# CONTENT

1. Preface ................................................................. 4  
2. Project Description ................................................ 4  
3. Nomenclature ....................................................... 7  
4. Summary ............................................................. 9  

The cooling market in EU27 countries .................. 9  
The DC market situation and prognosis ............... 9 
Five import local markets .................................. 10  
Energy Efficiency Directive in respect to DC market ... 10 
Global society impact ............................................ 10 

5. Introduction ........................................................ 11  
5.1 Background ....................................................... 11  
5.2 Verifying use of ECI for market estimations ....... 11 

6. Cooling market in EU27 ........................................ 12  
6.1 Delimitations .................................................... 12  
6.2 Present cooling market saturation estimations .... 13  
6.3 Cooling market estimation from Renewable Heating and Cooling .................................................. 14  
6.4 Conditions for estimation of the future cooling market ........................................................... 15  
6.4.1 Population estimations and urbanisation ......... 16  
6.4.2 Types of buildings .......................................... 17  
6.5 Rescue new estimation of EU27 cooling market growth ................................................................. 17  

7. District Cooling market development .................. 19  
7.1 Present District Cooling market share ............... 19  
7.1.1 Statistics from Euroheat&Power .................. 19  
7.1.2 Present market saturation of DC .................. 21  
7.2 District Cooling market prognosis .................... 22  
7.2.1 Scenario 1 – Rescue influence in target cities ... 23  
7.2.2 Scenario 2 – Rescue also initiating new DC projects .................................................... 24  
7.2.3 Scenario 3 – Based on the Swedish development speed .................................................... 24  
7.3 Where it must happen ....................................... 26  

8. The EU 2020 environmental targets ................... 29  

9. Opportunities, trends and challenges ............... 32  
9.1 Introduction ...................................................... 32  
9.2 Opportunities - Responses from interviews ....... 32  
9.2.1 Awareness of possible synergies ................. 32  
9.2.2 Economy .................................................... 33  
9.2.3 Permission and legislation ......................... 33  
9.2.4 Avoiding electrical grid and power production investments .................................................. 34  
9.3 Trends - Responses from interviews ............... 34  
9.3.1 Environmental performance factors .............. 34  
9.3.2 Certification systems for buildings ............... 35  
9.4 Challenges - Response on interviews ................ 35  
9.4.1 Primary energy usage ................................. 35
9.4.2 Legislation issues and permits .......................... 36
9.4.3 Unfamiliar product ........................................ 36
9.4.4 Economic issues ........................................... 37
9.4.5 Competition and Third Party Access ................. 38
9.4.6 Market barriers for DC expansion .................... 39
9.4.7 Conclusions on market development ................. 51
9.4.8 Why is DC market growing so slow in Europe ....... 52
10. References ......................................................... 54
11. Appendixes ......................................................... 56

11.1 Description on cooling market prognosis 2020 and 2030 56
Lot 10 “domestic ventilation” .................................. 56
Lot 6 “non‐domestic ventilation” .............................. 57
Market saturation of cooling in EU27 ......................... 58
11.2 Certification systems for buildings ...................... 60
11.2.1 GreenBuilding .............................................. 60
11.2.2 LEED .......................................................... 61
11.2.3 BREEAM ....................................................... 62
11.2.4 Examples of applying certifications on a service buildings in Sweden 62
1. PREFACE

This report has been elaborated in the RESCUE (Renewable Smart Cooling in Urban Europe) project. This IEE (Intelligent Energy Europe) co-funded project is scheduled from June 2012 to November 2014.

The sole responsibility for the content of this report lies with the authors. It does not necessarily reflect the opinion of the European Community. The European Commission is not responsible for any use that may be made of the information contained therein.

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- ICLEI Europe (www.iclei-europe.org)
- Regional Energy Agency of Liguria (www.areliguria.it)

If you would like to know more about RESCUE project please visit our website www.rescue-project.eu.

2. PROJECT DESCRIPTION

Cooling energy demand within Europe, especially in urban regions, is rising significantly, mainly caused by building design, internal heat loads, heat island effects, and comfort reasons. If served conventionally using small scale and distributed electric driven compressor chillers this would result in a significant rise in primary energy consumption, greenhouse gas emissions and peak electricity demand.

The RESCUE project focuses on the key challenges for further development and implementation of District Cooling (DC) using low and zero carbon emitting sources, thereby enabling local communities to reap the environmental and economic benefits of this mature technology. Although DC allows the application of high efficient industrial chillers or absorption chillers driven by waste heat it is estimated that DC market share today is about
1-2 % in the service sector (which is about 3 TWh) but less than 1 % of the total present existing European cooling market including residential. The main steps to extend the use of smart, energy efficient and renewable DC Systems are:

1. Dissemination of essential background information.
2. Decision making based on (pre-) feasibility studies exploring cooling options.
3. Implementation, monitoring and optimization.

The RESCUE project focuses on steps 1 and 2 within the project duration addressing main actors and target groups, i.e. Local Authorities (LA), utility companies, building owners, and the financing sector. The main objectives of the project are therefore:

- Promote DC as a high potential, sustainable energy solution.
- Increase familiarity and reliability of information available to decision makers and LA about the DC business.
- Improve networking activities and experience exchange.

A key action of the project is to provide a number of target cities with a decision-making support package assisting LA to account for DC in their planning policies and to guide them when looking for cooling options fitting best to their Sustainable Energy Action Plan (SEAP). Key outputs and main deliverables of the project, available to the public, are:

- An impact calculator which shows the key figures in comparison between Central and Distributed solutions.
- A set of guidelines and handbooks related to the DC business and the decision making process.
- Reports describing the cooling energy market, the energy performance evaluation as well as DC best practice and show cases.

