable. However for smaller CHP units such a micro CHP, for use by SMEs and domestic consumers, access to capital is the predominant concern. Consequently, the fostering of alternative business models such as Energy Services Providers that deliver energy efficiency improvements to final customers, on national and EU level should be a central part of any pro-CHP policy framework.

The European Commission, through its 'Heating & Cooling Strategy', has demonstrated an intention to take a holistic approach to energy policy that puts greater emphasis on the primary energy saving potential of CHP. However, for this intent to have tangible results it should be manifested in concrete legislative reform.

The 2012/27/EU directive on energy efficiency (hereafter EED), provides a structure to make progress in terms of heat planning, with suitable measures being required from Member States to promote CHP where their analysis reveals a socio-economic benefit at the Member-State level. However, the EED has been written to allow Member States considerable latitude in how they apply Articles 14 and 15, which are the most relevant to CHP. It could also give Member States clearer and more coherent guidelines as to how they can achieve energy savings obligations using CHP in Article 7. Equally a greater attention to primary energy in the 'energy market design initiative' would ensure that future grid infrastructures are conceived with CHP in mind.

On a Member State level it is evidenced from our 2016 National Cogeneration Snap Shot Survey on the European CHP market, and policy environments and from the findings of CODE 2, that there is a strong perception of fragmentation and uncertainty in CHP legal frameworks across Member States. For investor confidence to be improved, states should avoid actions that create unpredictable or unbalanced market conditions. Germany has introduced a fully-fledged CHP law, as a well-integrated component of its overall energy and environmental policy. This was regarded by the German respondents of our Snap Shot Survey as being a significant factor in unlocking CHP potential in the country.

A stronger political commitment to CHP is an important pre-condition to foster the comprehensive legislative approach necessary for its full potential to be reached.

What is micro-CHP and what does it have to offer in terms of domestic heating and cooling?

Micro-CHP refers to the small-scale production of heat and power for commercial and public buildings, apartments and individual houses. To this end the EED defines 'micro-cogeneration units' as those with maximum capacity below 50 kWe. It is an energy efficiency solution for homes and small businesses, that can address the decarbonisation and energy efficiency objectives of buildings today and in the future, while empowering consumers to become active actors in the energy markets. Micro-CHP technologies have high potential to reduce energy bills for users and improve their environmental footprint, while delivering important energy savings, CO_2 emission reductions and grid services at the energy system level.

In a home of average energy use in Germany or the Netherlands, fuel bill savings of between 26% and 34% were found to be achievable between 2015 and 2020 respectively by using a micro-CHP compared to using a condensing boiler and electricity from the mains[18]. There are around 100 million boilers installed in residential buildings across Europe, 64% of which were inefficient non-condensing boilers in 2012. Micro-CHP is well suited to replace a large proportion of the inefficient heating appliances installed in European homes today. Moreover, the latest additions to the micro-CHP family – fuel cell micro-CHPs - have low "heat-to-power ratios", which makes them particularly suited for new buildings with lower heat demand, while still being adaptable enough to cater to existing buildings also.

Micro-CHP transforms European households into energy 'prosumers', giving them greater control over their energy bills. This also allows households to participate in the market, through 'demand response'[19], enabling buildings to change their electricity production and demand to suit grid conditions. Because micro-CHP production patterns coincide most of the time with peak power demand, CHP can "step in" when the wind is not blowing or the sun is not shining. In

18 Figures based on 2015 Delta-ee modelling. Further details in the publication "The benefits of micro--CHP. A summary of the fundamentals and benefits of micro-CHP for Europe", produced by Delta-ee for COGEN Europe.

19 Demand response is the ability of domestic net-consumption of electricity to respond to real-time prices (net-consumption = consumption- production).

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addition, micro-CHP can be aggregated together as a "virtual power plant", which can be dispatched when intermittent renewables are not generating, helping to reduce grid operating costs as well as additional grid infrastructure investments.

Demand side participation is specified in both the EED and Directive 2009/72/EC, concerning common rules for the internal market in electricity. In the pre-amble of the former it is stated that demand response can help achieve a more optimal use of power systems (making a more efficient use of generation assets and existing power grids). Residential and commercial CHPs are ideal not only for providing ancillary services and reliable capacity to the grid operators but also for this purpose because those individual 'prosumers' can also take part to demand response programmes and reduce their electrical consumption while exporting the power that would have originally be self-consumed.

Micro-CHPs in the higher size range (above 10-20 kWe) are generally cost-effective when installed in large buildings and small businesses (e.g. hotels, spas, farms); future growth in this segment is linked to the need for more awareness about these technologies[20]. The challenge for the lower size micro-CHPs, designed for small buildings (e.g. family houses), is reducing product cost through economies of scale. Projects like ene.field[21], Europe's large scale fuel cell micro-CHP field trial, are demonstrating that the industry is committed to reducing product cost and bringing fuel cell micro-CHP closer to mass commercialisation. Momentum is building up with the market launch of several fuel cell micro-CHPs by European manufacturers, while engine-based micro-CHPs have already been available to customers for a few years. In this context, for micro-CHP potentials to be reached, the industry's efforts will need to be matched by high level political commitment to reward the customer for the environmental and energy security benefits provided by these technologies.

In addition to pre and early commercialisation support, needed at both the EU and national levels, there are still some regulatory barriers that can hamper further market penetration of micro-CHP. Grid connection can be quite burdensome in some countries, despite the Energy Efficiency Directive recommending a simplified "fit and inform" procedure.

European industry is a major consumer of heat. How can CHP contribute to supplying European industry with low-carbon, cost-effective heat?

European Industry is indeed a major consumer of heat: industrial consumption reflects 37% of Europe's heat demand. One of the key virtues of CHP is its appropriateness for efficiently meeting this demand. Industrial processes demand large amounts of heat, making them ideal for high-efficiency cogeneration. CHP is embedded in many sectors including food, agriculture, ceramics, chemicals, refining and paper and in the supply chain of many more industries including packaging, food processing and the automotive sector.

CHP also provides industry with alternative business models that give entities more control over their energy supply at local level. Instead of consuming electricity in a passive way and being subject to fluctuating electricity retail prices, industrial plants are able to generate their own power and heat. These benefits allow industries to boost their productivity by reducing the cost of heat by up to 30%[22]. The savings obtained through cogeneration may be reinvested in the production process and make European industry more competitive.

