CONCERTED ACTION
ENERGY EFFICIENCY
DIRECTIVE

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Concerted Action Energy
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7

Efficiency in Energy Supply

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1 Introduction and context

The Concerted Action for the Energy Efficiency Directive (CA EED) was launched in spring 2013 in order to support the effective implementation of the Directive on Energy Efficiency (2012/27/EU) in all EU Member States as well as Norway. By providing a trusted forum for exchange of experiences and collaboration, the CA EED helps countries learn from each other, avoid pitfalls and build on successful approaches when implementing the Directive. The CA EED is financed under the Intelligent Energy Europe Programme of the European Commission.

This report summarises the work carried out by the CA EED between January 2013 and October 2016 on district heating, district cooling and combined heat and power. The objectives of the work were for the Member States (MS) to gain a deeper understanding of Article 14 of the EED and to exchange experiences relevant to the implementation of Art.14.

The main objectives of this area of work are:

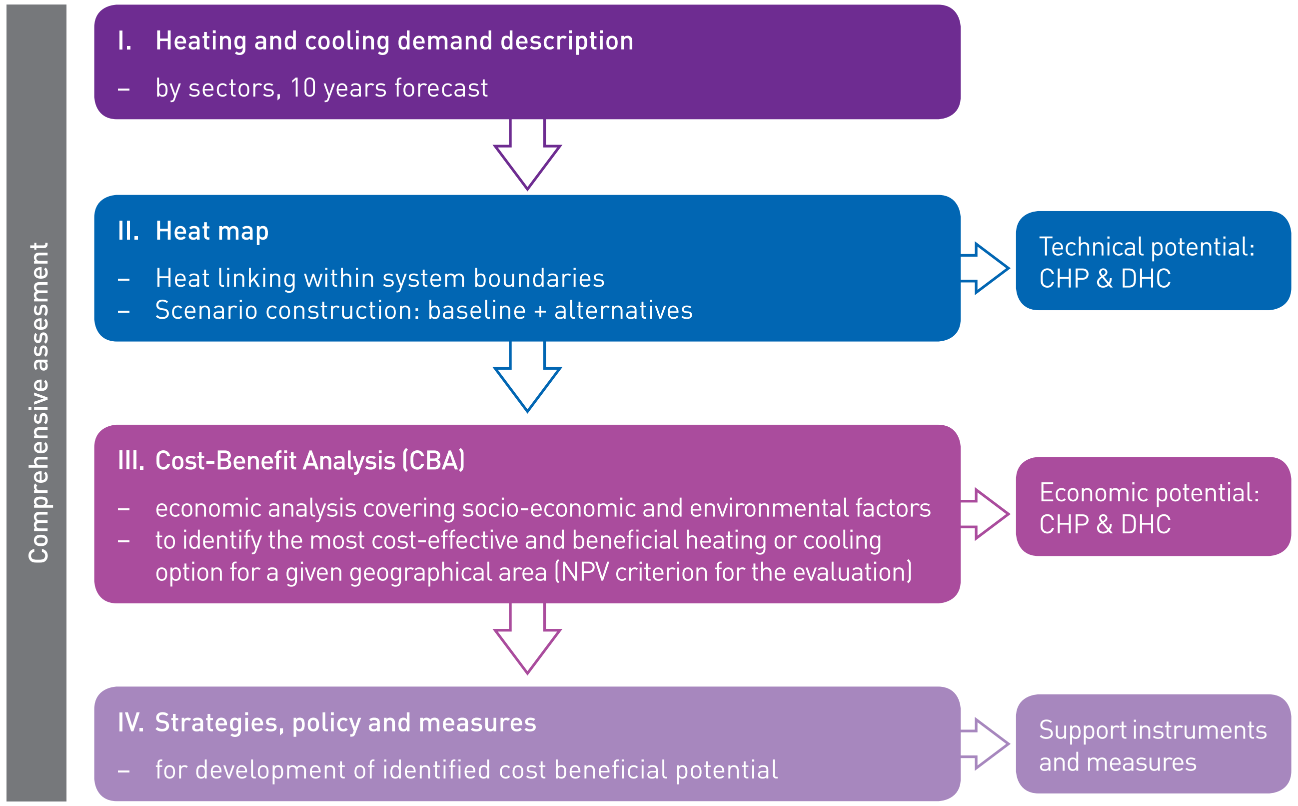
- To ascertain a clear and common understanding of the purpose of Article 14 and Article 15 and the associated annexes.
- To exchange experience of relevant implementation practices already in place in member countries.
- To support the ongoing implementation of Article 14 and Article 15 in the EED through exchange and development of best practice.
- To share experiences of opportunities and barriers to the transfer of best practice experiences between MS.
- To make available to all participants existing tools and methods as inspiration.

The main objective of Article 14 of the EED is to encourage the identification of the potential for cost effective delivery of energy efficiency in heating and cooling, and to foster secure delivery of these measures. It principally encourages exploration of the use of high efficiency cogeneration and efficient district heating and cooling (DHC), but also addresses other energy efficient heating and cooling supply options.

The recently published EU Strategy for Heating and Cooling, emphasises the importance of heating and cooling planning and aims to address the key challenges associated with delivering long-term decarbonisation objectives, energy security, the risk of a heating crisis caused by the interruption of natural gas supply and the increasing competitiveness of EU industry.

This report looks at the lessons learned regarding the implementation of the comprehensive assessment (CA) as a framework for policy implementation. A large number of participants from MS provided input in the form of presentations, provision of relevant documents and input to research conducted within the CA EED, providing an overview of challenges as well as good practice related to the main steps of the CA following Annexes VIII and IX of the EED (Figure 1). This document also contains information and examples produced within the framework of a number of projects supported by the Intelligent Energy Europe and Horizon 2020 programmes of the European Union. More information on these projects can be found in this report and also in two recent overview documents of the European Commission on support activities and projects of the European Union on energy efficiency and renewable energy in the heating & cooling sector: https://ec.europa.eu/energy/sites/ener/files/documents/overview_of_eu_support_activities_to_h-c_-_final.pdfhttp://ec.europa.eu/easme/sites/easme-site/files/heating_and_cooling_projects_market_uptake_activities_0.pdf

Figure 1: Main steps and results of the Comprehensive Assessment



2 Mapping of demand and supply for cooling and heating

Comprehensive mapping of demand and supply options for heating and cooling is the foundation for any assessment of the potential for increased efficiency of energy supply.

The availability of data on energy demand varies considerably across MS. The best coverage is on heat demand in residential buildings. Industrial energy demand is more challenging, and the mapping of cooling demand is less well-developed in almost all MS. In addition, information on supply options is not always readily available. In this regards, although solar and biomass resource maps are in many are cases available in MS, other potential sources of thermal energy such as waste/excess heat from industrial processes is generally lacking.

MS apply different methodologies for assessing heat demand and for mapping the geographical distribution of the demand.

In March 2014, the CA EED discussions showed that a very low number of MS had existing experience in the mapping of heating/cooling demand and waste heat. According to CA EED research conducted on MS implementation of the Comprehensive Assessment, the majority of MS seem to be planning to outsource at least some parts of the mapping to external partners outside government. The role of the national energy authorities regarding the analytical work is therefore primarily that of defining the tasks and setting the requirements for the results of the tendered activities.

