

District Heating & Cooling

A VISION TOWARDS 2020 – 2030 – 2050

Contents

- 4** Introduction
- 6** The future starts today
- 14** **Vision 2020 - Deploying best practices**
Low-hanging fruit
Towards 2020
- 20** **Vision 2030 - Realizing the greater potential**
Integrated solutions
Towards 2030
- 24** **Vision 2050 - Zero carbon solutions**
Envisioning 2050
- 26** **Annex: DHC – Fundamental idea**

Introduction

This document contains the European Vision for District Heating and Cooling (DHC) technology.

Starting with the present-day situation, the Vision sets out in global terms how District Heating and Cooling stakeholders see the future development of their industry. It reflects on the basic features of District Heating and District Cooling and on the ways the systems are expected to evolve throughout their subsequent stages of development – showing why they are key infrastructures for a resource efficient European energy system, both of today and of the future.

Challenged by climate change, the need to secure sustainable economic growth and social cohesion, Europe must achieve a genuine energy revolution to reverse present-day unsustainable trends and live up to the ambitious policy expectations. A rational, consistent and far-sighted approach to heating and cooling is key for ensuring such transformation.

While overlooked by policy discourse for years, the heating and cooling sectors are major players on the energy market, responsible for more than half of total final energy consumption and a significant share of European greenhouse gas emissions.¹

It is clear that heating and cooling – and more specifically the most optimal forms of it – should figure prominently

For the future, District Heating and Cooling can offer Europe:

BY 2020

- Avoidance of 9.3% of all European **CO₂ emissions by District Heating**
- Additional 40 – 50 million tonnes of annual **CO₂ reductions by District Cooling**
- **Decrease of primary energy consumption** with 2.14 EJ (595 TWh) per year,

BY 2030

in national, European and international climate change and energy policy strategies for the decades to come.

District Heating and Cooling is based on the 'fundamental idea' of using local heat, cold and fuel sources that under normal circumstances would be lost or remain unused. Another essential feature is that it provides a flexible infrastructure able to integrate a wide range of (renewable) energy sources. At present, with approximately 86% of heat deriving from a combination of recovered heat, renewable energy and waste resources, modern District Heating and Cooling comes very close to fulfilling its fundamental idea in practice.

However, a far greater potential waits to be exploited.

This document aims to draw a realistic picture of goals and expectations. Currently, there are differences in the state of District Heating and Cooling technology throughout Europe; therefore the timeframes in the Vision represent the final, pan-European state of technological achievement. In the most advanced schemes progress is much faster, but as the older systems are upgraded, innovations can be applied wherever there are networks.

This Vision was prepared by the District Heating and Cooling plus (DHC+) Technology Platform. Aiming to promote research and innovation in District Heating, District Cooling and kindred technologies, the Platform gathers and consults a wide range of key stakeholders throughout Europe.

As a follow-up step to the Vision a research agenda will be prepared, setting out in further detail the objectives and the strategic research and innovation efforts required to attain them.

For more information on the DHC+ Technology Platform and its activities please visit our website: www.dhcplus.eu

corresponding to 2.6% of entire **European primary energy demand**

- 25% share of **renewable energies** in District Heating

- **A smart energy exchange network**, allowing for optimal resource allocation between the multiple low carbon energy sources feeding into the system and various temperature demands of customers.

BY **2050**

Fully carbon neutral energy solutions through regional, integrated networks.

Yves Delaby (Dalkia),
Chairman of the Platform

“District Heating and District Cooling represent the most suitable energy solutions for satisfying urban heat and cold demands”

The Future Starts

An aerial photograph of a city, likely Copenhagen, showing a mix of modern and traditional architecture. In the foreground, there are several multi-story apartment buildings, some with distinctive colors like red and white stripes. A large, modern building with a curved facade and blue-tinted windows is prominent. The city extends to the horizon under a clear blue sky, with a prominent church spire visible in the distance. Green spaces and trees are interspersed among the buildings.

What is District Heating and Cooling?

District Heating and Cooling is a technological concept comprising infrastructure for delivering heating and cooling services to customers throughout Europe and other parts of the world.

Heating is the largest single energy end-use in Europe, it is responsible for approximately 50% of total final energy consumption.² Taking an average dwelling in Europe as example, 68% of its total energy demand is used for satisfying space heating needs and 14% for producing warm water.³ The current total cooling demand, while much smaller is growing exponentially: expectations are that by 2020 at least 60% of commercial and public buildings in Europe will be equipped with cooling appliances. World-wide at least 10% of electricity used is for cooling purposes, in the United States cooling buildings represents one sixth of total generated electricity [see Annex].⁴

District Heating systems provide space heating and hot tap water to residential, commercial, public and industrial customers. District heat is also used in low to medium temperature industrial processes like rinsing, evaporation, and drying. In the agricultural sector district

heat is used for greenhouses, fish farms, biofuel production and larger agricultural structures.

District Cooling provides space and process cooling primarily for commercial and public buildings, but also for the industrial and residential sectors.

'Unity in diversity'

District Heating and Cooling systems are inherently diverse: while employing similar operating principles each network develops according to specific local circumstances and the historical developments of the technology in the region. Furthermore each individual network adapts to changing requirements, new opportunities and innovation.

This makes District Heating and Cooling into a true technological 'unity in diversity': unity in that the fundamentals are similar, diversity in that systems have their own individual characteristics and performance.

District Heating and Cooling today

There are more than 5.000 District Heating systems in Europe, currently supplying more than 10% of total European heat demands with an annual turnover of €25-30 billion and 2 EJ (556 TWh) heat sales. Market penetration of District Heating is unevenly distributed, being close to zero in some countries while reaching as high as 70% of the heat market in others.

"Heating and cooling are responsible for more than 50% of total final energy consumption in the European Union."

It is mainly the northern, central and eastern European countries that have high penetration of District Heating, while Poland and Germany have the

Today

largest total amount of district heat delivery. Highest growth rates for District Heating are achieved in Austria and Italy.

In cities like Copenhagen, Helsinki, Warsaw, Vilnius, Riga as much as 90% of residential heat demands are satisfied by district heat. Commercial and public buildings show high connection rates in district heated cities.

The European share of District Heating in industry is around 3.5%. Higher market shares (10 to 15%) appear in individual countries including Hungary, Poland, Finland, Netherlands, and Czech Republic.⁵

It is generally accepted that most state-of-the-art District Heating systems are situated in western parts of Europe, Scandinavia in particular. These networks score high in terms of energy efficiency, renewable energies integration, economic performance, reliability and customer confidence.

District Cooling in Europe today has a market share of about 2% of the total cooling market, corresponding to approximately 10 PJ (3 TWh) cooling. The market penetration of District Cooling shows great diversity. Overall, this market has emerged quite recently and is consequently less developed than the District Heating market. It is, however, growing fast with the last decade seeing a tenfold growth in installed capacity.

“The fundamental idea of District Heating and Cooling is to use local heat, cold and fuel sources that under normal circumstances would be lost or remain unused”



Sweden for instance succeeded in achieving its goal to reach 25% District Cooling market share for commercial and institutional buildings. Cities that have reached or are on the way towards reaching 50% District Cooling shares include Paris, Helsinki, Stockholm, Amsterdam, Vienna, Barcelona, Copenhagen.⁶

Urban energy service

The benefits of District Heating and District Cooling are most apparent in areas with high density energy demands. Therefore, District Heating and District Cooling represent the most suitable energy solutions for satisfying urban heat and cold demands.