The RESCUE project consists of seven Work Packages (WP), whereas WPs 1, 6 and 7 are dedicated for project management and communication, WP2 is dedicated to conducting a market survey for cooling in Europe and to establish how DC can contribute to the 20-20-20 targets. WP3 is to showcase examples of DC systems in Europe in order to demonstrate their performance and to provide details on the use of renewable energy sources (RES), improvements in energy efficiency and CO₂-savings. Within WP4 a “Decision Making Support Package” is developed, applied and enhanced to guide and assist LA in their decision processes regarding cooling issues in local energy concepts. The purpose of WP 5 is to provide practical information related to start-up of DC systems and the DC business in general.
<table>
<thead>
<tr>
<th>WP1 Management</th>
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<tbody>
<tr>
<td>WP2 EU cooling market</td>
<td>WP3 District Cooling Show cases</td>
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<td>WP4 Decision making tool</td>
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<td>WP5 Guideline – How to do it</td>
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| WP6 Communication | WP7 EACI Dissemination |
### 3. NOMENCLATURE

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Absorption (chiller)</td>
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<tr>
<td>AC</td>
<td>Air Conditioning</td>
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<tr>
<td>BREEAM</td>
<td>Building Research Establishment Energy Assessment Method</td>
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<tr>
<td>CHP</td>
<td>Combined Heat and Power</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CoM</td>
<td>Covenant of Mayors</td>
</tr>
<tr>
<td>COP</td>
<td>Coefficient Of Performance</td>
</tr>
<tr>
<td>DC</td>
<td>District Cooling</td>
</tr>
<tr>
<td>DCS</td>
<td>District Cooling System</td>
</tr>
<tr>
<td>DE</td>
<td>District Energy</td>
</tr>
<tr>
<td>DH</td>
<td>District Heating</td>
</tr>
<tr>
<td>DHC</td>
<td>District Heating &amp; Cooling</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>ECI</td>
<td>European Cooling Index</td>
</tr>
<tr>
<td>EER</td>
<td>Energy Efficiency Ratio</td>
</tr>
<tr>
<td>EPC</td>
<td>European Project Centre</td>
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<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>FM</td>
<td>Facility Management</td>
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<td>LA</td>
<td>Local Authorities</td>
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<td>LCC</td>
<td>Life Cycle Cost</td>
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<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<tr>
<td>LG</td>
<td>Local Government</td>
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<tr>
<td>PE</td>
<td>Primary Energy</td>
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<tr>
<td>PEF</td>
<td>Primary Energy Factor</td>
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<tr>
<td>RES</td>
<td>Renewable Energy Sources</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>Rescue</td>
<td>RENEWable Smart Cooling for Urban Europe</td>
</tr>
<tr>
<td>SEAP</td>
<td>Sustainable Energy Action Plan</td>
</tr>
<tr>
<td>SGBC</td>
<td>Swedish Green Building Council</td>
</tr>
<tr>
<td>SSEER</td>
<td>System Seasonal Energy Efficiency Ratio</td>
</tr>
<tr>
<td>TPA</td>
<td>Third Party Access</td>
</tr>
<tr>
<td>USGBC</td>
<td>US Green Building Council</td>
</tr>
<tr>
<td>WG</td>
<td>Working Group</td>
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<td>WP</td>
<td>Work Package</td>
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4. SUMMARY

This report discusses the EU27 cooling market today, 2020 and 2030. In the scope lies also an estimation of the DC market.

THE COOLING MARKET IN EU27 COUNTRIES

Earlier project Ecoheatcool from 2005 did present an estimation of the European cooling market. In Ecoheatcool the European Cooling Index (ECI) was created. Rescue has in a previous report verified, by the use of DC customer measurements, that the ECI can be used for cooling market estimations. The ECI takes into consideration types of buildings, residential and service sector, building standard and space requirement in different countries and climate conditions. The EU27 countries cooling market is now estimated to be 1220 TWh, whereas 710 TWh respectively 510 TWh for the residential respectively service sector.

The present penetration of AC in Europe is significantly lower than in comparable markets in USA and Japan. Due to financial crunch and recession, and especially in Europe, has slowed down the market expansion of AC. Rescue now estimates the present AC market in EU27 countries to be 285 TWh. The prognosis for the penetration of AC in EU27 countries for 2020 and 2030 is expected to reach 400 respectively 500 TWh.

THE DC MARKET SITUATION AND PROGNOSIS

Official statistics of DC in the EU27 countries for the recent three years show no development of the DC sales. It is still 3 TWh, corresponding to only 1% of the present cooling market in EU27 countries. No clear indication of an expanding market can therefore be observed. However it does only need a political dedication, a corporate dedication and a market approach.

Since DC still is an undiscovered solution it cannot be made any secured prognosis or estimations of the DC development in the EU27 countries. It is all depending on the political determination, corporate determination and the focus on the market’s interest.

Based on that DC is expected to get a recognition of the environmental benefits Rescue has made a prognosis of DC for 2020 and 2030 based on three different scenarios. The period for the Rescue project is too short to register any development, to establish a new DC system generally takes 3-4 years from feasibility study until start-up of the first operations. The result from Rescue will then only be possible to observe in the future. One of the targets of Rescue is that at least 10 cities in EU27 separately will initiate feasibility studies. If the results are positive it can lead into actual development of DC systems in the target cities.

One scenario is that Rescue can initiate 10 new DC systems with an average capacity of 50 MW each it can only lead into a new DC market in EU27 of 3.3 TWh in 2020 and 3.5 TWh in 2030. So if DC should make a real contribution to the EU 2020 environmental targets it is needed new DC systems in many other cities as well.

Another scenario is that Rescue can start a snow-ball effect. Each initial local target project will also lead into a market interest in 5-10 other cities for each target city project. The new DC market in EU27 can then reach 4 TWh in 2020 and 12 TWh in 2030.
Rescue has also calculated the DC market with a scenario that is based on the Swedish experience. The historic Swedish actual development during 15 years has now been projected for the whole EU27 market and climate conditions. The new DC market in EU27 could then reach 33 TWh in 2020 and 66 TWh in 2030. Also note that the Swedish DC market share is fully utilised, it is possible to double this. Based on the same assumptions the estimated EU27 DC market share could then also be doubled.

FIVE IMPORTANT LOCAL MARKETS

The Nordic European countries do take a leading position in development of DC in respect to market share in respect to a very limited population, that even though that the climate is colder in the northern Europe than in the south of Europe. For instance 30% of the DC in EU27 does exist in Sweden. Finland does also have a steady growing DC market. One explanation is that district heating is well established in the Nordic countries. The Nordic DC development has however less importance since so few people live in the Nordic countries. If a real impact of DC shall be accomplished the development need to start where the climate is warmer and where most of the people in EU27 are living.