Good practice examples

Heat Atlas in the Netherlands

The Heat Atlas is an online, open, interactive, digital geographic map viewer showing heat supply and demand in the Netherlands. On the supply side, users can find (potential) suitable locations of deep geothermal, thermal storage, biomass and waste heat. On the demand side, the atlas shows an overview of the heat demand of residential areas, industry and horticulture. This instrument will contribute to the energy efficiency and sustainability of the Dutch energy system.

The advantages

The Heat Atlas

- aims to provide a current picture of all heat demand and supply
- is used in all sectors: Built Environment, Greenhouse Horticulture, Industry and Energy
- stimulates the synergy between spatial planning and energy at provincial and municipal levels
- provides quick insight into local heat demand and the availability and quality of renewable heat sources
- grows by displaying comprehensive sustainable heat utilisation projects
- is a source of inspiration for new thermal projects

Hurdles in setting up an atlas

- lack of good industrial waste heat data
- how to deal with confidential data

Target group and application

The Heat Atlas Netherlands is intended for anyone undertaking sustainable heat projects, such as municipalities, developers, engineering firms, universities, national and regional governments, industry associations and other interested parties.

www.WarmteAtlas.nl

The National Heat Map, England

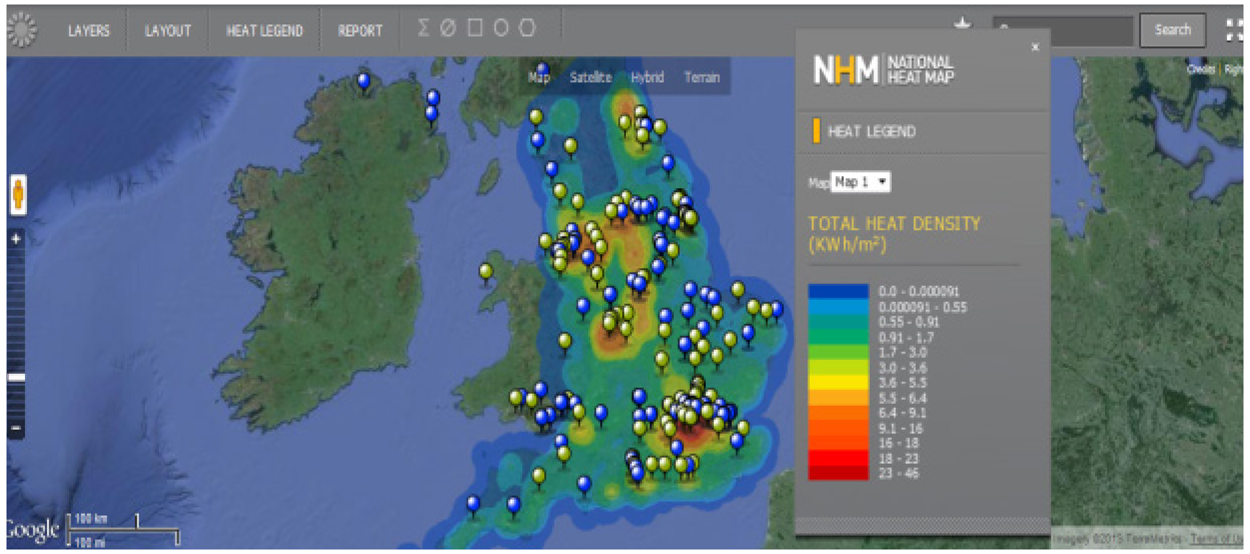
The UK Department of Energy and Climate Change (DECC) is developing a policy to support good quality natural gas CHP. Part of this work involves the development of a National Heat Map for England. The main purpose of the initiative is to assist local authorities in planning for heat supply.

The map is high resolution and offers many of the same functions as Google Maps. It shows heat demand density as well as potential heat supply points. Through this, the map helps identify areas where district heating could match potential heat sources with a corresponding heat demand.

Heat demand is assessed on the basis of information on building type obtained from the National Energy Efficiency Data Framework (NEED) and Ordnance Survey data[1]. The map is produced using meter readings for public buildings. A study of the viable district heating demand in England suggests a potential of 20%: areas of more than 3MW/km2 could potentially be viable. The main sources of energy are natural gas CHP supplemented by lower carbon fuels such as biomass and biogas.

DECC is in the process of developing a heat networks model to better understand this potential. The development of the heat map has been good value for money: the cost of developing the map was £150,000. If each local authority had done their own mapping, costs could be £4-20 million for England. A Heat Networks Delivery Unit was established by DECC to provide guidance and funding to local authorities in heat network development.

Figure 2: The National Heat Map, England



The CODE2 project on the promotion of combined heat and power production

The CODE2 project, which received support under the Intelligent Energy Europe Programme of the European Union, developed national roadmaps for cogeneration across Europe. The project built on the findings of the CODE project, which concluded that many non-economic barriers to cogeneration remain, that awareness of cogeneration outside traditional user groups is low and much policy is poorly targeted.

CODE2 analysis included bio-energy and micro CHP and used MS published data and projections. Of particular relevance to the CA EED are:

- Micro CHP roadmap for each MS and supportive analysis
- Bio-energy roadmap for each MS and supportive analysis
- 7 national CHP roadmaps for pilot MS
- Web based tool for first-pass assessment of economic feasibility of a specific CHP installation
- "How-to" guide for potential users of CHP interested in how to approach a development of CHP (hotels, hospitals, food industry, paper industry and small commercial are particular targets)

For more information, please refer to: http://www.code2-project.eu/

Cooling potential assessment, Denmark

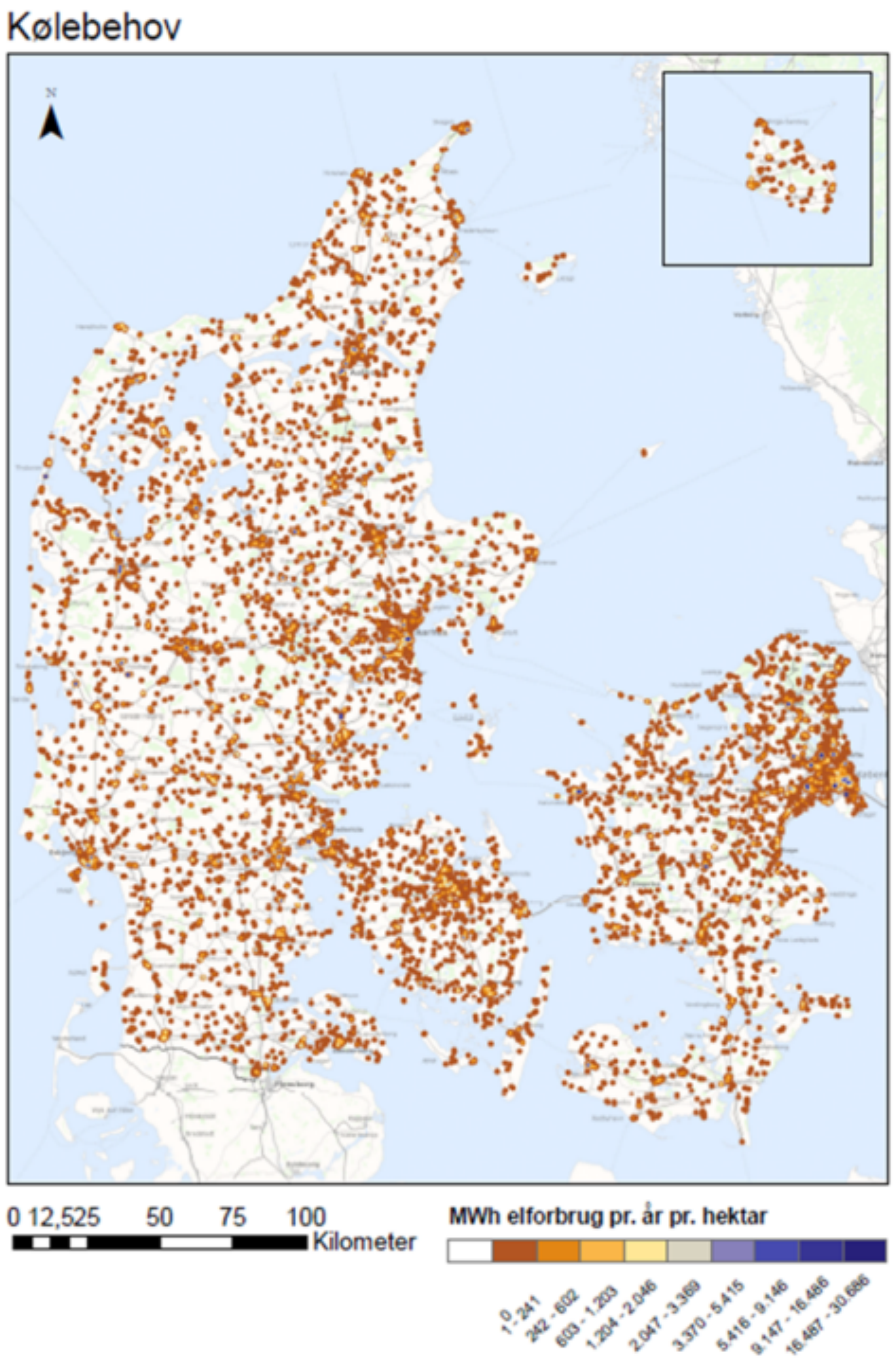
The Danish Energy Agency has undertaken a comprehensive assessment of the potential for district cooling and recovery of waste heat from cooling systems.