In the European Union some 73% of the population live in cities, rising to an estimated 80% by 2030. At present 69% of total primary energy demands are concentrated in urban areas. Energy consumption per capita is less in European Union cities than those in the USA and Australia, partly due to a greater use of District Heating.⁷

Considering the modest aggregate market share of District Heating and Cooling throughout Europe, a great deal can be gained by wider penetration of these technological solutions in cities.

Apart from urban environments, energy demands from industry and intensive agriculture are suitable for district heat. In these sectors an additional benefit is that the District Heating network makes it possible to capture and transport CO₂ for industrial processes and greenhouses, representing another carbon abatement opportunity.

In some countries including Iceland, Denmark, Finland and Sweden high shares of single-family houses in lower heat density areas are also connected to District Heating (shares going up to 85%).⁸

Customer service

District Heating and District Cooling provide a reliable, comfortable and simple energy service at stable and affordable prices.

Heat and cold are delivered directly to customers. No boilers and burning flames are needed inside the building, while individual substations are small and silent. This is much more convenient than the conventional solutions that require individual heating and cooling equipment in each building. Especially in the case of District Cooling the aesthetics of

buildings can be boosted as air conditioners are eliminated from the façades, also saving valuable commercial space.

Professionals take care of the installation, operation and maintenance of the system. To ensure efficient operation, utility supervision of customer installations and the reading of consumption levels is increasingly performed through remote-controlled measuring equipment. Various forms of service and ownership arrangements can be agreed between customer and supplier.

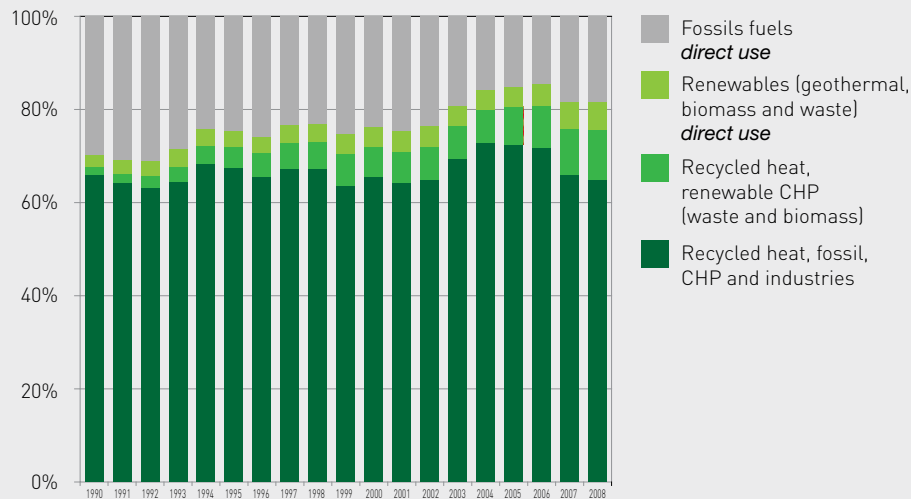
Good economy

District Heating and Cooling is a competitive and cost-effective technology. Although initial investment costs in the systems are high, with the life-time cost and energy system benefits in mind, very good value for money is achieved.

One of the primary barriers to the expansion of District Heating and Cooling systems in Europe is the financial climate favouring fast returns on investment. District Heating and Cooling infrastructure however provides a long-term, secure investment opportunity in real value, which is important for a healthy and stable economy.

“District Heating and Cooling provide a flexible infrastructure able to integrate a wide range of (renewable) energy sources on a large scale.”

EU27 - Heat sources for District Heating



“86% of heat for District Heating derives from a combination of recovered heat, renewable energy and waste resources”

District Heating and District Cooling reduce primary energy demand [see next page]. This frees financial resources for redistribution into other spheres of the economy. It also reduces the need for investment in more generation capacity.

As a system using local heat and cold resources and infrastructure, local economic opportunities are improved. Investment in networks and customer connections is local investment. The supply of renewable sources is also mainly local, providing value and promoting the sustainable management of regional resources. The system’s ability to integrate a wide variety of energy sources also boosts competition between the various sources on the market.

Europe is leading the world in district energy technology. Increased interest for such solutions in the Middle-East, Asia and North America leads to many business opportunities with corresponding positive impact on the export balance of expert services and technology.

Increased energy security

At present the EU imports 54% of all primary energy sources from outside its zone. According to even the most positive scenarios this percentage is expected to rise to between 56 and 60% by 2020,⁹ and possibly to 70% by 2030.¹⁰

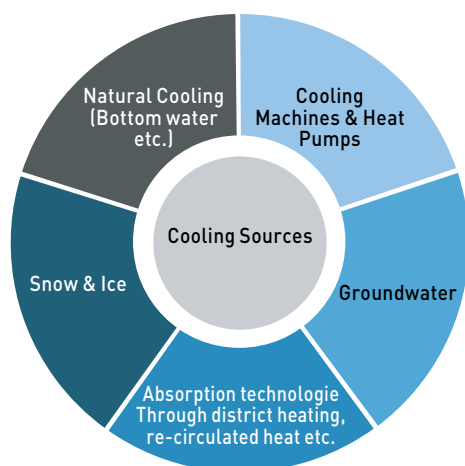
District Heating and Cooling can reduce this potentially unstable dependency on energy imports in two ways: by reducing the overall need for primary energy and by replacing imported energy with local resources. As practically any type of fuel or energy source can be utilized, a relatively quick switch to other fuel sources can be achieved should shortages arise.

District Heating and District Cooling provide a robust infrastructure with high levels of reliability in energy supply that is capable of adapting to potential climatic and other emergencies.¹¹

Lower primary energy consumption

Reducing primary energy consumption is the first and foremost requirement for attaining the main European energy policy objectives. Primary energy consumption in Europe has been rising steadily since the 1970s. Trends based on a business as usual scenario predict an increase in total primary consumption of 5 to 9% by 2020 and 10 to 26% by 2030.¹²

Sources for District Cooling



Based on the fundamental idea of using 'surplus', 'recycled' or 'recovered' heat (i.e. heat generated as inevitable by-product of other processes that otherwise would be wasted) as a valuable energy resource, District Heating and District Cooling reduce primary energy demand [see Annex]. At present around 82% of district heat in the European Union is derived from sources of surplus heat. By far the largest proportion of this heat originates from combined heat and power installations, corresponding to more than three quarters of total district heat energy supply. The result is a reduction in European primary energy demand of at least 0.9 EJ (250 TWh) per year.¹³

District Cooling, due to its use of surplus heat from the District Heating network and natural cooling sources, has a resource efficiency rate 5 to 10 times higher than electrically driven air conditioners. The last trends based on a business as usual scenario predict, in the most optimistic cases, that total primary energy consumption will remain at the same level until 2050.

“Energy consumption per capita is less in European Union cities than those in the USA and Australia, partly due to a greater use of District Heating.”

Sustainable fuel mix

District Heating and District Cooling imply a highly flexible energy mix. New fuels and energy sources can be integrated with minimal adjustment by the operator. For customers no adaptation measures at all are required when a switch of energy source is made.

In particular, District Heating and Cooling networks constitute vital infrastructure to ensure large scale integration of renewable energy sources. The majority of energy use for heating and cooling takes place in urban areas where it is most difficult to make use of renewable energy systems. The use of solid fuels is for example not welcome in urban areas because of delivery and storage logistics, raised local emissions and extra pressure on space.