Taking climate conditions and population into consideration 65% of the cooling market in EU27 countries is in the 5 largest countries, Germany, Italy, France, Spain and UK. Focus must now be targeted on finding DC development in these countries. If not the AC market will continue to grow with only autonomous single building related solutions, which will use much more electricity than DC solutions.

ENERGY EFFICIENCY DIRECTIVE IN RESPECT TO DC MARKET

The background of the Rescue project in general is the potential contribution of in achieving the EU 2020 environmental targets. The European Union wants to reduce CO2-emissions by 20%, reach a share of 20% of renewable energy and reduce primary energy consumption by 20% in 2020. Regarding the energy efficiency target of reducing primary energy consumption by 20% in 2020 the European Union is, according to the European Commission, not on track.

In the Energy Efficiency Directive (EED) district cooling has been recognised as one of the important pillars for achieving the energy efficiency target of reducing primary energy consumption by 20%. There is a definition of efficient district cooling, meaning a system using at least 50% renewable energy, 50% waste heat, 75% cogenerated heat or 50% of a combination of such energy and heat. Actually it would have been more natural on aiming on a definition of efficient district cooling as reduction of primary energy consumption. District cooling is a flexible technology that takes measures on using possible local solutions. Each system has its unique conditions. District cooling is competing with already established on-site building related solutions.

GLOBAL SOCIETY IMPACT

The rapidly growing air-conditioning market will lead into a higher use of primary energy and then leading into a substantial increase of the CO2-emissions. District cooling can reduce the use of primary energy and also reduce the increase of CO2-emissions.

District cooling is saving primary energy compared to local air-conditioning solutions. District cooling can therefore reduce the need of new electricity production and also
enforcement of the electricity distribution systems. The investment on global society level for new electricity production and distribution are actually higher than the local investments for district cooling.

5. INTRODUCTION

5.1 BACKGROUND

The energy demand for buildings varies depending on countries and outdoor temperatures. Different buildings have different demands and identical buildings have different demands due to the kind of business within the building. As it is difficult to define a “typical building” we do have to account for different types of buildings with different technical standards: new and old ones.

In Ecoheatcool /REF 1, REF 2/ both the EHI (European Heating Index) and the ECI (European Cooling Index) were developed. The EHI and ECI are used as factors directly proportional to the energy demand in buildings depending on their geographic location. There are a number of assumptions taken in the creation of the EHI and ECI. One important fact was that the EHI and ECI should be easy to use and not too complex in their structure.

When using the ECI for calculating cooling demand for different DC systems and countries we need to ensure that the ECI is as accurate as possible. This report shall update some of the Ecoheatcool project information. The methodology to be used is verifying the ECI by measuring cooling in actual standardised buildings located in different European cities.

When analysing and estimating existing and potential DC markets there are a number of key points to consider:

- Population
- Urbanization (people moving from rural areas to cities)
- Cooled floor area
- Ambient conditions
- Saturation of cooling supply in the building stock
- Types of building stock (energy usage level due to building material and the usage inside the building)
- New building developments and refurbishment in the existing building stock
- Location of potential customers (cooling area density must be high enough)

5.2 VERIFYING USE OF ECI FOR MARKET ESTIMATIONS

The recent published Rescue project report, Measurement analysis and ECI comparison /REF 3/, analysed cooling demands in respect to the ECI by using measurements from European cities with DC systems.
The ECI assumes that the cooling demand is driven by the climatic conditions but experience shows that the cooling of a building consists of two parts:

- A base load that is independent of the climate, which are internal loads originating from people and electric equipment.
- Comfort cooling that depends on the ambient temperature.

The base load for cooling is only applicable to the service sector. From the measured real values it was established that the average base load energy demand for cooling is approximately 30 kWh/m² for office buildings. Buildings that also included restaurants, data rooms, sports facilities and shops have a higher base load cooling demand than the buildings which accommodate only offices.

The base load constitutes between 40 to 60 % of the total cooling energy demand. The Nordic systems are in the range of 55 to 60 % while Lisbon and Vienna are around 40 %. It is expected that the base load constitutes a larger part of the total energy demand for cooling in colder countries and a smaller part (about 25 %) in warmer countries where the load for comfort cooling is predominant. While the influence of the base load is more considerable in Northern European cities on an aggregated European level this is of less importance. The Northern European countries are not densely populated and do therefore not influence the overall European cooling demand significantly.

When separating the different parts and using the average base cooling load for service sector buildings and use a revised comfort cooling demand, instead of only the original ECI, the total impact on the aggregated cooling demand will only result in a deviation of approximately 4 % of the total residential and service sector cooling market in EU27.

Since the observed difference in cooling demand between different buildings is to a high extent dependant on the usage of the building. It is necessary to have detailed knowledge of the building’s usage and design of the building in order to establish an individual cooling demand form this building. When estimating a cooling market demand for a country or on the EU level, it will be sufficient to use the average values represented by an ECI caused by the ambient temperature.

In conclusion it is possible to use the ECI for an estimation of the cooling demand on an aggregated European level.

6. COOLING MARKET IN EU27

6.1 DELIMITATIONS

Buildings need both heating and cooling in order to achieve a good and even indoor temperature. Today the main driving force for building standards and the use of building materials (walls, insulation and windows) originates from the heat demand. This was also the motivation for constructing the EHI first and constructing the ECI on the same basic principles. Due to these building standards and the use of building materials however the cooling demand rises significantly since internal loads from people and electric equipment stay within the building envelope and need to be cooled down.
The whole of Europe consists of 48 countries. The methodology for this analysis of the market for DC and also the benefits in respect to EU targets can be estimated based on the population. Each person will require a certain building footprint area, both for residential and service space.

Rescue will only focus on the possibilities and the benefits of DC in EU27. Available information and statistics is mostly collected on EU27 level. However EU27 only consist of approximately 60% of Europe’s population, see the population figures from 2010 in Europe, Table 1. The possible environmental benefits of DC for Europe are actually far larger than what the Rescue project is estimating for only EU27.