Just as Cogeneration technologies are ideally placed to satisfy industry's energy demand, industry is well positioned to transfer cogenerated electricity supply onto the grid. Industries using CHP have much to offer electricity networks in addressing issues of capacity and predictability of supply. Industrial CHP electricity is reliably available with scheduled maintenance times, and plant capacity is

20 CODE2 has developed a Smart CHP App and "How to guides" for installing CHP in businesses.

21 The ene.field project receives funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n°303462. More information at www.enefield.eu

22 This Figure comes from internal COGEN Europe evaluation.

normally modest in size compared to central generation, allowing industries to play a role in aggregated supply.

Is the CHP sector as well-established in Europe as in other regions of the world? In terms of policy support, is there anything that Europe can learn from other regions?

The US is behind Europe in terms of the total CHP share in annual national power generation (9% in the US and 11.7% in the EU where it is in decline). While there are several European countries that the US out performs, on average the market and policy climate in the EU appears to be more conducive to CHP investment. However comparisons between the US and EU's heavily regulated and highly taxed business and energy environment are difficult to make. In the US, fuel prices and tax credits are more influential on CHP investment levels and their energy policy-makers operate under different mandates and political conditions.

Greater political commitment to CHP in the US is evidenced on a state level with at least 8-10 US states having advanced CHP policy frameworks. Equally, a growing number of states, have established tradable renewable portfolio standards that include CHP (or waste heat recovery), which mandate that energy providers meet a specific portion of their electricity demand through renewable energy and/or CHP. On a federal level President Obama's Executive Order 13626 of August 2012, 'Accelerating Investment in Industrial Energy Efficiency', calls for 40 gigawatts (GW) of new, cost-effective CHP by 2020. We would like to see similar leadership on a European level, given the comparatively advanced state of the EU cogeneration principle and its manufacturing base. What is interesting about the USA's approach is that it is especially targeting barrier removal. For industry this is a key element of what is needed.

In Japan, industrial CHP makes up 80% of total installed cogeneration capacity. However, the most practicable lessons, that the EU should take from Japan are from its more recent polices on small-scale CHP units. These include, direct subsidies for high-efficiency gas fired units accelerated tax depreciation for small and medium-sized businesses, and expanded research, development and demonstration of fuel cell CHP. The IEA has reported an overwhelming increase in installed stationary fuel cell CHP. Europe should look to the consistent methodologies and coherent funding criteria that were applied in Japan to support committed industry in bringing micro-CHP fuel cell technologies closer to mass commercialisation.

The 2004 CHP Directive and subsequent EED have set up a solid foundation for Member States to further harness the energy savings and CO_2 emission reductions potential of CHP. Ambitious and consistent implementation of the existing EU legislation is the first step in addressing the barriers that the CHP industry faces today. Further CHP deployment will also depend on the EU energy and climate policy framework taking a more integrated approach towards the energy system, exploiting synergies between heat and electricity and addressing supply, transmission, distribution and demand together.

The multi-jurisdictional presence of the CHP industry has been increasing steadily. A plurality of countries at different stages of industrial and commercial development have been seeing the virtues of CHP in terms of its contribution to energy efficiency, and decarbonisation. Maintaining the transnational dialogue is key to building up the global CHP market.

Roberto Francia

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SETIS feature article

H&C in buildings: a holistic approach to energy renovations

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A zero-energy building is a building with zero net energy consumption, meaning that the total amount of energy that it consumes throughout the year is supplied from onsite renewable sources. Achieving zero-energy status requires a two-pronged approach, where the latest construction techniques are combined with renewable energy technologies in a holistic approach that simultaneously reduces the buildings' energy demand while increasing its onsite energy production capacity.

Buildings are responsible for 40% of energy consumption and 36% of CO_2 emissions in the EU and heating consumption in the residential sector in the EU has been calculated at 1702 TWh/y.[23] Cooling, while currently accounting for a significantly smaller share, is expected to see a major increase in demand in the mid to long-term. Consequently, technologies that contribute to reducing the heating and cooling requirements of a building, and that efficiently supply its heating and cooling needs from renewable sources, will be critical in achieving a building's zero-energy status, and go a long way towards decarbonising the residential sector in Europe.

For new build, significant decarbonisation can be achieved relatively easily, by state-of-the art intelligent building design combining the latest insulation materials with renewable energy systems and other techniques in a holistic approach[24], subject only to cost constraints.

23 https://ec.europa.eu/energy/sites/ener/files/documents/2014_final_report_eu_building_heat_demand.pdf

24 Such techniques may include thermal storage, intelligent building controls, shadings and passive cooling, efficient heat exchangers for ventilation, connection to a low carbon heating and cooling grid, etc.

Indeed, the European Parliament's Energy Performance of Buildings Directive requires all new buildings to be nearly zero energy by 31 December 2020. All new public buildings should achieve this target by 31 December 2018. However, the challenge is more daunting when it comes to the existing building stock. The replacement rate of the existing housing stock is very low (1-1.5% per year), and reorganisation of the sector is a very complex task due to its extreme fragmentation: more than 50% of residential buildings are privately owned by individual private owners. Energy renovations in existing buildings have to cope with the structure and configuration of the building, which often limit efficiency or applicability of the technical options available.

The Horizon 2020-funded BuildHeat project aims to address the challenges posed by the existing residential building stock, by elaborating systemic packages for the deep rehabilitation of residential buildings and developing innovative technologies to facilitate their renovation. To ensure the large-scale entry to market of the new technologies, the project will also devise inventive financial instruments to enable large public and private investments. Finally, to increase awareness and stakeholder involvement, the project will engage with stakeholders all along the construction chain – from owners, to professionals, to investors - from the very beginning and throughout the building life cycle.

In order to increase the market penetration of its residential deep energy rehabilitation solutions, BuildHeat will ensure that these solutions offer high energy performance, comfort and a healthy home environment. The solutions will also be unobtrusive and easy to install and be scalable (from dwelling to district level) in terms of energy management and financing. The systemic renovation packages proposed by the project will exploit opportunities offered in terms of RES availability at building level (i.e. aero-thermal and solar energy). In designing the systems, attention will also be paid to the final energy consumption, which is related to the users' annually incurred cost; to the primary energy, which is related to the overall environmental impact; and to the capital cost.

With respect to the technologies used, the project will investigate photovoltaic-driven air-to-air heat pumps, with integrated domestic hot water production and power storage capability. This innovative heat pump system will combine renewables at building level with ambient heat recovery to supply the buildings' heating and hot water needs. The project will also work with centralised heating systems, incorporating warm water storage tanks and local solar thermal collectors in a systemic approach to space heating and domestic hot water supply. Both of these technological approaches will integrate compact thermal energy storage, facilitating the shift of demand from peak to off-peak periods and making it possible to reap the maximum benefits from the renewable energy source.