Benefits of scale associated with centralized energy production make viable the use of hard-to-manage combustible renewables and other renewable and natural energy sources that would otherwise remain unused or would be less (cost-) effectively exploited in individual applications.

District Heating and Cooling networks play a strategic role in the rational management of non-recyclable municipal waste. Instead of landfilling, this resource is used to generate power, heat and cooling in waste-to-energy plants, thereby displacing fossil fuels and reducing greenhouse gas emissions, while also reducing local authority spending on landfill gate fees.

The combined share of biomass, geothermal, solar and waste in the energy source mix is currently around 14%. This compares favourably with the average European Union share of renewable energies which is currently 7% of primary energy demand and 8.5% of final energy consumption.¹⁴

The share of renewable energy sources varies greatly by country. The highest shares are found in Sweden, Norway, Denmark and Finland (between 30 and 50%). Iceland with a 97% geothermal supply stands out as being almost fully renewable.¹⁵

The example on the next page shows how the District Heating energy mix has developed in Sweden from 1980 to 2010, making apparent the enormous potential for energy mix diversification and the integration of renewable sources.¹⁶

District Cooling often uses a variety of sources simultaneously dependent on the availability of these sources in the vicinity of each system. These include natural cooling sources like ground, lake, river and sea water and ice and snow. For example, a District Cooling system under establishment in Copenhagen will use 30% sea water, 30% absorption chilling based on district heat and 40% compression chilling for its cooling supply.¹⁷

“Trends based on a business as usual scenario predict an increase in total European primary consumption of 5 to 9% by 2020 and 10 to 26% by 2030.”

Reduced greenhouse gas emissions

At present, District Heating alone is responsible for avoiding at least 113 million tonnes of CO₂ emissions per year. This corresponds to 2.6% of total European CO₂ emissions.

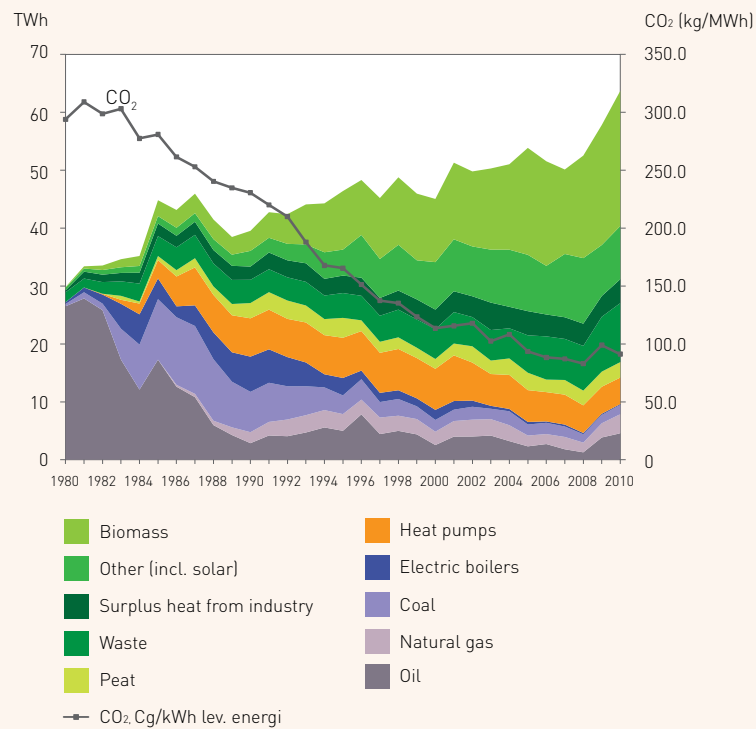
District Cooling can, due to its highly energy efficient performance, reduce CO₂ emissions by as much as 75% as compared to conventional electrical chillers.¹⁸

Pollution prevention and control

District Heating and District Cooling reduce local pollutants such as dust, sulphur dioxide and nitrogen oxides by replacing exhausts from individual boilers. In addition to the reduced use of fuels, far more effective pollution prevention and control measures can be taken in central production facilities.

District Cooling also reduces emissions of HFC and HCFC refrigerants and provides a technical option for phasing them out, in accordance with international agreements.

Energy mix In Swedish District Heating





Vision 2020

Deploying Best

- Cornerstone of realistic strategies for attaining European Union 2020 energy policy targets
- European-wide expansion
- Innovation for new generations of technology
- Modernization where required

Practices

Low-hanging fruit

Being a proven solution with a track-record of development, the benefits of District Heating and Cooling technology are ready to be exploited.

As identified by the Intelligent Energy Europe supported European heat and cold market study 'Ecoheatcool',¹⁹ District Heating can double its share of the European heat market by 2020 (reaching approximately an 18 – 20% share) and by the same time District

Cooling can grow to satisfy 25% of cooling demands. The expansion of state-of-the-art systems coupled with further improvements of existing networks, would bring a multiplication of the benefits District Heating and District Cooling are already providing today.

20-20-20 by 2020 and more...

With European Union energy policy priorities and '2020 targets' in mind, the following benefits can be achieved within Europe by expanding the District Heating and Cooling markets as described.²⁰

CO₂ emissions

District Heating reduces 517 million tonnes of CO₂ emissions per year: more than 9.3% of all carbon emissions in Europe. District Cooling achieves a further 40 to 50 million tonnes of CO₂ emission reductions per year.

Energy efficiency

District Heating decreases European primary energy use by 2.14 EJ (595 TWh) or 50.7 Mtoe per year. This corresponds to a 2.6% reduction in the entire European primary energy supply: equal to the whole annual primary energy supply of Sweden.

District Cooling saves 50 to 60 TWh (180 – 216 PJ) of electricity per year.

Renewable energy sources

The share of renewable energy sources directly and indirectly utilized in District Heating and Cooling systems is increased to at least 25%.

Import dependency

District Heating reduces European import dependency by 4.45 EJ (1236 TWh), or 5.5% of the entire European primary energy supply: more than the total energy balance of Poland.

District Cooling further decreases import dependency because of its highly energy efficient performance and use of local cold sources.

“Three main strategies to increase contribution to EU 2022 energy targets: progressive technological innovation, modernization and expansion.”

Towards 2020

Considering the different stages at which District Heating and Cooling technology presently exists in Europe, three simultaneous and complementary strategies are foreseen in order to achieve the technology’s full contribution towards the ‘2020 targets’: progressive technological innovation, modernization and expansion.

Progressive innovation: towards next generations of technology

Modern District Heating and Cooling systems can still benefit from progressive improvements to the generation, distribution and customer sides.

Innovation focused on upgrading materials, equipment and processes can lead to even higher levels of efficiency, cost-effectiveness and customer service. The standardization of solutions and equipment deserves special emphasis.



In District Heating new types of synergies with sustainable energy sources and production technologies are adopted and existing ones significantly extended. Various biofuels and waste resources increasingly replace fossil fuels in existing and new cogeneration and boiler facilities. Other renewables like (deep) geothermal and solar from large thermal plants are increasingly integrated. Even surplus wind energy can be stored as heat in District Heating networks by means of electrical boilers and heat pumps.



Higher efficiency, lower costs and greater overall confidence in District Heating systems extends viability to lower temperature surplus heat sources transported over longer distances. This increases the range of heat sources that can be effectively employed. The potential to tap surplus heat sources including industrial waste heat, the use of which was not considered earlier for reasons of cost-effectiveness, is increased. The polygeneration of heat, electricity and biofuels is extended.