<table>
<thead>
<tr>
<th>EU27:</th>
<th>Population 2010</th>
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<tbody>
<tr>
<td>Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Slovak, Spain, Sweden, United Kingdom</td>
<td>501 100 000</td>
</tr>
<tr>
<td>Other European countries:</td>
<td>315 300 000</td>
</tr>
<tr>
<td>Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Croatia, Georgia, Iceland, Kazakhstan*, Liechtenstein, Macedonia, Moldova, Monaco, Montenegro, Norway, Russian Federation*, San Marino, Switzerland, Serbia, Turkey*, Ukraine, Vaticane state</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>816 400 000</td>
</tr>
</tbody>
</table>

*) Kazakhstan, Russian Federation and Turkey are located both in Europe and Asia

Table 1: Population in Europe from 2010

6.2 PRESENT COOLING MARKET SATURATION ESTIMATIONS

The European cooling market can be characterized as a still un-developed field. The saturation of cooling demand is significantly lower than in Asia and USA. Most sources predict a growth of cooling in Europe. This will significantly increase the need for more electricity production. DC can reduce the need of new installations for electricity production and distribution, due to the higher energy efficiency and flexibility compared to other cooling solutions. In Table 2 the saturation of cooling in the commercial and residential sector in 2005, give a good picture of the lower penetration in Europe compared to USA and Japan. A more recent presentation has not been found.
Table 2: Estimated cooling saturation in Europe compared to USA and Japan from 2005.
(SOURCE: Ecoheatcool)

For instance in Japan there is an average of 2.4 AC units per household and at least 85% of all households have one AC unit.

The trend in the service sector for real estate is that commercial space is much harder to lease out. Some form of cooling supply is requested. On a local market where some buildings do have cooling supply the remaining real estate will have a low value.

The Building Services Research and Information Association (BSRIA) /REF 4/ studies the cooling market in European countries by sales statistics for a number of countries. What can be seen are the differences for different types of air conditioning (AC) equipment during the past years. A drop in sales in one year is often evened out in the following year. There are two main driving forces influencing the sales: warm climate and economic situation. For residential AC during a warm summer higher sales, which can almost be classified as impulse purchases, can be registered. Even the following year higher sales can be observed. However for the residential market the economic situation does have a stronger impact on sales than climate conditions. The saturation of AC in countries in Europe with low GDP is low even if they have a warm climate. In the USA sales are more strongly linked to climate conditions than the status of the economic situation, which can possibly be attributed to a generally stronger domestic consumption.

6.3 COOLING MARKET ESTIMATION FROM RENEWABLE HEATING AND COOLING


\[
\begin{array}{|c|c|c|c|}
\hline
\text{(\% saturation)} & \text{USA} & \text{Japan} & \text{Europe} \\
\hline
\text{Commercial} & 80 & 100 & 27 \\
\text{Residential} & 65 & 85 & 5 \\
\hline
\end{array}
\]
This RHC market prognosis included a very steep growth of cooling from 2006/2007 until 2020 with 82 % increase in the residential sector and 60 % increase in the service sector. This prognosis was based on an increase in floor area the period before. After 2020 RHC estimated that the saturation would be high and the growth would only account for 6 % until 2030 and 1 % until 2050. The slower growth was attributed to an expected technology development, changes in social behaviour and energy savings. RHC estimated the European cooling saturation in 2020 to be 60 % for the service sector and 40 % for residential buildings.

The current financial situation in the world and especially Europe’s will have an impact on the cooling market in the coming years. Rescue therefore estimates that RHC’s estimation on a rapid growth from the years 2006/2007 until 2020 will be hard to accomplish.

The floor area in EU27 according to Ecoheatcool/REF 2/ is estimated to be 18550 million m² for residential buildings and 6405 million m² for the service sector. Based on these figures the RHC cooling market saturation seems rather high for the service sector and low for the residential sector.

6.4 CONDITIONS FOR ESTIMATION OF THE FUTURE COOLING MARKET

The primary market for DC is dominated by buildings for the service sector (commercial use). Unfortunately statistics for this sector are not comprehensive and detailed enough on a European level. For most EU27 countries statistics for commercial buildings either do not exist or if they do exist they are not in time series, not harmonised, and not comparable nor coming from an official source.

Statistics on the residential building sector on the other hand are generally good and detailed. Statistics on service sector buildings lack similar availability of information. This deviation can be explained by that living and housing have a strong social and political link to follow the development of the residential sector. Such a political motivation is missing for the service sector to a high extent. Cooling demand saturation will be subject to:
Population estimations

Urbanisation

Saturation growth of AC and indoor quality added values

Usage trends, equipment causing excess heat, density of offices space

Changing of building material in new buildings replacing old buildings, leading to different energy demand

Energy savings

USA and Japan have reached a high AC penetration for the service sector, which is approximately some 80 to 100%. The same figure for EU today shows only 40%. How the EU cooling market develops can be estimated based on sources of information on the sales of AC equipment. One example of this are the BSRIA country by country reports /REF 4/. However the BSRIA reports do not cover all of EU27.

6.4.1 POPULATION ESTIMATIONS AND URBANISATION

The market analysis is based on the fact that each person, on average, requires a certain residential and service space. With figures on population and building space or estimations on key figures (when actual figures are missing) we can estimate the cooling market. This approach links cooling demand and population.

In 1960, 402.6 million people lived in what is now the EU27. In 2010, 501.1 million people lived in EU27. In the year 2009 the population in EU27 grew by only 1.4 million, corresponding to less than 0.3%. The Eurostat population report 2011 /REF 6/ gives a stagnant population forecast for EU27 until the year 2050. The trends are an aging population and low birth rates and that together with the net migrations is forecasted. The scenario can be summarised as a growth of 5% until year 2035 and then a decline of 3% until year 2060, see Figure 2.

Figure 2: World and EU27 population prognosis. (SOURCE: Eurostat)
Based on this population forecast it would not be required any significant floor space growth due to a population growth either on a EU27 or country basis. Social behaviour and modernisation of the existing building stock will probably have a greater impact on cooling market.