A GIS mapping exercise was undertaken using building and enterprise registries combined with detailed mapping of energy demand for cooling by industry sectors. District cooling costs and benefits were compared with those of individual cooling systems to assess the potential for district cooling.

The results of the analysis show a district cooling potential of 40% of total cooling demand. Most of the excess heat from cooling could be profitably recovered for heating purposes.

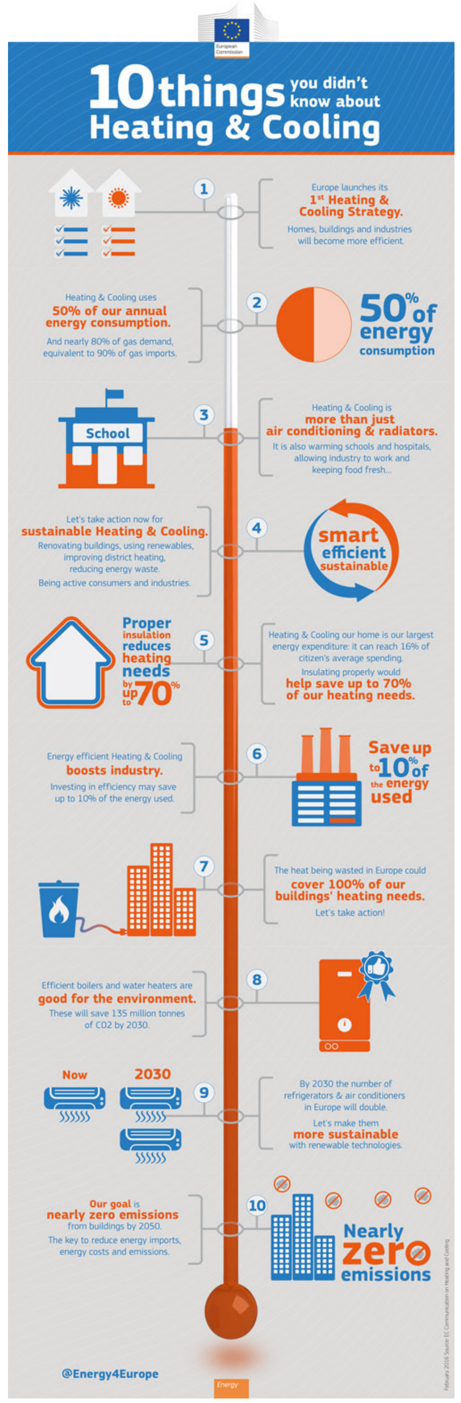
1 See https://www.ordnancesurvey.co.uk/business-and-government/products/opendata-products.html

Figure 3: Cooling demand mapping, Denmark



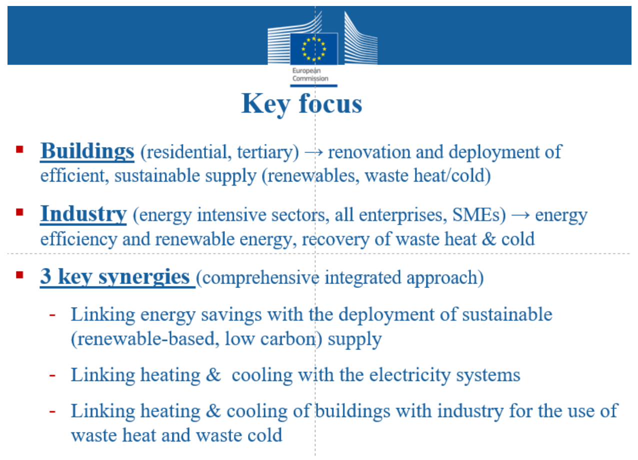
3 Huge untapped potential for efficient heating and cooling in EU

Figure 4: Key facts and challenges of heating and cooling in EU



On 16 February 2016, the European Commission published its EU Strategy on Heating and Cooling[2]. This first ever comprehensive strategy outlines proposals for how the massive amount of energy used to heat and cool Europe's buildings can be addressed through EU energy policy. (Figure 4) The communication is a strategy (not an action plan) that aims to raise awareness of the key issues, facts and options for follow-up actions to increase the uptake of efficient, low carbon heating and cooling in EU (Figure 5)

Figure 5: Key focus of the Strategy



Several good practice examples have demonstrated that there is huge untapped potential for efficient heating and cooling in the EU that should be considered by MS. The results of ongoing and completed EU financed projects could contribute to the successful implementation of the CA.

2 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.

Good practice examples

EU district heating potential assessment – Heat Roadmap Europe and STRATEGO project

Heat Roadmap Europe (www.heatroadmap.eu) analysed the potential role and several development scenarios of district heating and cooling in the future EU energy system. The analysis combined hourly energy system modelling of the electricity, heating and transport sectors with detailed mapping of local heat demands and surplus heat resources and proved huge untapped potential of DHC all over the EU.

A major improvement in energy efficiency in the energy system with DH is a result of the use of surplus heat (heat from a power plant, waste incinerator, industry or renewable energy sources) which already exists in the energy system, captured and moved into the building, thus replacing other fuels that are currently used to heat those buildings. Analysis results indicate that initial large capital costs, primarily due to the development of the heating network, are often compensated by the lower cost of individual heat exchangers and lower cost of alternative surplus heat compared to the alternatives, primarily natural gas. Heat sector analyses should not be carried out in isolation, but should rather be included and integrated in analyses of the entire energy sector long-term perspectives and obligations (e.g. electricity and cooling demand in industry and transport).