District Cooling can similarly make use of a greater range of natural cooling sources situated at greater distances from the customer. Further enhancements in the efficiency of cooling cycles and ice sludge technology is pursued. The innovative use of new cooling sources, like cold recovery from liquefied natural gas (LNG) regasification processes, is constantly considered.

Research and deployment of pilot demonstration sites is a necessary step for approaching the large-scale implementation of innovative systems.

Additional customer service models and communication channels with (potential) customers are devised.

Modernization: transferring best practices

The performance of existing District Heating systems across Europe will be much more consistent when the successful techniques of the most effective systems are transferred to older, less efficient networks.

By 2020 each refurbished system in Europe has reached performance levels comparable to the levels attained by the best performing systems deployed in 2012. Performance levels of these 'best' systems serve as benchmarks for those systems in need of modernization.

Precisely due to the difficulty of comparing District Heating networks, achieving this aim requires consistent and flexible quality assessment tools and systems of best-practice transfer. Best-practice transfer does not mean full replication of existing schemes, which may not even be feasible, but an inventive application of the techniques and best-practices to each particular regional and local circumstance.

“District Heating can realistically double its share on the heat market, while District Cooling can achieve a 25% cooling market share”

The deployment of best-practices needs to address both technology and policy issues. The development of District Heating networks in parts of Europe has been closely connected to the political framework in place. Similarly, the progressive modernization of the technology will in part be dependent on the provision of the right types of political incentives.

Expansion of existing networks

To ensure a doubling of the District Heating and a 25% market share for District Cooling by 2020, a significant expansion of existing networks is required. This applies to systems in most European countries, even though the required growth rates differ in accordance with the market situation in each country.

“District Heating and Cooling: cornerstone of realistic strategies for attaining EU 2020 energy policy targets.”

Comprehensive, multi-level country strategies addressing all relevant stakeholders are established. Far-sighted, rational energy planning at national and local levels, carried out in cooperation with energy providers and investors, will boost the possibilities for expansion. Channels for sharing international and European experience are actively used to ensure that optimal solutions are deployed with the installation of new systems.

Regulatory aspects of energy markets will be analyzed and improvements proposed to policy frameworks at European, national and municipal levels. This will be focused on ensuring that the benefits of District Heating and District Cooling are correctly accounted for and assist the growth and development of innovative features. Promoting primary resource factor as the basis for evaluating the efficiency of end-user solutions, and creating a level playing field on the market (e.g. with regard to natural gas pricing, reducing administrative barriers) are amongst the priority areas of attention.

Awareness raising of the working principles and the benefits of District Heating and District Cooling is of great importance. This is true in particular for countries where the District Heating market is undeveloped and knowledge about the technology is likely to be limited. However, it is also recommended for countries where District Heating is well-established: even here District Heating and Cooling is often a largely ‘invisible’ solution among society at large. Communication and dialogue with customers, the wider public, national, regional and local policy-makers, investors, universities, architects, builders and other stakeholders is pursued as a vital element of successful expansion strategies.

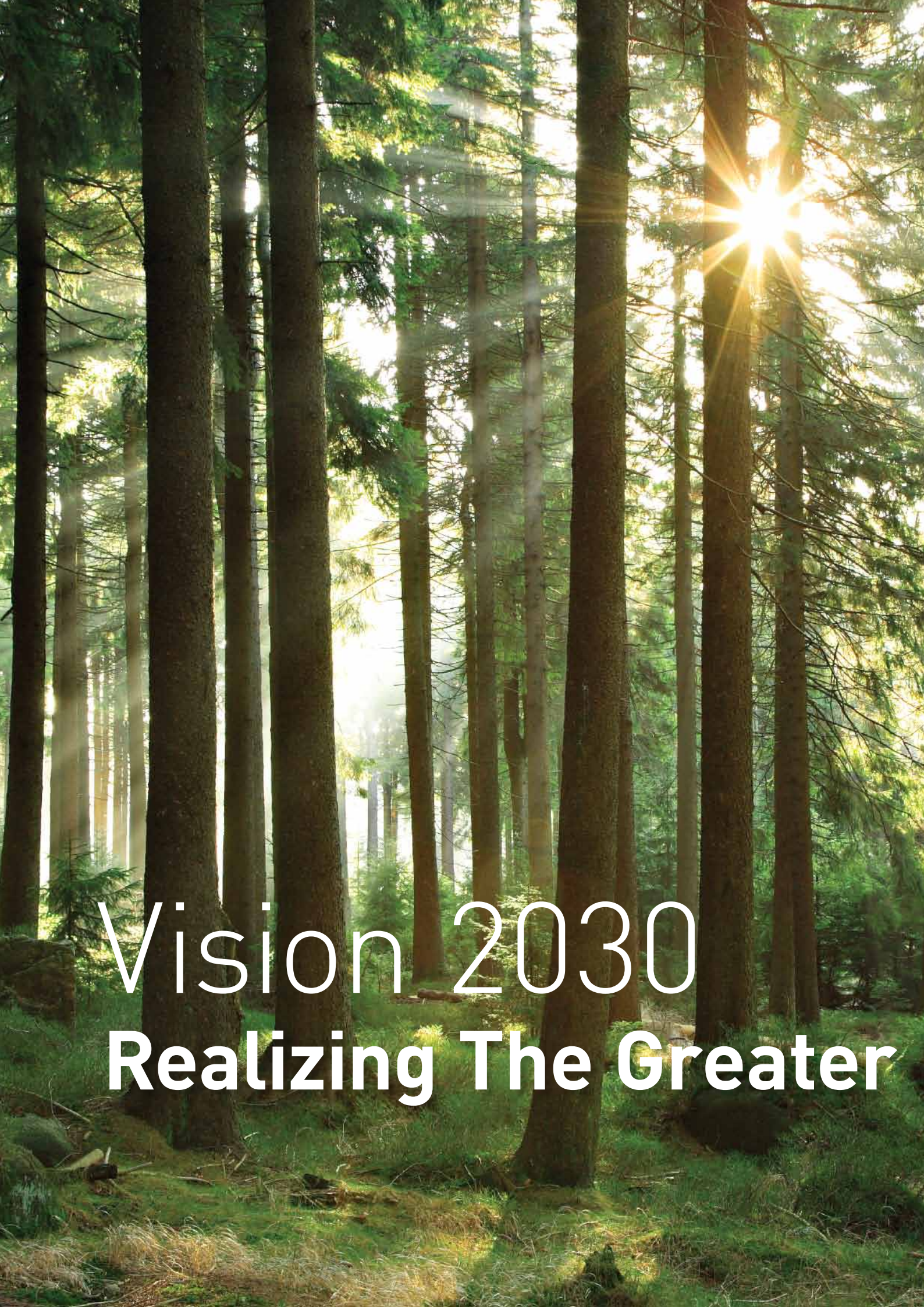


“The Louvre museum: one of the many customers supplied by District Cooling”

Modeling future demands

Another crucial area of activity to the entire European sector is to gain a better understanding of the trends in energy and customer demands and

urban planning circumstances to help District Heating and Cooling providers and policy-makers pursue informed choices for the future.