DC supply is mainly interesting for urban areas. During the last century a huge urbanisation has taken place in Europe. In Europe during the period of 1950 to 2005 the rate of urbanisation was approximately 0.65 %. According to the 2005 World Urbanization Prospect /REF 7/ the rate of urbanisation for 2005 to 2030 is to progress significantly, albeit at a slower pace, in the range of 0.33 %. However there are developments such as re-urbanisation to be taken into account, where a movement towards the inner cities can be observed. In the last 10 years most major cities in Germany experienced a growth in population although the total population decreased slightly. Likewise the population forecast for major cities in Germany shows accelerated growth compared to the whole of Germany. Cooling demand suitable for DC is of course highest in areas with high density, such as larger cities, especially inner cities. Taking these developments into account an expansion of the building stock in urban areas, as well as further densification of the energy demand can be expected. However to gauge the development further studies on a local level, together with city planners and social scientists would be necessary.

6.4.2 TYPES OF BUILDINGS

Service sector buildings cover the wide field of: commerce, hotel & restaurants, offices & administration, education, health & social work and other commodity social & personal service activities. All of these buildings do to some extent need cooling.

The main potential market for DC is of course service sector buildings, with the commercial areas for offices and retail. Campus areas, hospitals, airports, universities can also serve as a local hub for a DC business. Depending on location and distance to city areas the campus areas can possibly be connected to a larger DC system.

A thesis - Energy Demand of European Buildings: A mapping of available data, indicators and models, /REF 8/ from Chalmers University in 2007 gives a good picture of what can be found in existing data sources. The thesis has collected and compared existing sources. The most comprehensive picture for the service sector buildings is referred to in the Ecoheatcool report. Where country by country information was not available Ecoheatcool uses the estimates based on the 20 countries that have available statistics.

In EU27 the floor area for residential use is three times larger than for the service sector. For various reasons DC systems have few residential buildings as customers. There is some potential for DC in in south and central Europe for residential areas with flats.

6.5 RESCUE NEW ESTIMATION OF EU27 COOLING MARKET GROWTH

The European cooling market is currently substantially smaller than the market in the USA and Japan. Many studies have provided market prognoses on the European cooling market growth estimating a market development up to a similar size/saturation of the market in the USA and Japan.

The penetration of AC in Europe is hugely driven by each country’s economic situation. Climate conditions are not the only pre-dominant driver. Even though there is a growing need for AC a dip of AC equipment sales has been observed after the financial crisis in 2009.
This dip may be rivalled by a corresponding growth in recovery years following the crisis. Yearly fluctuations cannot be predicted and in the past differences between years evened out over the long course. The Rescue market estimations have therefore been based on long term average estimations.

The market for residential AC equipment is a volatile market. It can almost be characterized as an impulse purchase market. Larger sales can be observed the year after a very warm summer.

In Ecoheatcool BSRIA-reports /REF 4/ were used as a source of information for the European growth of cooling. The BSRIA reports of sales of AC equipment do not cover all EU27 countries. So estimations for the countries not included statistics for in the reports were needed.

The ECODESIGN project has a comprehensive statistics of present sales, stock and estimations of future sales for AC equipment. The reports cover both “domestic” and “non-domestic” sales of AC equipment. /REF 9, REF 10, REF 11/.

The total future EU27 cooling market is now estimated based on statistics and estimations of each country’s floor space area and the use of the ECI (European Cooling Index) that was developed in Ecoheatcool /REF 2/. ECI takes into consideration climate conditions and building standards. With the knowledge of cooling demand in buildings in one city the ECI can be used for estimating the cooling demand in buildings in other cities in North, Central and South Europe.

We have first analysed the present cooling market in Europe. The cooling market has been analysed based on the installation stock of AC equipment plus market estimations of future sales. Rescue has used the project reports from the project ECODESIGN on statistics and the market estimations of sales of AC equipment and we have transferred it into an estimation of the development of cooling market saturation in EU27. The ECI has been taken into account for different countries. Actual needed capacity has been established by making considerations on what are new installations and what is refurbishment. In our experience most installations are over-sized compared to the actual needed demand by consultants and suppliers. The market estimation was reduced accordingly. We estimate the future EU27 cooling market to be 1 220 TWh per year based on these considerations, see Figure 3. See appendix 9.1 for the prognosis market detail information.
The market expansion of cooling in the EU27 countries corresponds to the following cooling supply saturation, see Table 3:

<table>
<thead>
<tr>
<th>(%)</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service sector</td>
<td>40</td>
<td>51</td>
<td>63</td>
<td>71</td>
<td>80</td>
</tr>
<tr>
<td>Residential</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 3: Rescue cooling market saturation estimation in the EU27 countries

The saturation of cooling in EU27 for the service sector has now passed 40 % and is around 7 % for residential buildings. The EU27 cooling market saturation is estimated to grow up to the same level as in the USA, with approximately 80 % in 2030. However the market saturation of cooling for residential is estimated to be substantially lower than in the USA market, only 13 % in 2030.

The Energy Technology Platform on district heating and cooling estimated a substantial growth of the European cooling market from 215 TWh in 2006/2007 up to 685 TWh in 2020 for EU27. The new Rescue estimation of 400 TWh in 2020 for the EU27 cooling market is significantly lower. The recent years of turmoil in the financial sector and prevailing economic conditions in many European countries have led to expectations of a slower expansion of cooling development. At the moment there is no clear indication of a quick recovery for the coming years. Therefore a slower expansion is considered to be more likely.

7. DISTRICT COOLING MARKET DEVELOPMENT

7.1 PRESENT DISTRICT COOLING MARKET SHARE

7.1.1 STATISTICS FROM EUROHEAT&POWER

For DC supply in Europe there are only three sources of information:
• Euroheat&Power (EHP) annual country survey aggregating statistics from the national DHC associations. /REF 12/ The latest existing survey from 2011 covers statistics from 2009. EHP also had available new (un-published) figures from 2010 covering Finland, France, Germany, Spain and Norway.