The project will also develop a façade system that allows easy setup of passive components, such as insulation, windows and shading systems, with active elements such as PV panels and solar thermal collectors. Efforts will also be undertaken to address envelope improvements, with a view to significantly reducing the buildings' heat needs, while at the same time controlling the risk of overheating. The approaches used in the systemic upgrade packages will be standardised, facilitating the easy integration of both the passive and active components.

Another project taking a systemic approach to the retrofit of the existing building stock is the Horizon 2020-funded E2VENT project. Like BuildHeat, E2VENT aims to develop, demonstrate and validate a cost-effective, highly energy-efficient, low-carbon system for retrofitting residential and commercial buildings. The project will achieve nearly zero energy building retrofit standards using smart modular heat recovery units (including thermal storage) along with high efficiency photovoltaic units, HVAC systems and high performance adapted products for external thermal insulation.

The technologies developed will be integrated into a ventilated façade, operation of which will be controlled by a real-time intelligent façade management system. This system will use weather forecasts to predict the level of decentralised electricity production, which will be correlated with the building's energy (electrical and

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thermal) demand, enabling the most efficient use of energy from renewable sources. The use of heat recovery units and other variables, such as the number of photovoltaic cells, natural lighting strategies, and the thickness of the insulation can all be adjusted depending on the characteristics of the building. This makes the E2VENT system versatile and adaptable to different building types and climates. The project's holistic approach, incorporating active and passive elements, will result in energy savings of more than 40% and a reduction of at least 40% of CO_2 emissions, thanks to the primary energy savings.

If the retrofit solutions developed by BuildHeat, E2VENT and other EU-funded projects are to have the desired impact on energy efficiency in the residential sector and achieve their full potential in contributing to the targets set in the Energy Performance of Buildings Directive, it will be necessary to target the wider community of building professionals and owners in order to raise awareness and increase the market uptake of these systems. To this end, both projects include stakeholder engagement components. As regards new build, the outreach efforts are supported by the Promotion of European Passive Houses (PEP) project. Funded by Intelligent Energy Europe, this project aims to promote the potential of the passive house concept in Europe by developing information packages and design tools for passive houses, organising workshops, symposia and conferences, and through an international passive house website.

For more information:
http://www.buildheat.eu/about-buidheat/
http://www.e2vent.eu/
http://pep.ecn.nl/

The biomass approach to heating and cooling

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Biomass in the form of log wood has traditionally been used for heating purposes since the discovery of fire and even now it is a very important energy source. In the year 2012, almost 54% of total renewable energy in the EU-28 came from biomass, while in the heating and cooling sector the share was 86%. The amount of biomass used for heating/cooling purposes is expected to increase by 24% between 2012 and 2020, while its share in the renewable energy mix is going to decrease slightly due to faster proliferation of other renewable sources[25]. When looking at the primary energy level, the expectations are that by 2020 biomass could contribute 13% of the EU primary energy demand[26].

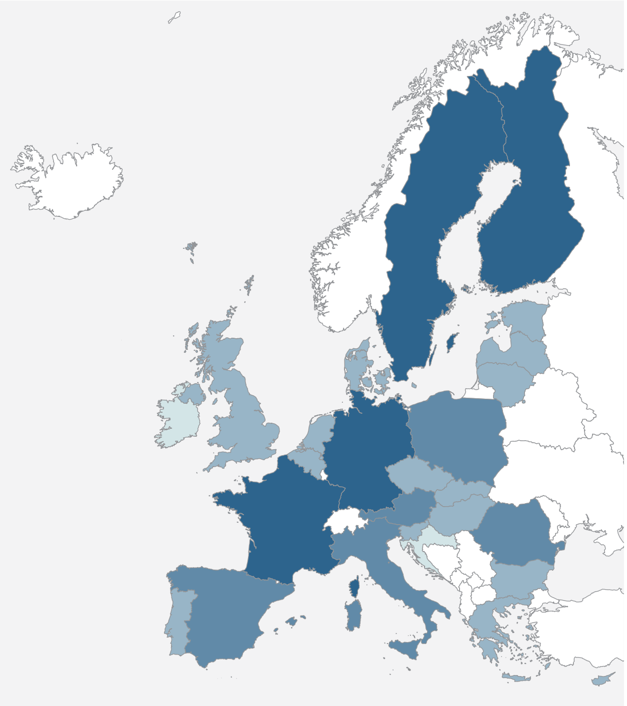
At national level, the highest amounts of biomass are used in large countries like Germany and France or countries with long heating season like Sweden and Finland. In order to reach their 2020 targets, most Member States will have to increase the use of biomass for heating and cooling purposes but some, such as Estonia, Austria and Slovenia, have already reached their targets, as indicated in the map above.

At household level, biomass for heating purposes is traditionally used in stoves where log wood or briquettes are fired to generate heat in a decentralised way at typically low efficiency between 10% and 30%[27]. Besides stoves, small scale boilers can also use similar types of fuel for small, household central heating systems. These systems

25 Source: Banja M., Monforti-Ferrario F., Bódis K.: Renewable energy technologies/sources path within EU 2020 strategy; EUR 27447 EN; doi: 10.2790/113648

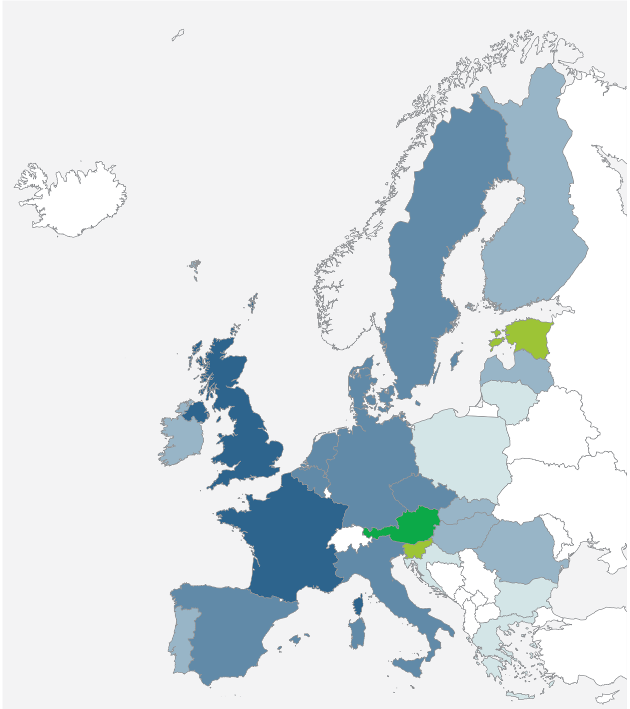
26 Source: Ruiz Castello P, Sgobbi A, Nijs W, Thiel C, Dalla Longa F, Kober T, Elbersen B, Hengeveld G: The JRC-EU-TIMES model. Bioenergy potentials for EU and neighbouring countries; EUR 27575; Luxembourg (Luxembourg): Publications Office of the European Union; 2015; JRC98626