Vision 2030
Realizing The Greater

- Central component in energy system transformation
- Intelligent energy exchange network
- Sustainable energy mix diversification
- New uses

Integrated solutions

The drive for transforming the energy system has reached full momentum and conventional thinking about energy is making place for structurally new approaches. Strategic decisions need to be made at this time, particularly when considering that by 2030 infrastructure associated with more than 50% of European Union electricity capacity will be in need of replacement, representing a potential investment of around € 900 billion.²¹

It has become apparent as reality, and no longer as visionary thought, that optimal energy solutions can only be achieved when more emphasis is put on the dynamic interaction between generation, distribution and demand. District Heating and Cooling's holistic approach to energy can be used as

example for the renewed way of thinking about the entire energy cycle.

The local dimension receives more focus and becomes an important element in planning rational energy solutions. Optimal supply-demand interaction can only be achieved when the difficulties and opportunities of the particular circumstances of a locality are taken into account. This understanding leads to a proliferation of tailor-made solutions making an increasingly inventive use of the energy resources available in each area.

Localization goes hand-in-hand with centralized, large-scale and highly efficient energy generation facilities. The crucial element for the success of this new approach is that an effective way for matching the various supply sources with the various energy demands is available. Apart from the electricity grid, District Heating and Cooling is the only other energy infrastructure that can be used for the effective exchange and redistribution of energy.

Towards 2030

European District Heating and Cooling infrastructure acts as an intelligent energy exchange network; a 'smart grid'.

From a classical District Heating configuration using one main energy source to supply customers, the step is made to a multiple source system. Operators can feed a wide variety of sustainable heat and cold sources into the system at different places in the

“Optimal energy solutions can only be achieved when emphasis is put on the dynamic interaction between generation, distribution and demand.”

Potential

network, depending on availability and need, and effectively and temporally match them to customer demands.

IT driven technologies combined with real-time smart metering devices and plug-and-play intelligent substations for individual customers, allow energy inputs and outputs to be identified and regulated in order to optimize the interaction between sources of energy supply and the various temperature demands of customers. Heat and cold storage, which have reached high rates of efficiency, are important for achieving the best allocation of resources in this process. Such a grid can simultaneously operate as a storage opportunity for the various energy sources dependent on fluctuations in natural circumstance.

This type of system presupposes the effective accommodation of different temperature energy sources. There are various ways to achieve this, depending on the circumstances of the particular network. Possible solutions include the adaptation of operational temperature levels throughout the entire network and applying innovative types of pipeline configurations. Also the use of transfer media other than water could contribute to the solution.

“District Heating and Cooling: smart infrastructure for an effective match of energy demand and supply”

Interactive buildings

Within the energy exchange framework provided by District Heating and Cooling infrastructure, the special case of interactive buildings deserves to be highlighted. Although the overall energy demand of the building stock is reduced due to more stringent efficiency requirements particularly for new buildings, great disparities in the building stock still remain.²²

The main differentiation in the building stock is that some buildings are energy-producing, e.g. by means of solar thermal capacity, while others remain to various degrees heat demanding. District Heating allows the exchange of heat from energy-producing buildings to buildings requiring heat input, either by integrating the excess heat into the network or by applying direct house-to-house connections.

Such systems are already in place in Sweden and experience from Denmark and Austria shows that ‘passive houses’ can be effectively connected to modern District Heating grids.

Extended uses

As well as developments in the infrastructure itself, District Heating contributes to rational energy use in a further way.

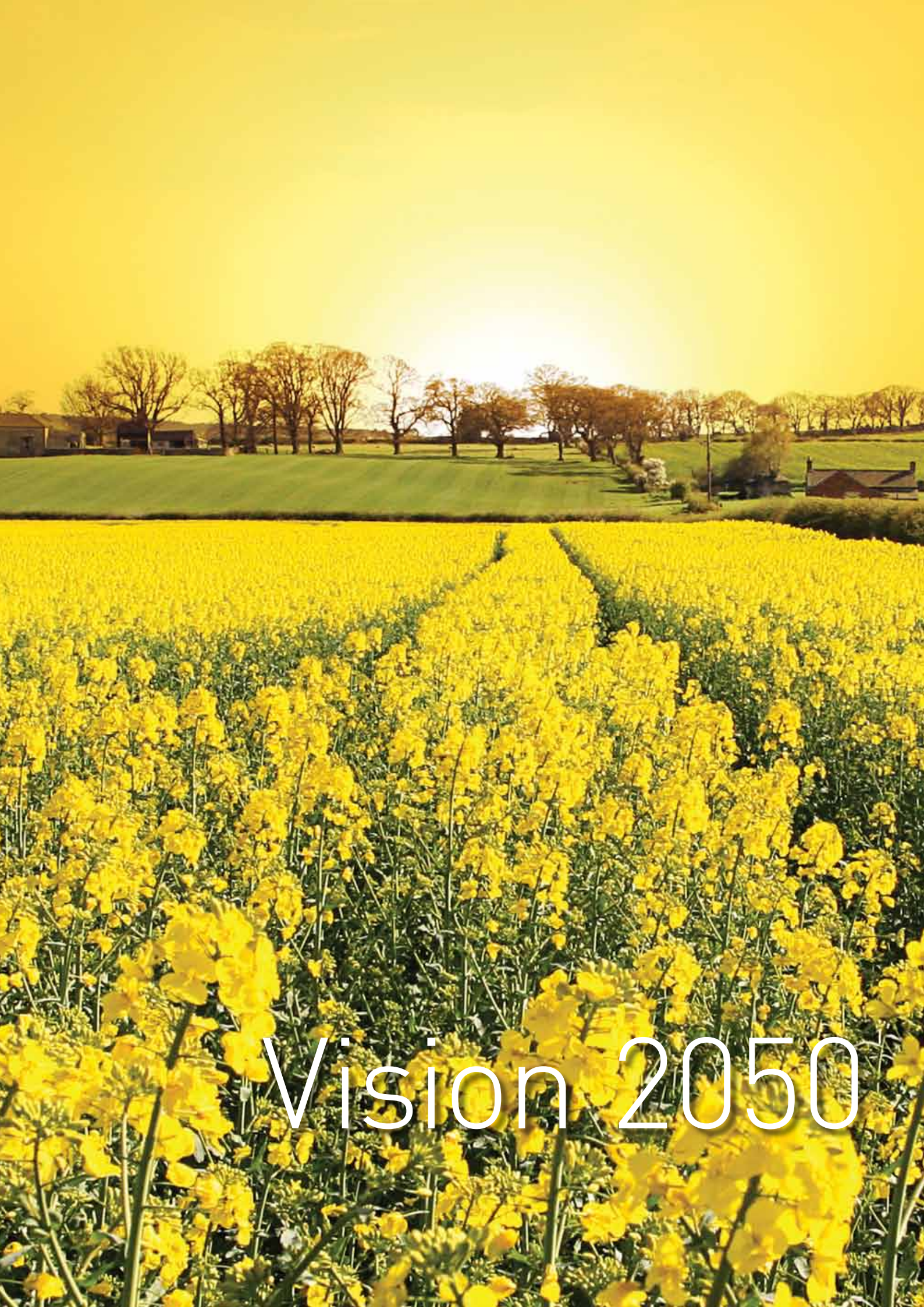
Over the years, lifestyle changes have been coupled with a trend towards higher comfort levels, more households and increased use of electric household appliances. These tendencies almost offset all energy efficiency improvements achieved in the residential sector during the period 1990 to 2004.²³ Presuming a growth of the economy over the long-term, the trend of higher comfort requirements and using more appliances will be on the increase.²⁴



“Lifestyle changes have been coupled with a trend towards higher comfort levels, more households and increased use of electric household appliances, these tendencies have offset much of the energy efficiency achievements in the residential sector.”