Several tools prepared within the STRATEGO project[3] (http://stratego-project.eu/) supported by the freely distributed modelling software (www.energyplan.eu) could be valuable support for MS in the process of comprehensive assessment preparation. As part of the work done in the STRATEGO project, a Pan-European Thermal Atlas has been developed which shows thermal supply and demand across the EU-28 and the impact of implementing various energy efficiency measures in the heating and cooling sectors of five MS (Czech Republic, Croatia, Italy, Romania, and the United Kingdom) has been quantified. STRATEGO has also produced a heat atlas comprising the EU-28 with a 1km2 grid resolution: for each 1km2 cell the map contains the modelled heat and cooling demand, the local density of both demands, the basic geometry of DHC supply, the available waste heat resources and the potential for renewable energy sources (solar thermal, geothermal, relative accessibility of biomass). The thermal atlas is accessible in http://stratego-project.eu/pan-european-thermal-atlas

Building on the aforementioned activities concerning the Heat Roadmap Europe and STRATEGO, Heat Roadmap Europe 4 (www.heatroadmap.eu) is a recently started project supported under Horizon 2020. This study is refining the already existing pan European thermal atlas by considering cooling demand in more detail and by also including the industrial sector in the calculations. In addition, the project foresees to undertake comprehensive study of the heating and cooling sectors in the 14 largest EU countries. High definition heat demand atlases for the 14 countries studied in this project are already available http://www.heatroadmap.eu/maps.php

Figure 6: Pan European Thermal Atlas: 30-50% of current heat is feasible for DH (above 100TJ/km² is suitable for district heating today, above 50TJ/km² is suitable for low temperature DH in the future).

Source: STRATEGO project.

3 The STRATEGO project, which is co-financed under the Intelligent Energy Europe Programme of the European Union.

Geo-DH project proved evident geothermal heat potential in the EU

There are more than 240 geothermal district heating plants in Europe with a total installed capacity of over 4.3GWth and a production of close to 13TWh. The crucial challenge is to promote geothermal district heating (GeoDH) in Europe and to facilitate its penetration into the market. The European GeoDH market can be divided into three segments:

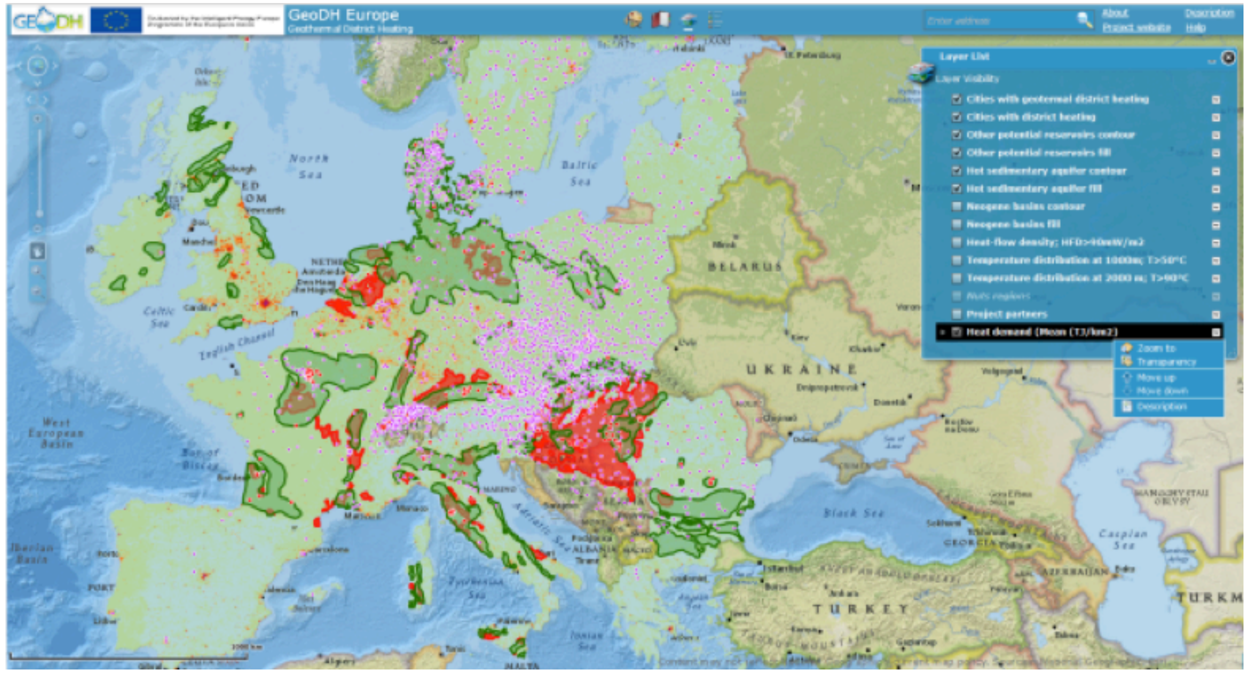
- **Mature markets**: several EU countries with a long tradition in GeoDH and ambitious 2020 targets: Germany, France, Hungary and Italy.
- **Transitional markets**: several Eastern and Central European countries, such as Poland, Slovakia and Romania with GeoDH systems installed. However, the potential is much larger.
- **Juvenile markets**: MS currently developing their first GeoDH systems such as the Netherlands, UK, Ireland and Denmark.

There is a huge untapped geothermal potential which could supply up to 25% of EU27 population. Three key areas have been identified by the Geo-DH project to improve this situation:

- The removal of regulatory barriers and simplified procedures for operators and policy makers.
- The development of innovative financial models for GeoDH projects, which are capital intensive.
- The training of technicians and decision-makers of regional and local authorities in order to provide the technical background necessary to approve and support projects.

Also supported by the IEE programme, the project worked alongside decision makers in 14 MS for the removal of the administrative and financial barriers affecting the further development of deep geothermal district heating (geoDH) systems. Among other outputs the project geodh.eu[4], produced an interactive GIS based mapping of the potential for geothermal for district heating purposes (map.mfgi.hu/geo_DH), case studies, training manuals and information on business models and financing mechanisms for geothermal district heating projects. MS should consider the extent to which these data are appropriate for the elaboration of national CAs according to Article 14.1.

Figure 7: GIS based EU heat and geothermal map



4 The GeoDH has received support from the Intelligent Energy Europe programme of the European Union.

Solar district heating projects: CBA analyses of the SDHPlus project

Solar district heating (SDH) plants are a large-scale solar thermal technology supplying renewable, zero-emission heat from large collector fields via district heating networks to residential and industrial areas in villages and cities.

Long term experience is available from demonstration projects in Sweden, Denmark, Germany and Austria. The commercial application of SDH is presently growing in some countries as heat generation costs below 50Ð/MWh have been already reached (net, without subsidies)[5]. Energy market changes, shorter running times of CHP and binding renewable energy targets have improved the outlook for heat generation in district heating and created more opportunities for SDH applications.

Cost benefit analysis (CBA) at installation level is useful for a general feasibility assessment of SDH. It is important to assess sensitive parameters such as interest rates, size of investments and the lifetime of major components, and to compare the proposed solution with alternative possibilities. Heat prices and economic/financial viability vary widely according to SDH plant types and actual design, and CBA depends significantly on the legal and regulatory framework in each MS.