• Official up-dated statistics for 2011 are also available from the national district heating associations in Finland, Germany and Sweden. /REF 13, REF 19, REF 14/

• Under the EHP umbrella, a Working Group / Task Force for DC have gathered separate cooling supply for the years 2003 and 2007. /REF15/

Unfortunately there are a number of countries that do not submit DC statistics to the latest EHP country by country survey, namely Denmark, Luxemburg, Monaco, Netherlands and UK. For the following countries no DC supply has been identified at all: Czech Republic, Estonia, Greece, Latvia, Lithuania, Romania, Slovakia, Belgium, Bulgaria, Cyprus, Hungary, Ireland, Malta and Slovenia.

Figure 4 shows the development of DC in EU27 (plus Norway) for 2003, 2007 and the latest available figures. The green staple represents a mix of 2009/2010/2011 figures, using the latest available information from the respective countries.

![Figure 4: Annual DC statistics for EU27 and Norway.](image)

The sum of the actual reported DC supply (from 10 countries) for 2009/2010/2011 adds up to 2679 GWh. If we include DC from the earlier reports of the remaining countries, plus an estimation of the expansion of the present DC supply in EU27 (plus Norway) we can assume that DC supply is around 3 TWh.
7.1.2 PRESENT MARKET SATURATION OF DC

In Europe there has not really been any significant expansion of DC for the last years. The supply has steadily been around 3 TWh. The latest statistics of DC supply for the two countries with the biggest sales, France and Sweden, shows that both have the same level of sales, namely 890 GWh. That means that the two countries with the largest DC supply represent as much as 60% of the EU27 DC market. Actually the market share of DC in Europe is dominated by the two cities of Stockholm and Paris. Following this analysis the potential for DC growth in EU27 is enormous. Naturally, the potential for DC’s contribution to the EU environmental targets 20/20/20 for 2020 are of equal magnitude.

However the DC market penetration in Sweden is actually significantly higher than in France, which is not surprising considering that France has a population of 64.9 million and Sweden 9.5 million. However Sweden does have a colder climate than France. The present DC supply figures could be given as 95 kWh/capita for Sweden and only 14 kWh/capita for France. Adapting the cooling index for Stockholm and Paris with an ECI of 73 for Sweden and an ECI of 95 for France enlarges the differences even more. Figure 5 shows the status of DC market penetration adjusted with the ECI. Interestingly enough the highest market penetration has in fact been reached in Nordic countries with cold climate, Sweden, Norway and Finland. If such a market penetration is possible in Nordic countries, the EU27 should have a good possibility to develop feasible DC options.

![Figure 5: Specific DC market status normalised to kWh/capita for the year 2011.](image)

Figure 6 shows what the EU27 DC market would look like if it reached the same market penetration as Sweden (normalised with the ECI).
If all EU27 countries would reach the Swedish market penetration EU27 would have a DC market of 66 TWh already. Considering that the Swedish DC market is still under development it is estimated that at least a doubling of the Swedish market penetration is economically feasible. Using this estimated Swedish market saturation the EU27 DC market has a potential of 132 TWh. Today’s DC market is only 3 TWh, corresponding to 0.2 % of the potential EU27 cooling market of 1220 TWh.

7.2 DISTRICT COOLING MARKET PROGNOSIS

The scope of the Rescue project includes compiling a prognosis of the DC market for 2020 and 2030. Today the DC supply in EU27 is in the region of 3 TWh only, corresponding to only 1% of the present cooling market (calculated to 300 TWh) or 0.2 % of the potential cooling market (estimated to be 1220 TWh). Unfortunately realistically accurate estimations for the future DC-market are currently not possible due to two main reasons:

- Estimations cannot be based on historical growth. This is due to the fact that in the last years there was hardly any significant growth due to the financial crises, their implications and the circumstance that most local energy suppliers have had priority on other issues, such as increasing CHP.

- Estimations cannot be based on the prognosis of total cooling market expansion. Since a DC market expansion needs an active decision of energy companies to invest in developing DC. Under current market conditions such investments are complicated and also depend highly on the ever changing framework, both legal as well as financial. Therefore such a development cannot be realistically forecasted.

The forecast for the future DC market will more be a matter of if and when a paradigm shift comes. Municipalities, energy companies, the real estate owners and their end-users must see not only the benefit of DC for society but also their own benefit. Then it is more a
question of what do we need to make it happen? This actually coincides with the purpose of the Rescue project, to assist cities in EU27 to consider DC options.

Stakeholders must be convinced of the environmental benefits of DC and it must in all cases prove to be a profitable business. There is an on-going market growth of AC in EU27. All on-site cooling solution does use much more electricity than DC solutions. That will actually lead to a huge need of investments for electricity production and distribution. The solution to avoid these investments is to develop DC. However avoiding such investments may benefit society as a whole but has no monetary incentive for the stakeholders investing in DC options, such as energy companies or their customers. The awareness of this huge investment need for electricity production and distribution in EU27 and that DC can contribute to the environmental targets for 2020 should be the largest driving force for a growing DC market on a society level. We can however only reach a growing DC market by:

• Political determination
• Corporate determination
• A market driven approach, respectively the right framework for addressing possible market failures
• Utilising synergies

The DC market in 2020 or 2030 will then be totally depending on all the stakeholder’s determination and project management skills. Projects with good experience will be very important role models for new developments.

One way of describing market developments of DC is setting up scenarios. To give examples of the future DC market the two following scenarios are considered:

• Scenario 1 – Rescue initiating new DC projects
• Scenario 2 – A Swedish development speed

7.2.1 SCENARIO 1 – RESCUE INFLUENCE IN TARGET CITIES

If a change of trends does not occur no significant development of DC in EU27 can be expected. The DC market share will be at the status quo, around 3 TWh/year only. The cooling market development will continue to consist of electrically driven devices with low COP. There will be a substantial demand for investments in new electrical power production and for strengthening the distribution grids. One of the strategic objectives of Rescue is to improve local and European energy security by reducing electricity demand through developing DC, supporting stable, non-overloaded grids in summer.

DC system efficiency can be 5 to 10 times higher than on-site stand-alone distributed solutions. A DC market share corresponding to 25 % of the EU27 future cooling market has the potential of avoiding new installations of 50 GW electricity peak load.