District Heating provides heat to a wide variety of in-house appliances that were formerly electrically heated. Such appliances include washing machines, tumble dryers, dishwashers, ventilation systems, low temperature cooking devices, and automatic integrated household operational systems. A demonstration house in Goteborg, Sweden shows the feasibility of coupling such devices to district heat.

Taking on these additional uses improves the cost-effectiveness of District Heating networks and further reduces primary energy consumption, decreasing the need to invest in new electricity generation capacity. Combined with the electricity demand reductions delivered by District Cooling systems, electricity can be reserved for uses where no better solutions are available.



Vision 2050

- Basic energy infrastructure
- Regional networks
- Zero carbon solutions
- Integrated climate comfort

Envisioning 2050

Basic energy infrastructures

District Heating and Cooling networks are widespread energy exchange systems. Forming an integral part of the infrastructure of most European cities and towns, they are installed together with other basic networks like electricity cables, drinking water and sewage pipes.

Regional networks

Interconnected local grids create region-wide District Heating and Cooling networks, resulting in even greater energy security, extended diversification of the sustainable energy mix, further balance in the supply-demand interaction and cost reductions.

Driven by efficiency, flexibility and intelligence, these systems will keep on tapping the untapped energy potentials.

Zero carbon solutions

District Heating and Cooling offers its customers entirely carbon neutral energy solutions. Energy input into the system is based solely on renewable, low carbon energy sources and those coupled to state of the art carbon abatement technologies.

District Heating and Cooling technology plays a major role in achieving at least an 80% reduction of total European greenhouse gas emissions, a 50% energy efficiency improvement of the European energy system and a 60% share of renewable energy in total European energy consumption.²⁵

“District Heating and Cooling provides entirely carbon neutral energy solutions to its customers”

Integrated climate comfort

With combined heat and cold supply, integrated District Heating and Cooling systems guarantee customers a stable indoor climate throughout the whole year in accordance with individual comfort requirements.

Zero Carbon Solutions

Annex

DHC-Fundamental idea

The 'fundamental idea' behind modern District Heating and Cooling is to use local heat, cold and fuel sources that under normal circumstances would be lost or remain unused.

Europe's wasted energy

The European energy system in its present state is responsible for a tremendous waste of energy. This waste occurs throughout the various processes starting from primary energy input into the energy system and ending with final energy end-use.

Taking the figure as example, the first bar reflects the total calorific value of primary energy input into the European energy system (e.g. fossil fuels, renewables, nuclear, etc.).²⁶

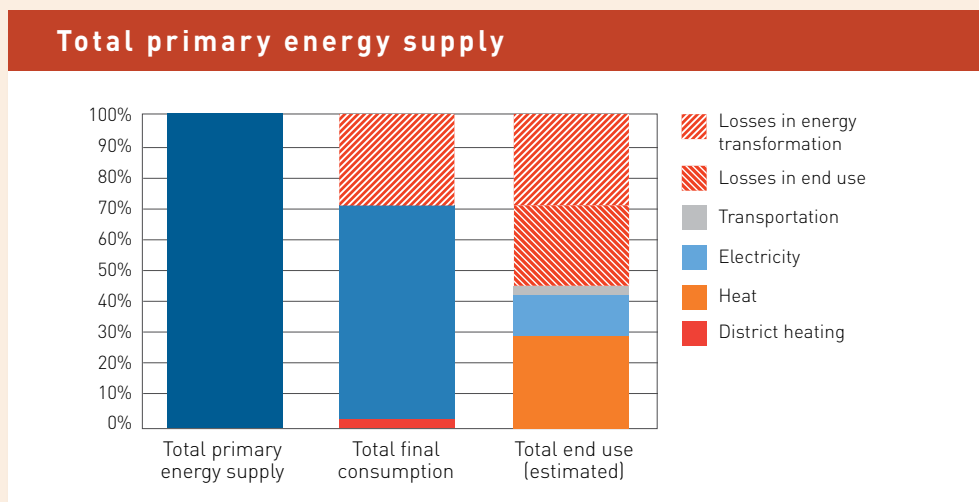
The second bar shows the total final consumption of energy in all sectors, reduced by the energy losses incurred in energy transformation. Energy transformation includes processes like power generation, oil refining, heat production and distribution losses in electricity and heat networks. These losses amount to approximately 25-30% of the total primary energy input and occur primarily in the form of heat.²⁷ Most of the losses are attributable to thermal power generation of electricity,

which has low conversion efficiency.

The third bar provides an estimated division of total energy end-use. Heat, with 50 to 60%, is the largest energy end-use. In end-use too, large energy losses occur in the form of heat. These losses are mainly incurred in high temperature industrial processes, heat generation in individual boilers and conversion losses from engines.

In summary, the overall picture of Europe's unsustainable use of heat is striking:

1. From primary energy supply to energy end use more than half of total European primary energy input is wasted;
2. Most of this waste occurs in the form of heat;
3. Around 60% of total energy end-use takes place in the form of heat.

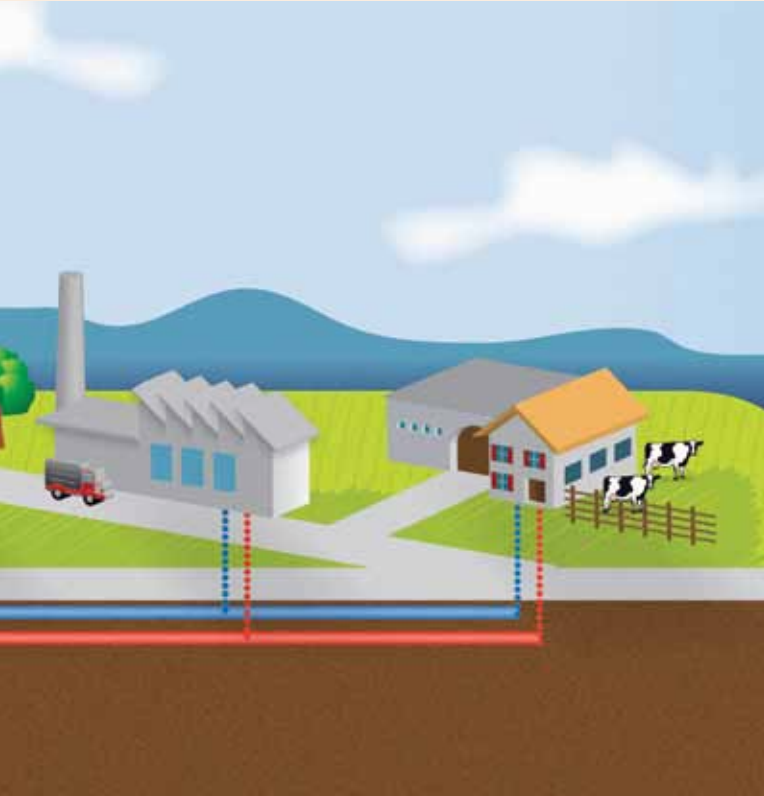


District Heating



District Heating, figuratively and literally speaking, provides the pipeline connecting these heat losses with heat demands, thereby reducing energy losses and the total volume of primary energy needed in the energy system. District Heating thus turns losses into opportunities thereby truly achieving more with less.