27 Source: Lacal Arantegui R, Jaeger-Waldau A, Bocin Dumitriu A, Sigfusson B, Zubi G, Magagna D, Perez Fortes M, Moss R, Lazarou S, Baxter D, Scarlat N, Giuntoli J, Moro A, Padella M, Kousoulidou M, Vorkapic V, Marelli L, Steen M, Zucker A, Moya Rivera J, Bloem J, Gutierrez Moles C, authors, Carlsson J, Vellei M, editors; 2013 Technology Map of the European Strategic Energy Technology Plan (SET-Plan)- Technology Descriptions; EUR 26345; Luxembourg (Luxembourg): Publications Office of the European Union; 2014; JRC86357



Renewable heat/cool from biomass-th 2012 (ktoe)

- <500
- 500 - 2 500
- 2 500 - 5 000
- 5 000 - 11 000
- n/a



Expected RES-HC from biomass-th 2012 (ktoe)

> Plan 2020

- >400
- 20 - 50

< Plan 2020

- 0.5 - 100
- 100 - 500
- 500 - 800
- >1 400
- n/a

Renewable energy from biomass in each EU MS, 2012 (left) – gap to 2020 (right)

can usually also use smaller sized fuels like pellets or wood chips, which enable automatic feeding. In recent years, with the development of modern condensing wood pellet boilers, the efficiency of these systems has increased to almost 90%.

Middle-sized centralised systems dedicated to heat generation in small networks use fuels which enable automatic feeding, like pellets or wood chips, and usually use hot water boilers to generate heat at the level of up to 90% efficiency. In wood industries it is not uncommon to find fire-tube steam boilers which generate saturated steam for industrial use and provide heat for heating purposes by the means of heat exchangers.

Larger district heating systems and industrial plants fuelled with bio-origin fuels usually use cogeneration technologies. In the case of solid fuels, like straw, forestry biomass, municipal solid waste or sewage sludge, water-tube steam boilers are often used, usually with a grate incineration system and sometimes with fluidised bed incineration. The steam turbine - generator set is used to convert energy from steam to electricity, while either bleeds or back-pressure outlet are used to generate heat in the form of steam. The use of condensing instead of back-pressure turbines increases operational flexibility and makes it possible to increase the profitability of a plant by selling more electricity to the grid. The efficiency of these plants directly depends on the way the plant is operated: with high heat generation and low electricity generation the overall efficiency may exceed 80%, while in the case of low heat generation and high electricity generation the efficiency may drop below 30%.

For smaller wood industries with significant heat demand throughout the year, organic Rankine cycle (ORC) cogeneration has also been proven to be a competitive technological option. These plants are usually designed as a combination of an oil biomass boiler where the energy from biomass is used to heat thermal oil, a heat exchanger where the energy from thermal oil is transferred to the organic medium which evaporates, and a turbine - generator set where the electricity is generated. The organic medium is then condensed in the condenser and the heat generated from this process can be used as commercial product. The overall energy efficiency of these plants at nominal capacity is higher than in steam Rankine cycle plants, but the problem is lower flexibility in operation. Another issue with these plants is that both thermal oil and the organic medium are flammable media operating at high temperatures, which is why the size of these plants is usually below 10MWel, but as the technology develops the size is increasing.

Another technology which is not widespread, but can be found in smaller scale systems, is the externally fired hot air gas turbine. This technology consists of a combustion chamber with a heat exchanger where the energy from biomass is transferred to hot air. Hot air at a temperature of between 800°C and 900°C enters the gas turbine – generator set where the electricity is generated and the exhaust air at the temperature 600°C enters the combustion chamber where the biomass is incinerated. Flue gases from biomass incineration leave the first heat exchanger at a temperature of between 300°C and 400°C, after which this heat can be used by means of another heat exchanger in a secondary circuit. For wider use of this technology it would be necessary to reduce capital costs.

Besides the direct use of dry solid biomass, another option which is commonly used is the production of gas from biomass. Dry solid biomass and municipal solid waste are suitable inputs for gasification processes, where the main product is syngas. Wet agricultural biomass, residues from farms and food industries and residues from waste water treatment systems and sewage systems are suitable input material for anaerobic digestion plants where decomposition of biodegradable material is carried out in faster and controlled conditions. The result of this process is biogas. In normal conditions, anaerobic digestion is a natural process which happens to all material of biological origin and for this reason can be found also on landfill sites, where the gaseous product is called landfill gas. Biogas and landfill gas consist mainly of methane (CH_4), while syngas also contains significant amounts of carbon-monoxide (CO). These gaseous fuels are used in internal combustion engines to generate electricity, and useful heat is collected from exhaust gases, engine cooling system and engine oil cooling system, which makes these CHP plants very efficient.

Several processes allow for the production of liquid bio-fuels, which can be used for heating or cogeneration purposes. However these fuels are most often used as biofuel in the transport sector.

When cooling is needed, absorption (COP between 0.5 and 2.2) or adsorption (COP 0.5-1.5) systems can be used to convert the available heat for cooling purposes. In the EU, 4.8% of the final energy for used heating and cooling is dedicated to cooling, with large differences across Member States, from 2.4% in Sweden to nearly 50% in Malta. Most of this cooling is produced by traditional mechanical compression systems, often electricity driven. When renewable or waste heat is available, thermal cooling by absorption or adsorption are interesting options.