More on the IEE supported SDHplus project[6] can be found on the project web page (www.solar-district-heating.eu) including the results of the projects' work to analyse new business opportunities for solar district heating and cooling (business models for SDH, case studies for 'first-of-its-kind' plants and innovative DH net integrations and marketing approaches). Activities of this project continue under the recently started Horizon 21020 project SDHp2m. This project activities focus on 3 regions Thuringia (DE), Styria (AT) and Rhone-Alpes (FR) Activities in a number of follower regions are expected in BG, IT, PL, and SE

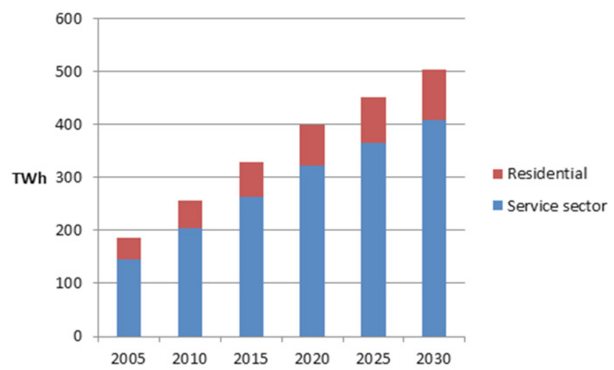
Figure 8: Example of solar district heating system in small community – Büsingen, Germany

Challenges for development of district cooling – RESCUE project

District cooling (DC) technology is a market established technology with the largest cool supply currently existing in France, Sweden and Germany (at approx. 1- 2% share of the total cooling market). The availability of cheap cooling sources (river, sea, lake, waste heat, etc.) close to dense and growing cooling demand in the service and industrial sectors (Figure 9) and economies of scale enable economical applications of district cooling using different cooling technologies across the EU. Effective cooperation between local authorities, energy companies and cooling customers is a prerequisite for the successful planning and implementation of DC projects.

The IEE-supported project REnewable Smart Cooling for Urban Europe (RESCUE, 2012-2015) addressed the key challenges for the further development and implementation of district cooling using low and zero carbon emitting sources, thereby enabling local communities to reap the environmental and economic benefits of this energy efficient technology. According to RESCUE in 2010 around 40% of service building sector floor area and 7% of the residential sector in Europe were equipped with some type of active cooling systems. A number of case studies, a guide for decisions makers on how to roll-out district cooling and tools and information can be found at the project web page www.rescue-project.eu. The guidelines are available in English, German, French, Polish and Italian.

Figure 9: EU27 cooling market projection and primary energy factors for different cooling solutions



Cooling solution	PEF
Conventional individual solution	
Conventional central and decentral on-site cooling systems	1,7 - 0,7
Conventional cooling systems combined with ground water usage	0,8 - 0,4
District Cooling system	
Modern industrial chiller with heat recovery in a District Heating grid	0,5 - 0,3
Industrial chillers combined with free cooling	0,3 - 0,1
Free cooling	0,1 - 0,06
Sorption chillers utilizing waste heat or direct use of renewable energy sources	0,13 - 0,07
PEF= Primary Energy Factor	

5 Denmark has been particularly successful: between 2010 and 2014, 35 plants were built, representing a total capacity of 264 MWth. Other experienced countries are Sweden, Germany and Austria and several European newcomer countries are now introducing SDH (e.g. Italy, France, Spain and Norway).

6 SDHPLUS is a project supported by the Intelligent Energy Europe Programme of the European Commission.

Smart City heating and cooling in Europe - experiences within the CELSIUS project

Led by the City of Gothenburg, the CELSIUS project collaborates across the entire spectrum of planning, implementing and optimising new and existing smart infrastructure solutions for heating and cooling. The common focus of the project is to support the target cities - Gothenburg, London, Rotterdam, Cologne and Genoa - to be more energy efficient and promote the role of district heating (DH) in making use of the excess heat that alwaysexists within the city limits (Figure 10). A number of innovative demonstrators are being implemented in these cities including heat recovery from sewerage in waste water systems, use of buildings for short term storage in district heating networks and utilisation of waste/excess heat from industry.

The CELSIUS project also offers support to a wider number of cities through specialist workshops, expert groups and access to demonstrators. Building on the knowledge and experience of the project team, a CELSIUS toolbox has been developed to assist city decision makers interested in further exploring district heating and cooling in their territories. Currently over 50 follower cities across the EU are already benefiting from the support that CELSIUS is offering. For more information and details of demonstrators, please visit www.celsiuscity.eu

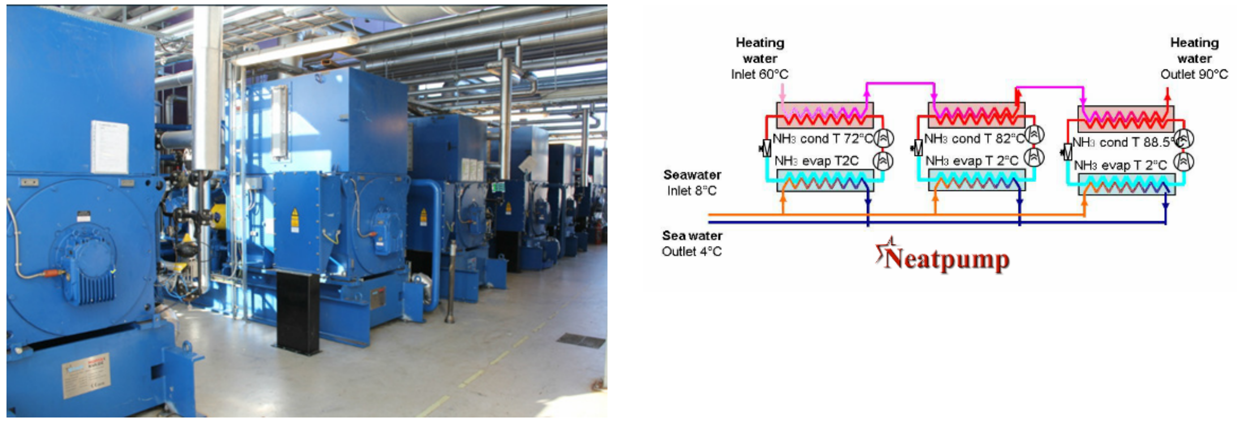
Figure 10: CELSIUS project best practice related to waste heat and other smart solutions for heating & cooling (utilisation of residual heat from the London Underground, waste heat hub storage, DH for ships in harbour and DH to household's appliances)

Large heat pumps – emerging technology for efficient heating and cooling supply

Heat Pumps are becoming cheap heating solutions compared to oil, gas and biofuels. Large heat pumps coupled with thermal (heating and cooling) networks can allow a far greater efficiency by coupling and balancing heating and cooling demands alongside renewable electricity supply. In the context of growing demand for cooling and increasingly intermittent renewable electricity production, larger heat pumps can bring new quality and benefits to existing and new heating and cooling technologies. The case of district heating from Drammen in Norway has successfully demonstrated that the technology exists for 90°C heat pumps in cascade that use natural, low global warming working fluids and achieve an efficiency of 305% even at heat outlet of 90°C from an 8°C fjord or river (Figure 11).

Significant heating efficiency gains could be achieved through temperature decrease. Low temperature heating is possible through 4th generation DH systems increasing the possibility of using excess heat sources and heat pumps in combination. It is anticipated that the 5th generation of DH systems will allow for an even lower system temperature (15°C) with local heat pumps used to boost the temperature to the level required by the building.