Although not all forms of wasted heat are (yet) suitable for recovery by District Heating, recoverable forms of heat do represent a large part of heat losses. Processes like electricity generation, waste burning, high-temperature industrial manufacture, fuel- and biofuel refinery and nuclear processes liberate heat at temperatures that can no longer be used for the process itself, but which can satisfy other heat demands. If not utilized, 'recycled' or 'recovered', for these other purposes, this **surplus heat** is simply lost to the atmosphere, rivers or lakes. Such losses reflect an unjustifiable waste of primary energy sources.



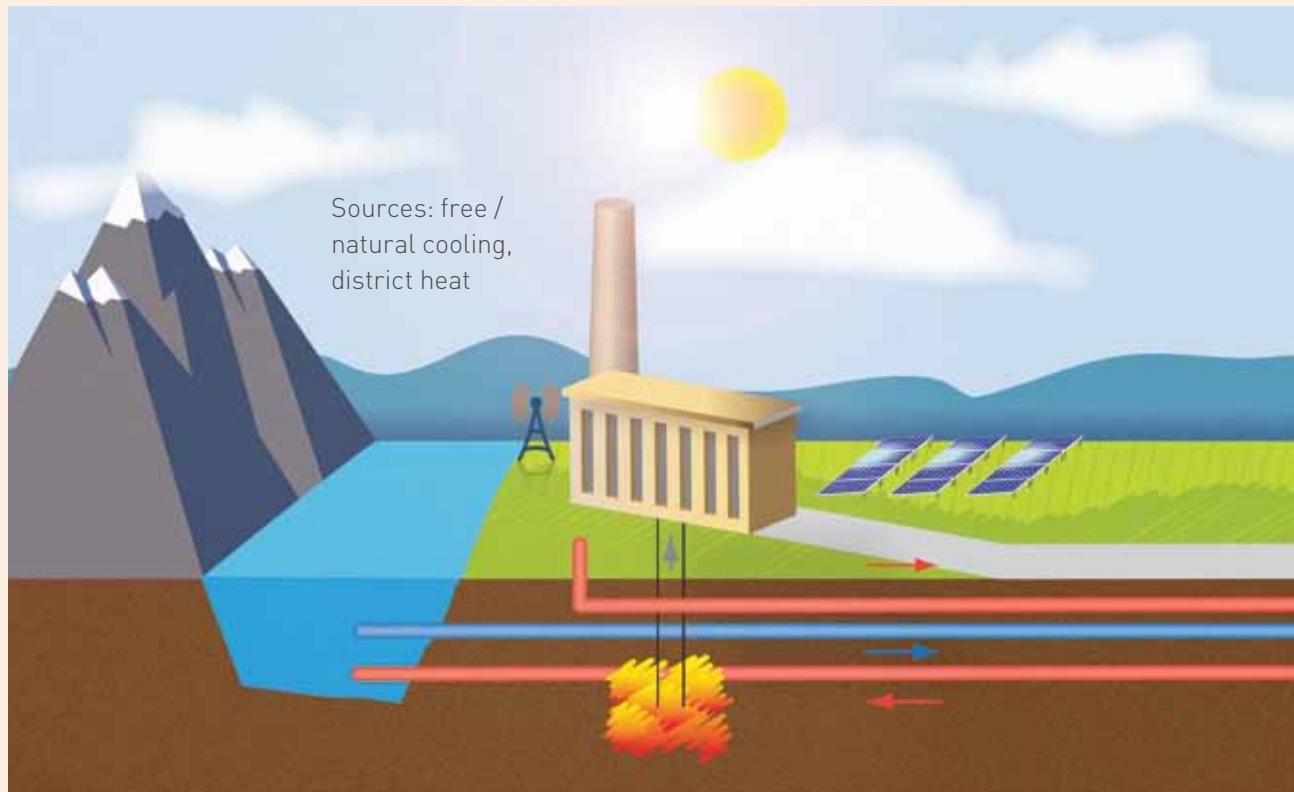
By means of combined heat and power, which boost the efficiency of thermal power generation from an average 45% up to 90%, or by directly channelling surplus heat from other sources into the network, District Heating enables waste heat to be recovered and used to satisfy existing heat demands. Use of surplus heat also averts further primary energy losses from individual boilers. These features make District Heating into a unique ally in the movement to reduce primary energy use and increase the efficiency of the entire energy system. This is precisely why District Heating received a great boost in various countries during the oil crisis of the 1970s.

The other major benefit of District Heating is that it can use a wide variety of difficult to handle, local energy sources that are less efficiently and cost-effectively deployed in individual applications.

As energy for District Heating is generated centrally and on large scale, it can for instance integrate combustible renewables that are difficult to manage in small boilers. This includes most combustible renewables such as wood waste, straw and olive residues, and also waste sources like municipal waste and sewage sludge. Various biofuels, geothermal, solar and wind resources can be effectively integrated into the District Heating network by means of different techniques.

At present around 86% of district heat derives from a combination of recovered heat, renewable energy and waste sources. More than three quarters of heat is supplied by combined heat and power (the renewable fuel component in cogeneration is around 9%).²⁸ This shows how close District Heating is to its fundamental idea.

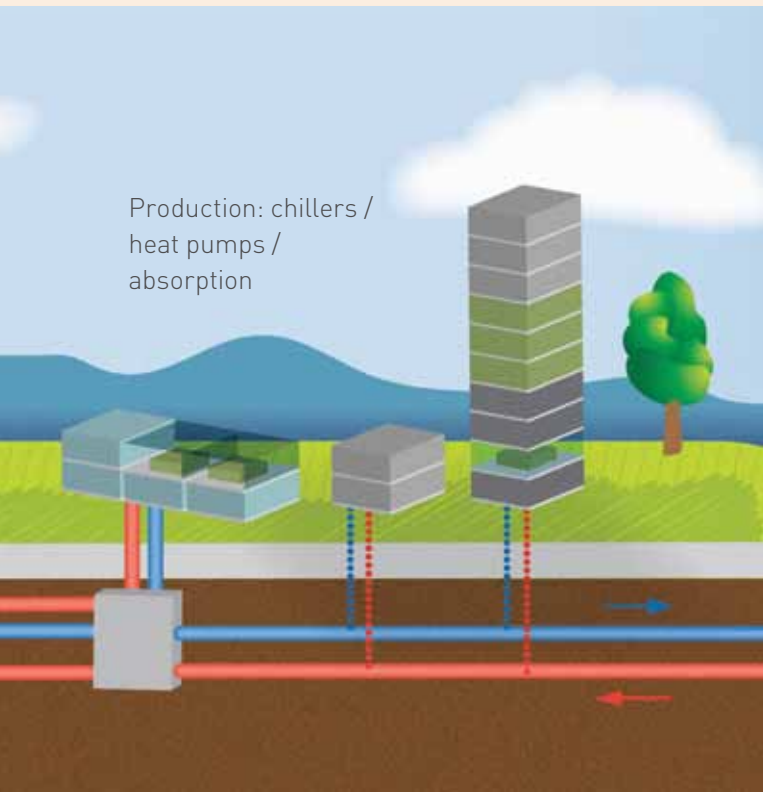
District Cooling



Just as for District Heating, the main idea of District Cooling is to use local sources that otherwise would be wasted or remain unused, in order to offer the market a competitive and highly efficient alternative to traditional cooling solutions. In District Cooling systems, cold water at a temperature of around 6°C circulates through buildings achieving effective cooling.

Space and process cooling is moving quickly from luxury into necessity and represents an exponentially growing market. This has remained relatively unnoticed by policy planners, partly because cooling needs are traditionally being met by electrical air conditioners, hiding the cooling element in the building's overall electricity consumption.