Hrvoje Medarac

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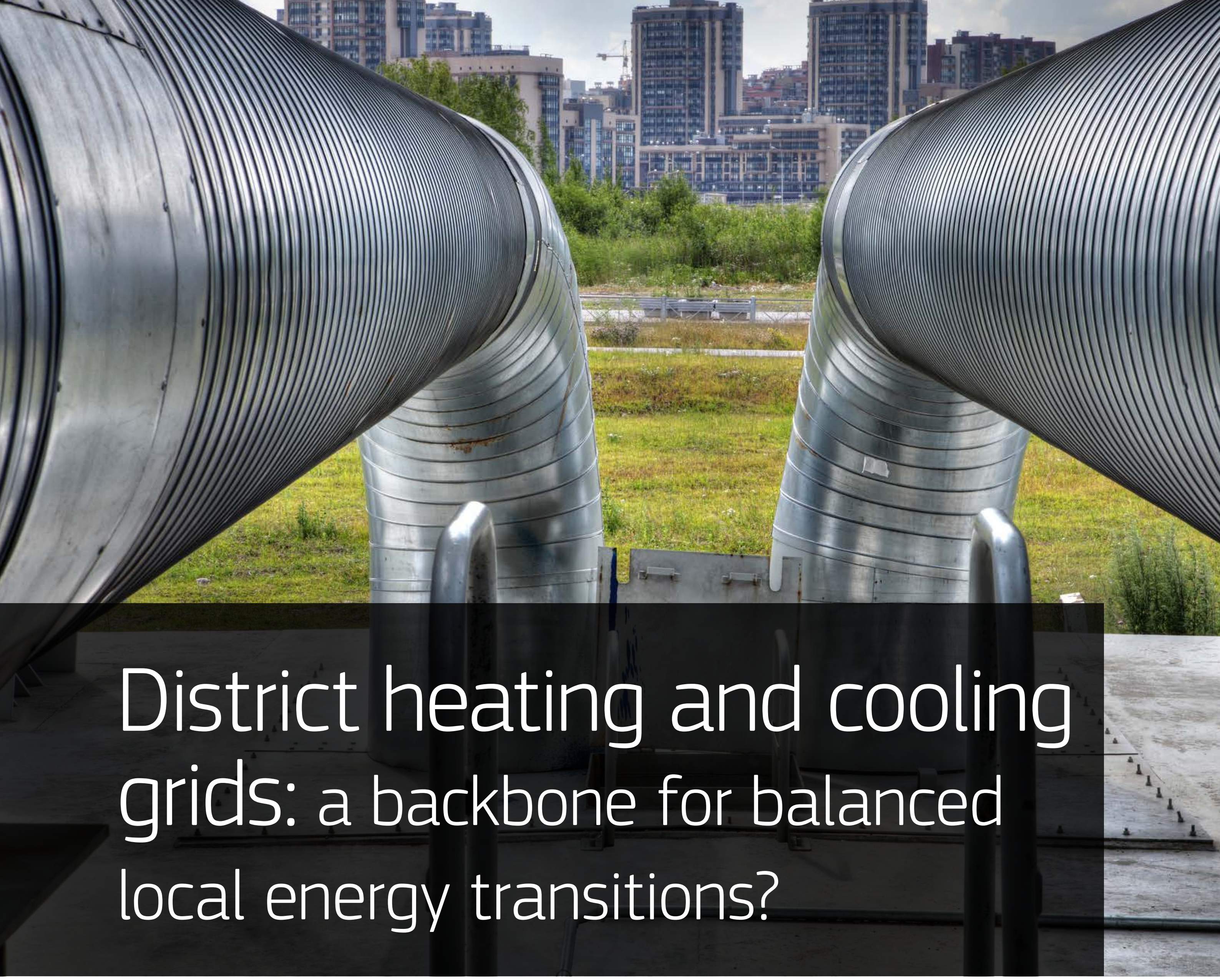

District heating and cooling grids: a backbone for balanced local energy transitions?

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As the energy transition focuses on holistic energy efficiency policies at the local level, more attention is paid to efficient district and heating and cooling (DHC) networks. Because of their various advantages, they appear in many respects as a potential backbone for coherent local strategies, mainly due to the fact that they enable local authorities to combine a variety of energy efficiency and decarbonisation leverages.

At one end, they can be supplied by several local renewable energies, ranging from various biomass fuels to geothermal energy, but also including biogas from waste or sludge, often through cogeneration, and other potential sources. At the other end, they are closely linked to efficiency policies in buildings, both as regards new construction and refurbishments. Although it is sometimes emphasised that progress in buildings' energy consumption might reduce the economic scope for urban heating grids, both can actually be part of a renewed strategy: many field cases evidence that those new building performances do not undermine the relevance of densifying or developing urban heating networks, though they certainly influence the technical models and pricing structures that underpin their development.

As an example, the new DHC grid of the Saclay research and universities cluster, south of Paris, which combines tertiary buildings and collective housing, mainly based on low-temperature geothermal energy, is being developed after it has been evidenced that it will provide a more efficient heating and cooling supply than autonomous, building-level solutions.

In many cases, this combination of fuel decarbonisation and optimised consumption is a powerful cost-efficient leverage for deep local decarbonisation. It also stimulates local economic activity and paves the way to more balanced, resilient energy systems.

But the scope for developing new, efficient heating and cooling networks goes beyond this, especially if one considers it from a mid- to long-term perspective. Two other sets of factors are to be considered, that will allow deeper energy optimisation to occur, and will provide increasing scope for developing efficient district heating and cooling in the near future.

The first one, particularly relevant in low- and mid-temperature grids (<40°C), providing both heating and cooling, is related to the numerous possibilities for energy recycling and exchanges which those grids make possible. In those cases, the grid not only conveys energy from primary sources to end users, but can be used as a complex optimisation system, connecting various energy profiles at different points of their cycles, in order to optimise their combination, and multiply secondary energy sources within the grid itself. New remote control and smart metering devices create a range of new possibilities in those grids.

The second set of factors builds on possibilities to connect those "smart" heating and cooling grids with electricity and gas grids. This will gradually enable real time arbitration between multiple energy sources to supply specific local needs. But it will also help in managing the costs and addressing the technical challenges of the instability linked to the increased share of renewables in electricity grids. The reason for this is that heating and cooling grids comprise key devices such as heat pumps, small cogeneration facilities or cheap centralised or decentralised thermal storage, which, when properly combined with local electrical systems, can help to efficiently manage intermittency from wind and solar sources, at a far lower cost than current electricity storage or power-to-gas devices. In a country like Denmark, the installed renewable capacity now roughly equals peak power demand: a large part of the resulting instability is managed through small, decentralised, power driven combined heat and power (CHP) facilities. Those small CHP facilities provide, on average, 50% of Denmark's electricity, and they are connected to various DHC grids, and to thermal storage devices, usually through water. They were consciously designed and gradually developed from the 1980s onwards as a key component of optimised systems enabling the country to develop its renewable power capacity well beyond the points that were long regarded as thresholds beyond which local electricity grids would become unmanageable, or unaffordable.