Figure 11: 14 MW high temperature heat pump using seawater for DH system in Drammen, Norway



Local district energy case studies from across Europe – ProgRESsHEAT project experiences

In the progRESsHEAT project, funded by the Horizon 2020 programme, six local case studies are analysed. The main objective of the project is to support policy makers and public authorities at a local, regional and national level in the development and implementation of integrated strategies and policies to enforce the use of renewable and efficient heating and cooling solutions in their regions.

The main pillars of the strategy development process are local case studies for six municipalities. The goal of these case studies is to develop heating and cooling strategies through a profound analysis of (1) heating and cooling demands with respect to future developments, (2) long-term potentials of renewable energies and waste heat in the regions, (3) barriers and drivers and (4) a model based assessment of policy intervention in scenarios up to 2050 together with the authorities. Different tools - a geographic information system (GIS) based map of energy demands and sources, energy system analysis tool (EnergyPRO) and a cost curve tool - have been used in comprehensive planning to find the cheapest solution depending on the location and type of building, comparing district energy costs to costs of increased energy efficiency and costs of individual energy solutions. In this way, the most cost effective solutions to increase RES heating and cooling at local level are identified.

High efficiency, sustainable energy sources and high connection rates are key attributes for the efficient green district energy solutions that are cheapest for the society and individuals as well. Long term policy target, use of proper planning tools (geographical data essential), proper regulation and access to cheap long term financing or subsidies are key success factors demonstrated by the ProgRESsHEAT project experiences.

4 Socio-economic cost-benefit analysis

The fundamental purpose of carrying out a socio-economic CBA for a project is to improve the basis for a qualified prioritisation of scarce resources within the society, normally at national level.

In order to establish a sensible prioritisation of resources across sectors and with varying time horizons, assessments must be made based on uniform and transparent preconditions, assumptions and methods. Special issues and non-monetised impacts need to be described in the best way possible. Through this process the basis for political decision-making can be improved even though it will always be a balance of both economic and non-economic considerations, including social and ethical matters. While financial CBA is widely used as an indicator of the viability of specific projects and technologies, only a few MS currently apply socio-economic CBA as a foundation for policy development. Projects relating to energy efficiency or renewable energy are often more viable from a socio-economic than from a financial perspective. The main reason is that, in most MS, the socio-economic discount rate is lower than the typical financial discount rate. Further, the socio-economic CBA would also take account of external costs and benefits such as carbon emissions. In most cases – although not always – the external costs of conventional technologies are higher than those of efficient technologies.

Good practice examples

The JRC Methodology for comprehensive assessment and CBA

The Petten JRC has developed technical background studies on possible best practice and informal guidance on the implementation of CA and CBA at a national and installation level and public heat maps. Three best practice guidelines have been prepared to provide comprehensive methodological support to MS for all implementation steps of the CA and CBA. All reports are available at https://setis.ec.europa.eu/newsroom/news/three-best-practice-guidelines-energy-efficiency-potentials-heating-and-cooling-sector

Summary of Danish national guidelines for socio-economic cost-benefit analysis

In Denmark, socio-economic analysis and assessments have been used within many parts of the public sector: health and welfare, environmental management, energy, transport, social security, etc.

A socio-economic analysis of a project is a statement of cost and benefit of a new/proposed project and a comparison of these with a reference scenario, typically the current situation or business as usual.

The main steps of the analysis can be summarised in this way:

1. The total net heat demand for the town is estimated, in physical terms like GJ.
2. The heat demand is calculated for both the reference and the new project.
3. The fuel demand is calculated based on figures for efficiency of individual oil fired boilers and efficiency for a wood chip boiler and heat loss in the district heating pipelines.
4. Investment costs for the new project are calculated and include costs for:
   - district heating boiler.
   - district heating grid.
   - minus scrap value as the network has longer life-time than the boiler.
   - conversion of installations at individual users.

   For the reference, necessary investments in renewal of oil burners and installations are also calculated.
5. Maintenance costs are worked out both for the reference and the new project.
6. Environmental effects for the reference and the new project are calculated and summarised – these include greenhouse gases: CO_2, CH_4 and $N2_0$ as well as NOx and SO_2
7. Finally all relevant figures for the reference and the new project are summarised.
8. The new project can be compared with reference:
   - costs and benefits seen from a socio-economic point of view.
   - differences between costs of the project and of the reference.

Of the wide range of effects resulting from the implementation of a project, only a small proportion can be valued in real life. Among effects with no direct value which can be fixed on a market are:

- Security of supply (diversification of energy sources).
- Non-valued environmental impacts:
  - Air emissions other than CO_2, SO_2 and NOx
  - Emissions into the aquatic environment
  - Visual / landscape effects
  - Odour
- Derived development of technology.
- Safety, comfort and health.
- Effects on distribution of income and wealth.

Damage caused by environmental impacts is typically determined by geographical conditions. General values for such effects might be difficult to fix and must be evaluated on a project by project basis.

Employment is normally ignored in cost-benefit analysis because in the long term total employment is determined by other factors, primarily the functioning of the labour market and because the workforce is able to obtain employment elsewhere (i.e. labour is a scarce resource in the long term).

For the purpose of consistency, the Danish Energy Agency has issued a broad framework of technical and economic data to be used for the cost-benefit analysis.

5 Policy and measures

Political and regulatory frameworks vary considerably across MS. These variations are reflected in the policies applied to promote efficient supply of energy.

Good practice examples

Feed-in tariffs for CHP and renewable energy systems in Slovenia

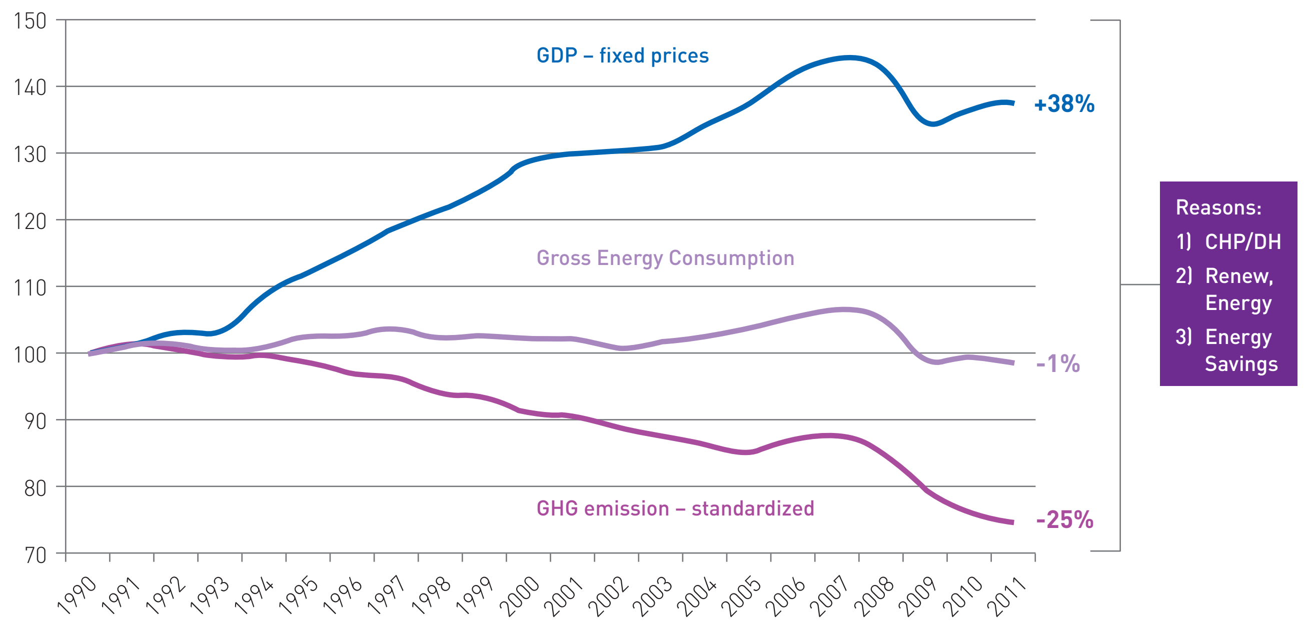
- 10 years guaranteed support for new plants (15 years for the use of renewable energy sources (RES)):
  - All CHP plants – up to 20MWe (all sectors up to 10 years old).
  - Special treatment of refurbished old plants.
  - Individual treatment of new immature technologies.
  - Higher support for units with up to 4,000 operation hours (heating).
- Shape of support:
  - Guaranteed purchase electricity price – units ← 1MWe or
  - Premium on all generated electricity – units → 1MWe.
  - Predictable methodology for annual adjustment of support based on forecast of the natural gas, wood biomass and electricity market price (minimise market risks for the investors).
- Support scheme is under reconstruction and new tendering entrance procedure will be introduced this year.