The rise in cooling demands is attributable to rising ambient temperatures, greater comfort expectations, the perception that cooling contributes to higher productivity, and



the increase in internal loads of electronic equipment. In existing District Cooling systems, 40 to 60% of the cooling demands are process related with a climate independent base load of 15%. In the USA, Japan and the Middle East around 80% of commercial buildings use cooling devices. While this share is lower in Europe a rise to 60% is expected by 2020.²⁹

Rising electrical power demand has been identified as one key indicator of the increase in cooling demands. Between 1990 and 2005, electricity consumption in the EU increased with by an average of 1.7% per year, with increased cooling demands in Southern European countries a particularly noticeable feature. Increases in

electricity consumption are predicted in all scenarios. By 2080, electricity demand in Italy and Spain is likely to increase by 50% due to space cooling needs, while in Athens overall energy demand in July is expected to rise by 30% due to air conditioning. London will see an increase in energy use in office buildings of 20%.³⁰ Electrical peak loads, traditionally occurring during winters, are now shifting to the summer months and challenging capacity limits.

District Cooling offers a resource saving alternative to such developments. With chillers driven by surplus heat from District Heating networks and with additional use of other, natural energy sources that would have remained unused without the District Cooling system (like ground- river-, lake- and sea water, snow and ice), District Cooling is 5 to 10 times more energy efficient than electrical airconditioning systems.

Due to this superior efficiency substantial primary energy savings can be achieved. District Cooling can reduce cooling-related electricity consumption by up to 80% compared with a conventional system. This because production is far less based on electricity and the electrical chillers employed are more efficient due to benefits of scale. Overall this has the potential to reduce investment needs for electricity capacity by around € 30 billion.³¹



Another role District Cooling can play in southern countries relates to the issue of water resources. In Europe 44% of total water consumption is used for cooling purposes in energy production, primarily in thermal power plants. Decreasing water availability in parts of southern Europe, coupled with the increasing trend of satisfying cooling demands by electrical airconditioning devices, may pose a serious threat to water supply in the region. Furthermore, across Europe, summer droughts are projected to be more severe, limiting the availability of cooling water and thus reducing the efficiency of thermal power plants.³²

In cogeneration a large proportion of the heat that would have required cooling is transferred into the District Heating network. This surplus heat can also be used to drive cooling equipment in District Cooling systems. Although water is needed within the network it circulates in a closed circuit.

Whole system approach

Although various technologies exist to provide space heating, warm tap water, and space and process cooling, some having higher energy efficiency credentials than others, none can claim to utilize an energy source that is routinely discarded in day-to-day functioning of our society. An important feature to be taken into account when assessing the efficiency of District Heating and Cooling is that, unlike other energy options, the main energy savings occur upstream of energy delivery to buildings.



With this approach, it is the primary energy savings achieved throughout the whole system that is crucial, not how an energy technology performs on a specific point in the energy chain.

Here, a potential contradiction comes to light between the achievement of net energy savings per individual building (e.g. through insulation) and low primary energy input into an entire built district (e.g. by means of a low resource energy solution). Under the given market conditions these goals might enter into competition, both from the points of view of energy efficiency as well as cost-effectiveness.³³

To allow a true comparability of the performance of energy technologies, District Heating and Cooling favours a whole system approach towards energy utilization. Most approaches nowadays tend to be fragmented in looking only at either supply or demand sides, entailing the risks of inconsistencies and an inability to deliver true system optimization. On the contrary, District Heating and Cooling prompts a comprehensive view of the entire energy cycle from generation, through conversion, to distribution to the final customer. By applying 'primary resource factors' the efficiency of a solution from primary energy input towards end-use is fully revealed.

Notes

- 1 European Commission, The Renewable Energy Progress Report, COM(2009) 192 & European Environmental Agency (EEA), Energy and environment report, 2008. Electricity and heat production account for 27% of total European Union greenhouse gas emissions (2005).
 - 2 European Commission, The Renewable Energy Progress Report
 - 3 European Construction Technology Platform
 - 4 European heat and cold market study 'Ecoheatcool' (EIE/04/110), 2005, www.ecoheatcool.org
 - 5 Figures quoted in section based on Ecoheatcool, relates to 2005 data, covers EU 27, Iceland, Norway, Switzerland, Croatia and Turkey
 - 6 Ecoheatcool & Capital Cooling
 - 7 International Energy Agency (IEA), World Energy Outlook: Global Energy Trends to 2030, 2008
 - 8 Ecoheatcool
 - 9 European Commission, Commission Staff Working Document, Second Strategic Energy Review, An EU Energy Security and Solidarity Action Plan, COM[2008]744
 - 10 European Parliament resolution of 3 February 2009 on the Second Strategic Energy Review, 2008/2239(INI)
 - 11 Many sensitive customers for whom a continuous heat and cold supply is a prerequisite are effectively connected to District Heating and Cooling. Fall-out rates in modern system are lower than with other energy solutions.
 - 12 European Commission, Energy Roadmap 2050 & IEA, Energy Technology Perspectives 2010 – Scenarios and Strategies to 2050.
 - 13 Based on Ecoheatcool and IEA statistics, update by Prof. Sven Werner, Halmstad University
 - 14 Based on Ecoheatcool and IEA statistics, update by Prof. Sven Werner, Halmstad University. Waste also has a renewable component. While different shares of renewables in waste exist throughout countries, the Europe-wide average is approximately 50% [Confederation of European Waste-to-Energy Plants (CEWEP)]. On renewables in Europe: European Commission, Second Strategic Energy Review
 - 15 Euroheat & Power, District Heating and Cooling Country by Country Survey, 2011
 - 16 Swedish District Heating Association
 - 17 Summerheat project (EIE/06/194), Final Publishable Report, www.summerheat.net. Calculations show that this system, expected to satisfy 22 GWh of cooling demand, will reduce electricity consumption by 80% and avoid 3,000 tons of CO2 emissions per year.
 - 18 Ecoheatcool
 - 19 Ecoheatcool (EIE/04/110)
 - 20 Benefits based on calculations made in Ecoheatcool
 - 21 European Commission, Andris Piebalgs, SPEECH/08/576
 - 22 At 2008 trends less than 0.5% of buildings is demolished yearly and less than 1% renovated, the buildings turnover being lower than 2% per year. Even if the process is accelerated it would take around 50 years to update all buildings in a meaningful way. (European Parliament 'Future Energy Systems in Europe', 2008 STOA)
 - 23 EEA, Energy and environment report
 - 24 EEA, Energy and environment report
 - 25 Based on European Parliament Resolution Second Strategic Energy Review
 - 26 Figure based on Ecoheatcool. Example year of 2003, covering covers EU 27, Iceland, Norway, Switzerland, Croatia and Turkey
 - 27 Ecoheatcool & EEA Energy and environment report
 - 28 EEA, Energy and environment report, 2005 data
 - 29 Ecoheatcool & Capital Cooling
 - 30 EEA, Energy and environment report
 - 31 Summerheat project
 - 32 EEA, Energy and environment report. This comes down to about 80.000 million m3/per year
 - 33 Ramboll, Heat Plan Denmark, 2008
- **Figure page 10:** Prof. Sven Werner, Halmstad University. Based on IEA statistics. Developments partly reflect improved statistics.
 - **Figure page 11:** Capital Cooling
 - **Figure page 13:** Swedish District Heating Association
 - **Image page 16:** A2A, Brescia plant



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