Energy systems will only be "smart" if they enable this flexible multi-energy supply to build up, and to a large extent, the backbone of those future multi-energy grids will be in DHC grids, because most of the devices and equipments allowing cost efficient, real time supply-need adjustment will be both rooted in local heating and cooling systems, and articulated with other energy supply grids and systems.

In order to facilitate these new transition steps, several policy challenges will have to be addressed at local, national and European level. Though heat represents more than 50% of our total energy consumption, the average share of district heating and cooling networks in its supply is currently only 12% in EU Member States.

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At the local level, a range of concrete challenges have to be faced by public city planners, grid managers and energy providers in order to allow for new grid architectures to emerge, allowing complex energy optimisation to occur. Some of these challenges are different in new urban areas and in old ones.

As regards new areas, planning authorities have to face a high degree of complexity, and the corresponding modelling work, in order to choose or promote energy solutions and grid architectures that will minimise total life cycle costs for new grids, including connection/metering and production/storage devices which are best suited to the needs and resources of the area.

This choice is not simple, for several reasons. Competing energy providers and various off-takers usually promote different solutions. The value of future price stability, which can be achieved by replacing market exposed fossil fuels by renewables such as geothermal energy or biomass, is hard to estimate on long period/life cycle budgeting approaches, which are relevant in these cases, and so are positive environmental externalities, most of which are under-priced in the current economic environment. Last but not least, defining a "collective local optimum" requires due consideration and ponderation of various parameters that affect various stakeholders in different ways.

Moreover, as efficient, downsized, sub-systems develop, though the benefits of a collective grid usually depend on the width, diversity and density of its customer base, choices have to be made in order to promote collective optima without deterring decentralised innovation, freedom of choice and initiative. This balance is not always easy to strike.

In older urban areas, where development of DHC networks is linked to various parameters, such as pre-existing boilers at building level vs individual ones, margins for developing new grids or extending existing ones may seem narrower. But densification can occur on a large scale, heating needs will remain much higher than in new, energy efficient, buildings, and yet unaddressed cooling needs may also provide scope to reengineer overall energy supply concepts, providing new scope for DHC grids. Several European cities, such as Stockholm or Vienna, have successfully conducted such developments in densely built urban areas.

At national level, adequate support schemes and relevant legislation can also play a key role in supporting highly efficient, environmentally friendly DHC grids. As the collective benefits of these projects increase over time, and as both the predictability of variable energy costs and environmental externalities are usually under-priced in the current EU environment, investment subsidies and tax incentives based on those criteria can alleviate the cost of service for the first users of innovative, capital-intensive solutions such as geothermal-fuelled DHC grids, who might bear a proportionally larger part of capital costs through tariffs than later users. In some cases, mandatory connection rules, which support densification and reduce overall investment payback, can also be relevant, provided that they maintain incentives for new competitive supply to be integrated over time.

As most of the decision-making power lies at municipal level, and part of those systems can be developed in-house by those public local bodies, EU policies can't shape the DHC markets as directly as they've done for gas and electricity supply. But numerous instruments remain available to support municipalities and local bodies to develop cost-efficient, environmentally friendly DHC grid systems.

On the supply side, cogeneration and tri-generation often appear as the cornerstone of smart local systems, especially when they combine industrial and household customer bases. A stronger support to those facilities, potentially articulated with emerging capacity market rules, could be a valuable way to indirectly support modern DHC grid systems.

On the conception and engineering side, the various means by which European policies support and finance efficient local energy systems, based on a combined assessment of needs and resources, also provide indirect support to DHC grids - which often emerge as the relevant off-taker of newly tapped local energy resources - and integrate them into a balanced, real-life assessment of energy needs.

Last but not least, research on smart grid systems must focus on multi-energy systems, and should integrate a stronger DHC grid component. The first demonstrators were mostly electricity focused, and lacked a multi-energy dimension. New European research programmes will also have to be up-scaled in order to enable public authorities to use system operation feedback as an input to new system architecture, and reduce investment in production and grids due to better peak shaving, the anticipation of which will spare both new capacity and grid reinforcement investments in local systems. They will also integrate a broader variety of energy uses, such as electric mobility, into the scope of their experiment.

Cyril Roger-Lacan

Mr Roger-Lacan is co-founder and CEO of Tilia, a Franco-German based company that develops innovative and efficient energy and environmental solutions and projects with cities, utilities, communities and industries, through result-oriented partnerships. Mr Roger-Lacan has held senior executive responsibilities both in government and public policy institutions, such as the French Conseil d'Etat, to which he belongs, and in the utility industry where he has been CEO for Europe of a large, global environmental services group. He has published more than 50 articles on environmental and energy policy, and new urban development patterns.

SETIS feature article

Solar thermal – fulfilling its heating and cooling potential?

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As an extremely convenient heating source, based on a simple concept enhanced by cutting edge technology, solar thermal energy has the potential to be a major source of heating and cooling in Europe. Technological advancements have seen solar thermal become not only a better option for more traditional applications, such as domestic hot water production, but also a promising solution for new and more advanced applications such as industrial process heat.

However, despite this potential, the share of solar thermal in Europe's supply of heating and cooling is still far below 1%, and European solar thermal markets are stagnating or declining. The market in 2014 amounted to 2 GWth (approximately 2.9 million m²), down 7.1% from the previous year. In the same year, the total installed solar thermal capacity registered a net increase of 1.6 GWth to reach 31.8 GWth (45.4 million m²), up 5.3% from 2013.[28] This poor performance is largely a result of the fact that the European market continues to suffer from declining sales in its largest national markets, where sales are currently at the level of 2007.

There are several reasons behind this sluggish performance, such as low gas prices, difficult access to finance for consumers, a slow-moving construction sector, fewer public support schemes for solar thermal and competition from other energy sources, (sanitary hot water heat pumps, condensing gas boilers, and so on) that are also eligible for incentives and offer cheaper installation costs. According to the EurObserv'ER Solar Thermal and Concentrated Solar Power Barometer 2015, the solar thermal sector also has to contend with 'internecine competition' from solar photovoltaic, which is also addressing the domestic hot water segment.[29]

Europe is making good progress towards its 2020 targets for electricity, but the heating and cooling sector risks missing the indicative

28 http://www.estif.org/fileadmin/estif/content/market_data/downloads/2014_solar_thermal_markets_LR.pdf

29 http://www.eurobserv-er.org/solar-thermal-and-concentrated-solar-power-barometer-2015/

target for 2020 by 19.5%.[30] If this trend is to be reversed, then a number of challenges will have to be overcome, including increasing the competitiveness of solar heating and cooling by reducing the price for solar heat by 50% compared to 2013. It will also be necessary to simplify thermal heating systems by developing easy-to-install compact solar hybrid heating systems that are more user-friendly. The solar fraction[31] will also have to increase from about 25% to 60% in solar active houses. Finally, the market for solar thermal applications will have to extend into new segments, such as industrial processes.