Summary of Danish policy experiences of efficiency in energy supply:

- Economic feasibility (Art. 14.3 and 14.5) has always been the main criteria in Danish heat planning. However combined with a central determined energy policy direction, it supports:
  - Partial heat planning: substitution of oil.
  - Nationwide heat planning: use of indigenous resources.
  - Project specific heat planning: use of natural gas, biomass, biogas, waste, surplus heat etc. and primary energy savings. 'Shift backwards' from CHP to heat-only boilers (HOB) in general not allowed.
  - National and municipal energy planning: EE and substitution of fossil fuels with renewables – under development.
- Nationwide heat planning and comprehensive heat assessments (Art. 14.1) was used in the eighties to identify potential for CHP and for local energy resources, and make strategic decisions at national level.
- Zoning/separation of the heat market:
  - National zoning: some parts of the country didn't receive natural gas supply due to better indigenous alternatives (biomass, surplus heat).
  - Local zoning: avoiding double supply at consumer level (either natural gas network or DH-network).

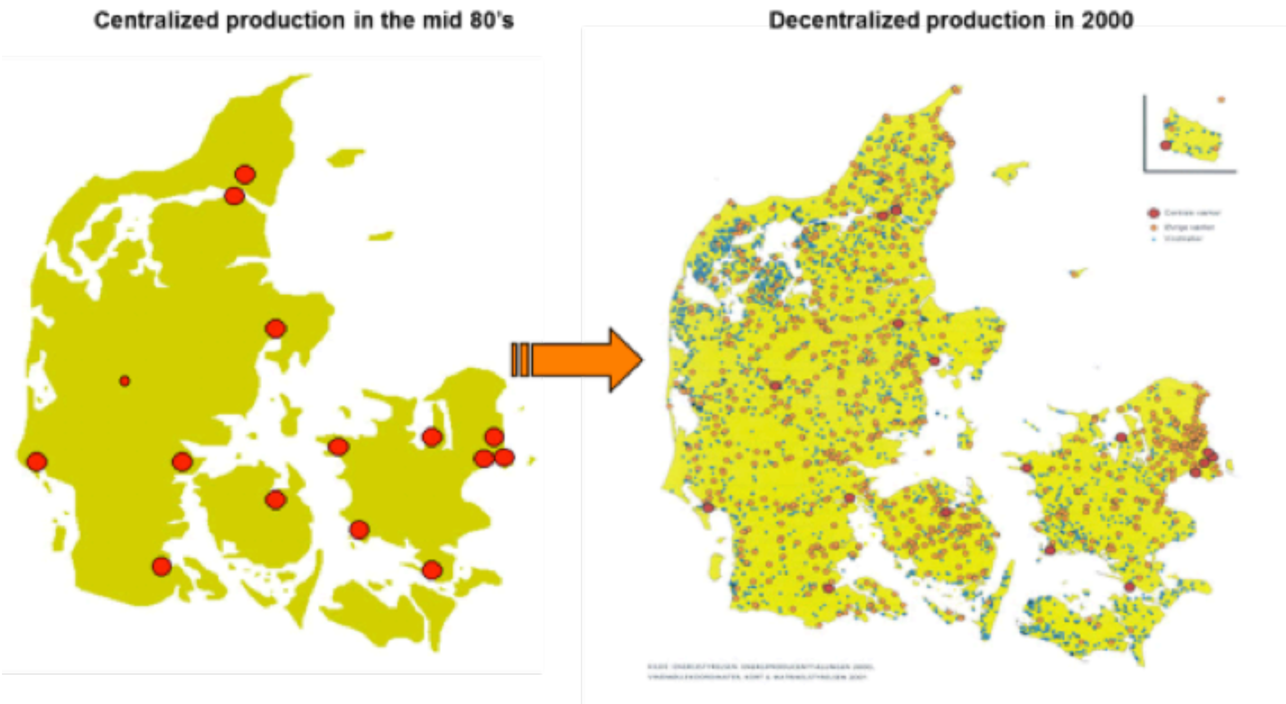
- Project specific CBA procedures (Art. 14.5) are being used, so that national guidelines are followed and local market for CHP/HOB are secured.
- Very important to provide and secure sufficient incentives and measures:
  - In general to secure the DH market and provide sufficient financial viability (loan guarantees by municipalities)
  - For urgent heat planning, heat pricing gives 'full CHP-advantage' to the heat side, providing a sufficient incentive for rapid development.
  - For nationwide heat planning, heat pricing allows for the same heat price to be paid for CHP as for HOB if it's the same fuel (political agreement in 1986). The incentive was not sufficient, resulting in slow development.
- For project specific heat planning:
  - In the 1990s, the focus was on expanding CHP production. Incentives included a feed in premium and investment subs, which provided sufficient incentives and results in rapid development.
  - In the 2000s, the focus was on maintaining CHP capacity. Incentives included a premium for installed CHP capacity and payment for regulation capacity (fluctuating electricity from wind). This now needs to be revised (current incentives expire in 2018).

Figure 12: Decoupling of GDP and GHG emissions in Denmark



Danish Kyoto Obligation: GHG reduced by 21% from 1990 to 2008-12

Figure 13: From centralised to decentralised production of electricity.
The vast majority of thermal power plants are CHP plants.



Good practice examples

Germany – support of CHP and district heating

- CHP is an important part of energy policy 'Energiewende' (efficient, reliable, RES compatible and less CO_2 intensive generation), where evident flexible CHP generation potential was assessed especially in big cities.
- Key support instruments:
  - Preferable access to the grid
  - Feed in tariff for 30,000 operating hours between 5.4 for small and 1.8ct kWh for big units (→ 2MW) to a maximum of Đ750million/annum.
- Installation of new CHP units.
- Modernisation only if the costs → 25%, or → 50% of the costs for a new installation.
- Investment grants for:
  - Small CHP (←20kWe:1,500 – Đ3,500 per unit)
  - Heat distribution infrastructure (heat grid/ storage systems): 30/40 % of investment cost, max Đ5/10million/project.
- Energy tax exemption for high efficient CHP during depreciation period (SA 33848 – 2011/N[7]).
- CHP fulfil building standards for new houses 'green heat' supply (EEWärmeG, EnEV).