Rescue has a target of working directly with 15 cities and that at least 10 cities initiate, separately financed feasibility studies (FS).
Development of infrastructure like DC is a long process. The lead time from feasibility studies and taking investment decisions until the actual supply of DC starts will normally take 3 years. All depends on the magnitude of the project, whether the business is starting with some temporary solution etc.

If Rescue can initiate 10 new systems of an average peak capacity of 50 MW the potential corresponds to a growth of 0.3 to 0.75 TWh DC only. This depends on prevailing climate conditions for each system’s location. It also depends on the schedule for connecting customers and their preferences. Since most new DC customers will, in most cases, already have some form of AC and finicalities as well as taxes etc. have to be taken into account not all customers can be connected in the short or even medium turn, even if they are interested in DC. The same considerations have to be done by the energy company. The progress for expanding the systems with the connection of customers according to a market plan can therefore be expected to last another 5 to 15 years.

An estimation of the direct linked impact from Rescue with 10 systems would correspond to a DC market in EU27 of 3.3 TWh in 2020 and 3.5 TWh in 2030.

7.2.2 SCENARIO 2 – RESCUE ALSO INITIATING NEW DC PROJECTS

The scenario 1 is representing only a conservative estimation. The pilot projects that Rescue can potentially initiate could function as role models on local national markets. Local experiences and success stories are essential in order to accelerate, the right framework notwithstanding. If each new Rescue initiated DC project can start a snow-ball-effect, each project could potentially initiate 5 to 10 more DC schemes. This could correspond to a DC market for EU27 of 4 TWh in 2020 and 12 TWh in 2030. (This is considering the starting years with a time delay for the second phase cities compared to the initial Rescue cities.) See Figure 7.

![Figure 7: Scenario 1 and scenario 2 - EU27 DC market prognosis, possible impact with the Rescue project](chart)

7.2.3 SCENARIO 3 – BASED ON THE SWEDISH DEVELOPMENT SPEED

This scenario is based on the actual historic development in Sweden. In this scenario the actual Swedish development is applied to the EU27 market. The Swedish DC development
consists of systems in approximately 30 cities/towns. The Swedish development cannot be considered “politically forced”. If the countries in EU focus on the fixed environmental targets, if customers are interested and if utility companies are provided with a business opportunity and a more progressive development is possible, however different legal, fiscal and economic frameworks in the different countries have to be taken into account as well. The DC development started in Sweden with the first feasibility study for the town of Västerås in 1990.

From a business and market development perspective we here in scenario 3 use the actual Swedish DC system development during the last 15 years as an example, see Figure 8.

![Figure 8: Swedish DC market growth during the last 15 years. Actual deliveries and not temperature corrected for normal year conditions (SOURCE; Swedish District Heating Association /REF 14/)](image)

The Swedish market has developed from 71 GWh in 1996 up to 888 GWh in 2011 during the last 15 years. Utility companies distribute cooling in 32 cities in Sweden. This development was in parts supported by the phase-out of refrigerants chlorofluorocarbons (CFCs) and hydro chlorofluorocarbons (HCFC) in 1996 and 2002. For this scenario a growth of DC in EU27 at the same expansion speed as the Swedish development is assumed to be feasible.

For the EU27 local national market and climate conditions the scenario 2 now use the historic growth of DC in Sweden as a EU27 by creating a development speed in TWh/year.

The scenario 2 development for EU27 is also considering that there is an initial phase of project development before the actual supply of cooling can commence. There is no verified information on how many cities and/or utilities have at the moment initiated feasibility studies or taken decisions to start DC. From feasibility study and investment decision until the first phase of DC supply the lead time normally will be in the range of 2 to 4 years. Figure 9 takes this into consideration for the period 2013-2015.
Figure 9: Scenario 3 for DC market in EU27, considering slower development during the initial years.

This scenario includes DC development in approximately 30 cities in Europe. It is assumed that most cities start feasibility studies now and after the positive outcome continue with project development. The DC supply in 2020 could then reach 33 TWh and 66 TWh in 2030.

Scenario 2 just defines a development pace for the EU27 market in accordance with the historical development in Sweden. However the Swedish DC market is not fully saturated. Actually almost half of the DC supply in Sweden is in Stockholm. A rough estimation is that only 50% of the DC market in Sweden has been developed up until 2013.

If DC can be recognised as feasible and interesting business opportunity a EU27 DC market development with doubled speed of the Swedish would then reach:

- 66 TWh in 2020
- 132 TWh in 2030

7.3 WHERE IT MUST HAPPEN

Within the Rescue project the cooling market is estimated to be 1220 TWh in EU27 based on climate (ECI), population (building area in service sector and residential) and the present supply of DC, see Figure 10. Even considering different climate conditions the result is that 65% of the potential cooling market is actually in the largest countries: Italy, Spain, France, Germany and UK, see Figure 11.
<table>
<thead>
<tr>
<th>Country</th>
<th>TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>22</td>
</tr>
<tr>
<td>Belgium</td>
<td>21</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>13</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>18</td>
</tr>
<tr>
<td>Cyprus</td>
<td>2</td>
</tr>
<tr>
<td>Denmark</td>
<td>12</td>
</tr>
<tr>
<td>Estonia</td>
<td>2</td>
</tr>
<tr>
<td>Finland</td>
<td>11</td>
</tr>
<tr>
<td>France</td>
<td>160</td>
</tr>
<tr>
<td>Germany</td>
<td>264</td>
</tr>
<tr>
<td>Greece</td>
<td>47</td>
</tr>
<tr>
<td>Hungary</td>
<td>24</td>
</tr>
<tr>
<td>Ireland</td>
<td>3</td>
</tr>
<tr>
<td>Italy</td>
<td>166</td>
</tr>
<tr>
<td>Latvia</td>
<td>3</td>
</tr>
<tr>
<td>Lithuania</td>
<td>3</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1</td>
</tr>
<tr>
<td>Malta</td>
<td>1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>26</td>
</tr>
<tr>
<td>Poland</td>
<td>58</td>
</tr>
<tr>
<td>Portugal</td>
<td>28</td>
</tr>
<tr>
<td>Romania</td>
<td>36</td>
</tr>
<tr>
<td>Slovak republic</td>
<td>15</td>
</tr>
<tr>
<td>Slovenia</td>
<td>4</td>
</tr>
<tr>
<td>Spain</td>
<td>143</td>
</tr>
<tr>
<td>Sweden</td>
<td>20</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>114</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1220</strong></td>
</tr>
</tbody>
</table>

*Figure 10: Rescue cooling market estimation country by country in EU27.*
Figure 11: Cooling market estimation by Rescue in EU27 countries, with the share of the 5 largest countries.