Reflecting these priorities, in its Solar Heating and Cooling Technology Roadmap[32], the European Technology Platform on Renewable Heating and Cooling (ETP-RHC) identifies three pathways to meet the main short to mid-term challenges for a significant increase in the solar thermal market share. These are the development of Solar Compact Hybrid Systems (SCOHYS), the development of Solar-Active-Houses (SAH) and the development of systems for Solar Heat for Industrial Processes (SHIP).

SCOHYS are compact heat supply systems that include a solar heating source and a backup (e.g. based on bio energy or heat pumps). In the case of domestic hot water (DHW) systems, which deliver only domestic hot water, these have a solar fraction of at least 50%, while combi SCOHYS systems, which deliver both, domestic hot water and space heating, have a solar fraction of at least 25%. By 2017, SCOHYS is expected to be available as prototype for single family homes (DHW and combi systems) and for multifamily homes (DHW) with solar heat costs reduced by 35% in comparison to 2013, leading to fossil fuel parity in southern Europe (<10 €ct/kWh).6 By 2020, it is planned that SCOHYS for multifamily homes will also be available as combi systems and the SCOHYS systems should be ready for broad market deployment with solar heat costs reduced by 50% compared to 2013, reaching the fossil fuel parity target for Central Europe.

30 Renewable energy progress and biofuel sustainability, ECOFYS et al, 2012
31 The share of solar energy in overall heat demand
32 http://www.rhc-platform.org/fileadmin/user_upload/Structure/Solar_Thermal/Download/Solar_Thermal_Roadmap.pdf.
33 Results for 1995-2012 are based on Member State Progress Reports and Eurostat.

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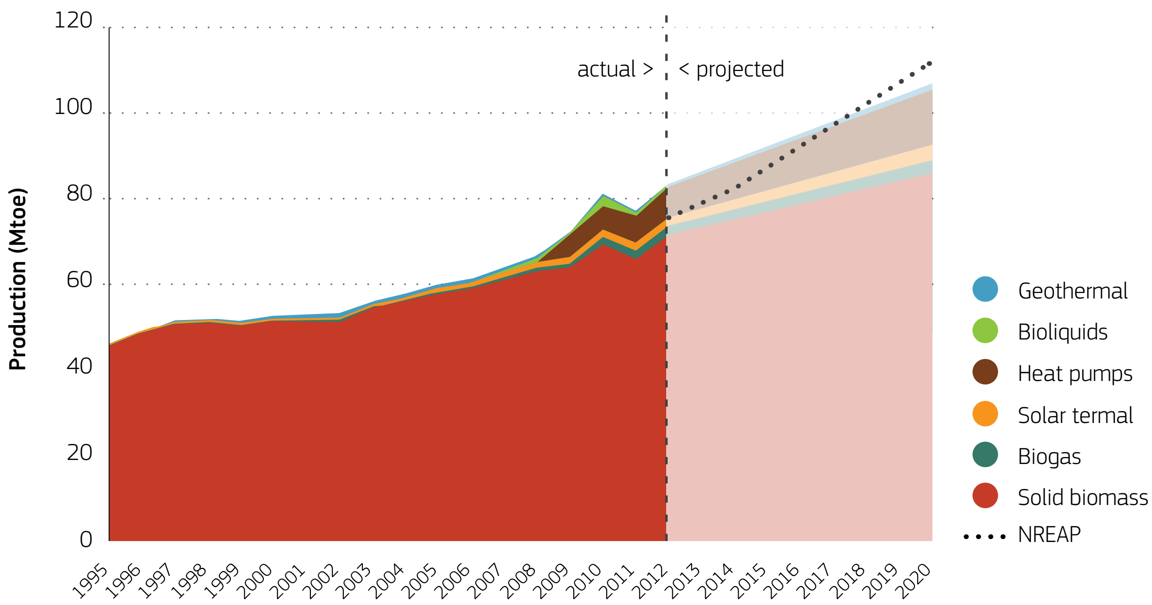
Production of heating and cooling from RES-H&C technologies in the EU-28 for 1995-2012 (actual) and 2013-2020 (projections)[33]



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Solar Active Houses offer a nearly zero energy solution for new buildings and buildings undergoing major renovations. Based on improved insulation standards for buildings and improved solar heating technology, the Solar-Active-House with a solar fraction of about 60% (SAH60) has been developed with a good combination of high solar fraction and acceptable storage volume. In Central Europe a typical single family Solar-Active-House needs a collector area of 30 to 40 m^2 and a water storage tank of only 5 to 10 m3. More than 1300 of these Solar-Active-Houses have already been built and, by 2017, SAH60 for new-build single-family homes should be available as a standardised solution that can be used by all planners and construction companies. By 2020, a standardised SAH60 solution for small multifamily homes and refurbished buildings is also expected to be available. The SAH60 aims to be cost-competitive with other nearly zero-energy buildings and will provide solar heat at costs comparable to today's combi systems in Central Europe (between 15 and 20 €ct/kWh).6

Solar Heat for Industrial Processes (SHIP) is a collaborative project that aims to provide the knowledge and technology necessary to foster the installation of solar thermal plants for industrial process heat. The project is currently at a very early stage of development - fewer than 120 operating SHIP systems are reported worldwide, with a total capacity of over 40 MWth (>90,000 m^2). Most of these systems are relatively small pilot plants. However, there is great potential for market developments based on innovations, as 28% of the overall energy demand in the EU28 originates in the industrial sector and the majority of this heat demand is in the temperature range below 250°C. By 2017, the SHIP roadmap pathway should achieve solar heat costs in the range of 5-9 €cent/kWh for systems with 10-20% solar fraction, by reducing the investment costs to 350 €/m^2 for low-temperature SHIP systems including storage and 400 €/m^2 for medium-temperature SHIP systems without storage. By 2020, it is expected that the solar heat costs will be further reduced to 3-6 €cent/kWh for low-temperature applications below 100°C and 4-7 €cent/kWh for medium-temperature applications below 250°C.6

Another obstacle to the advancement of solar thermal heating and cooling identified by EurObserv'ER is the fact that, for several years there has been a dearth of communication on the solar thermal sector with no national institutional promotion campaigns. If the targets set in the ETP-RHC roadmap are to be achieved, communications campaigns will be essential, as they will imply public authority advocacy of solar thermal technology and help guide consumers in their investment choices, allowing solar thermal to reach its potential as reliable supplier of competitively-priced heating and cooling in Europe.