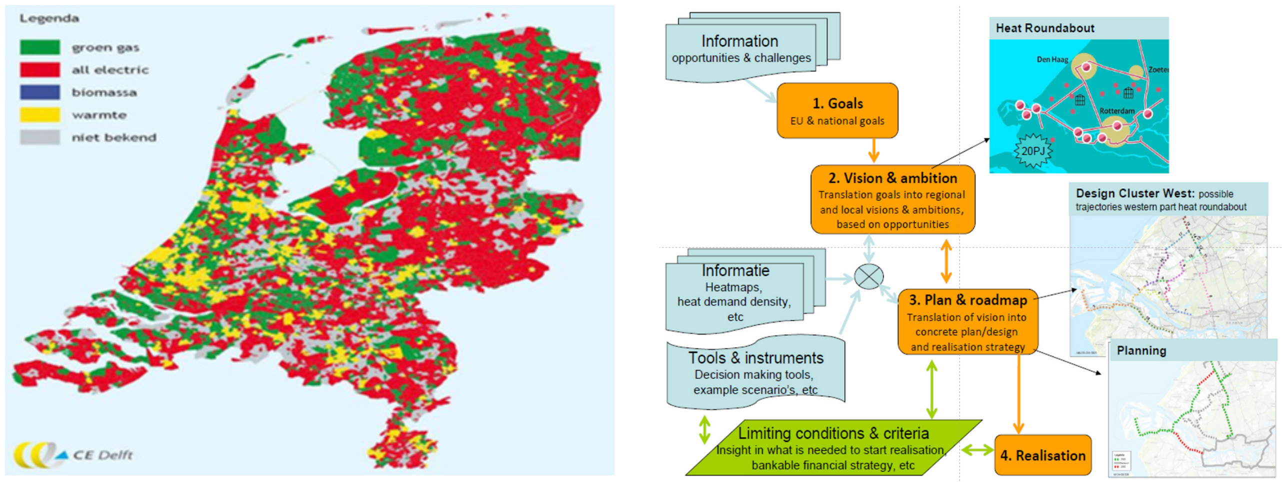
7 See http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=3_SA_33848

Netherlands heating policy and Art. 14 EED

The Netherlands has a very high natural gas penetration for heating and reducing natural gas consumption is one of the main challenges of its heating policy based on their climate goal to be very low CO_2 or nearly climate neutral by 2050. Natural gas for buildings is being phased out by 2050 (except for peak supply) mainly through demand reduction (insulation), all electric (heat pumps), district heating (residual heat, geothermal) and biogas/biomass (Figure 13). An "energy dialogue" has been initiated with all relevant stakeholders to achieve these challenging goals.

A comprehensive planning approach has been demonstrated in the case of the Heat Roundabout South-Holland, which takes an integrated approach by using waste heat from Rotterdam port to heat greenhouses and buildings in nearby cities[8].

Figure 14: Long term projection of heat supply in the Netherlands
and the concept of Heat roundabout South-Holland planning.



8 Demonstration video about the project is available at https://www.youtube.com/watch?v=6vslyxbjass

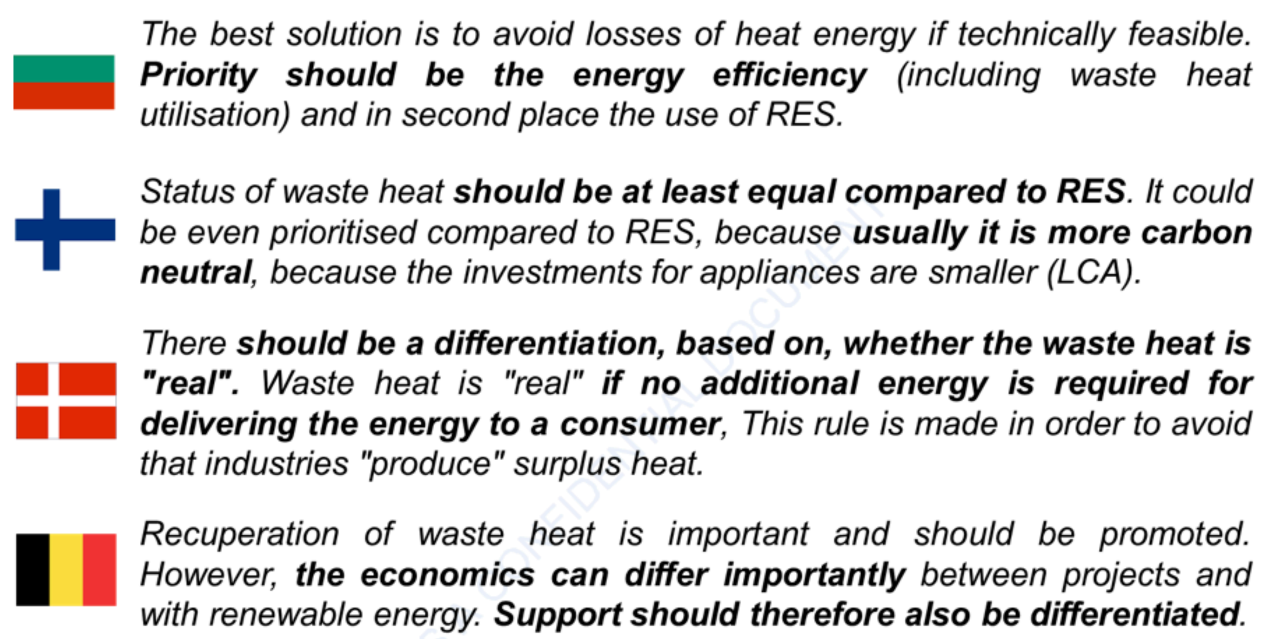
Good practice example

Status of waste heat utilisation

Our survey results indicate that CA implementation in MS has contributed to a better understanding of the potential for using waste heat in more than 50% of responding MS. The highest potential identified is in industry (15% high and 50% medium for own heating and cooling supply, and 15% high and 30% medium for waste heat supply to DHC systems). The potential for using waste heat has also been evidenced in power generation (20% high and 30% medium) and in services (11% high and 37% medium). MS responses indicate that the waste heat market is becoming active in the majority of MS who participated in the survey (64%) and 36% of respondents stated that use of waste heat is considered as an eligible measure under their energy efficiency obligation schemes (Art. 7).

Our survey also confirmed the importance of waste heat utilisation compared to renewable energy with 53% of respondents agreeing that they should be treated as equal in status (less than 30% disagree). Some additional views from MS on the status and importance of waste heat utilisation are shown in Figure 15.

Figure 15: Opinions on the status and importance of waste heat utilisation.



6 Concluding remarks

The history of energy sector regulation varies widely across MS, as do the overall energy policy frameworks and climatic conditions. This is reflected not only in the level at which MS have prepared and implemented regulation to promote efficiency in energy supply but also the policy measures applied. There is, therefore, significant potential for exchange of experience regarding the development of regulation to improve efficiency of energy supply where CA could be a framework for successful policy implementation.

This Core Theme report has picked up a wide variety of good practice relating to the implementation of Article 14 Comprehensive Assessment. These include mapping of energy demands, the potential for efficient heating and cooling assessment, new technology best practice, cost benefit analysis and applicable regulatory policy and measures.

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