For more information:
http://www.rhc-platform.org/structure/solar-thermal-technology-panel/

The Horizon Prize for a Combined Heat and Power (CHP) installation in a hospital using 100% renewable energy sources

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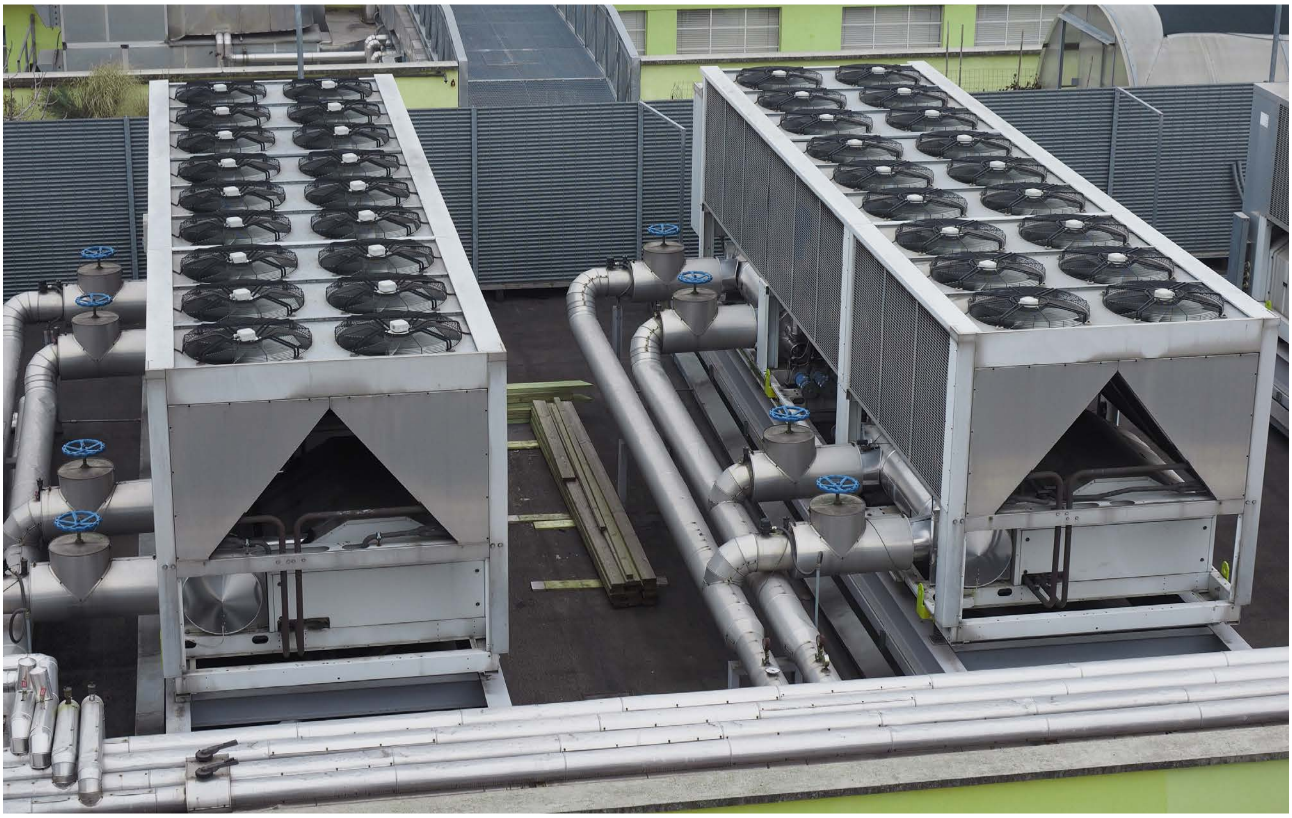
The European Union is committed to reducing its greenhouse gas emissions by 20% by 2020 and by at least 40% by 2030 compared to 1990 levels. Moreover, the Renewable energy directive sets a binding target of 20% final energy consumption from renewable sources by 2020 and the EU countries have already agreed on a new renewable energy target of at least 27% of final energy consumption in the EU as a whole by 2030.

Many aspects concerned with the integration and use of renewable energy in buildings for heat and power generation still need to be addressed to achieve a reliable and cost-effective supply. This is particularly challenging in the case of hospitals, for which security of energy supply is of paramount importance.

The European Union supports research activities to address the Societal Challenge "Secure, clean and efficient energy" through the Framework Programme for Research and Innovation "Horizon 2020". In the third quarter of 2016 a new Horizon 2020 initiative to promote innovation in renewable energy technologies will be launched: a Horizon Prize for a Combined Heat and Power (CHP) installation in a hospital using 100% renewable energy sources.

The prize will induce innovative renewable energy solutions integrating several technologies into one energy system able to supply both electricity and heat. Installing this kind of integrated equipment in the ecosystem of a hospital will not only ensure the security of its energy supply but also raise public awareness and provide a showcase for many other applications.

The prize, indicatively worth EUR 1 million, will be awarded in late 2019 to the installation with the best performance in terms of (among others) reliability, integration with the premises, operation



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and maintenance costs and reduction of greenhouse gas emissions. The installation should be recent, but operated continuously for at least six months, and contain an innovative energy storage component. The system will have to cover 100% of the hospital's annual energy needs, supplying at least 2 million kilowatt-hour electricity per year. The solution should also be replicable to other sites and include three different European renewable energy technologies.

The Horizon Prize is part of the European Commission's series of "challenge" or "inducement" prizes, which offer a cash reward to whoever can most effectively meet a defined challenge. As policy tools, these prizes are particularly adapted to circumstances where a number of competing technologies can deliver similar outcomes.

The specific rules of contest will be published later in 2016. For more information, please visit:
Horizon Prizes: https://ec.europa.eu/research/horizonprize/
Horizon 2020 Work Programme 2016 - 2017 'Secure, Clean and Efficient Energy'

This article was contributed by the European Commission's Directorate-General for Research & Innovation (DG RTD).

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