The main focus for Rescue is to facilitate the process for EU27 to reach the environmental targets by assisting cities to spread DC system usage. It is therefore essential to find out means of initiating DC systems in these five countries. So far development and growth of DC in Europe has taken place predominantly in the colder Nordic countries.

One key issue for the development of the DC market in Europe will be to identify why so little is happening and also to find out what is needed to start much more DC in Italy, Germany, Spain, France and UK.
8. THE EU 2020 ENVIRONMENTAL TARGETS

The background of the Rescue project in general is the potential contribution on achieving the 2020 environmental targets. The European Union wants to reduce CO₂-emissions by 20%, reach a share of 20% of renewable energy and reduce primary energy consumption by 20% in 2020. Regarding the energy efficiency target of reducing primary energy consumption by 20% in 2020 the European Union is, according to the European Commission, not on track.

Therefore on 25 October 2012, the Directive 2012/27/EU on energy efficiency (Energy Efficiency Directive - EED) was adopted by the European Union. Within the EED district cooling has been recognised as one of the important pillars for achieving the energy efficiency target of reducing primary energy consumption by 20%. However, there are still barriers remaining that prevent an accelerated adoption of this energy efficiency technology. Member States are therefore obliged to assess the potential for the application of district cooling (and district heating and combined heat and power) and if there is such potential, take adequate measures for such systems to be developed.

This analysis and the corresponding measures are connected to a definition of efficient district heating and cooling, meaning a system using at least 50% renewable energy, 50% waste heat, 75% cogenerated heat or 50% of a combination of such energy and heat.

Since the energy efficiency target is aiming at a reduction of primary energy consumption it would have been a logical step to link the definition of efficient district cooling to primary energy consumption, for instance via primary energy factors and taking into account a possible alternative solution. Such an approach would have guaranteed that for a flexible technology such as district cooling all possible local solutions would be measured by the actual target that the EED wants to achieve without narrowing down the possible technical solutions.

The chosen path of defining the shares of energy composition in district cooling does not reflect the complex reality of these systems nor does it take into consideration the economic framework where district cooling has to compete with already established on-site solutions.

To calculate the impact on environmental targets if the development of air conditioning is continuing with local chiller solutions at the customer’s premises is comparatively easy. Local solutions are dominated by air cooled chillers with a coefficient of performance (COP) of 2-3.2, depending on whether normal, old technology is being used or modern high efficient types of air cooled chillers are being utilized.

To calculate the impact on environmental factors for DC on a global level is not so easy. DC does not have a narrow definition. Actually each DC system is shaped by local conditions. The production mix will be different in every city. Therefore calculating a figure for the EU27 district cooling mix is impossible if we do not know what options are available in each city’s system. Consequently, thresholds such as the ones introduced in the EED’s definition of efficient district cooling seem random and not based in reality.

Even if a general production mix could be calculated the question still remains whether these predetermined solutions are the most efficient in terms of environmental benefit and costs. As stated above district cooling operates in a highly competitive market, where
established solutions are dominating. A high use of renewable energy sources may be a technical possibility but could lead to a not very cost effective system. This would result in a lack of competitiveness and would actually prevent the development of a district cooling scheme and the perpetuation of the status quo. District cooling development has therefore to take into account the business possibilities.

To illustrate this point here are some examples of district cooling technologies that normally will be included in the district cooling production mix:

- Deep sea water cooling plants: COP\textsubscript{el} 15-40.
- High efficient district cooling plants with a large amount of natural cooling: COP\textsubscript{el} 10-15.
- District cooling plants with some free cooling: COP\textsubscript{el} 7-9.
- District cooling plants utilizing only natural cooling from cooling towers in warmer countries. COP\textsubscript{el} 4.5-6

The COP\textsubscript{el} definition is not directly applicable on absorption chillers that use heat instead of electricity. Here the COP is around 0.7, defined as produced cold in relation to heat input. However, the idea of using heat for cooling is to use energy that would otherwise be wasted. For instance heat from a waste incineration plant could be wasted during the summer even if it is used for district heating purposes in winter time. When using this heat to produce cold in summer there are large environmental benefits involved, not reflected by the COP. Below are examples of primary energy factors (PEF) and CO\textsubscript{2}-emission levels for some types of cooling production for district cooling systems, Table 4.

<table>
<thead>
<tr>
<th>Typ of cooling production</th>
<th>PEF</th>
<th>CO\textsubscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( f_{P,dc} )</td>
<td>( K_{P,dc} )</td>
</tr>
<tr>
<td>Deep sea water cooling</td>
<td>( f_{P,dc} )  ( \leq 0,17 )</td>
<td>( K_{P,dc} )  ( \leq 28 )</td>
</tr>
<tr>
<td>DC plant and large amount of natural cooling</td>
<td>( &gt;0,17 )</td>
<td>( \leq 0,25 )</td>
</tr>
<tr>
<td>DC plant with some natural cooling</td>
<td>( &gt;0,25 )</td>
<td>( \leq 0,35 )</td>
</tr>
<tr>
<td>DC in warmer climate + cooling towers</td>
<td>( &gt;0,35 )</td>
<td>( \leq 0,55 )</td>
</tr>
<tr>
<td>Efficient air cooled chillers</td>
<td>( &gt;0,55 )</td>
<td>( \leq 0,80 )</td>
</tr>
<tr>
<td>Older air cooled chillers</td>
<td>( &gt;0,80 )</td>
<td>( \leq 1,30 )</td>
</tr>
</tbody>
</table>

Table 4: PEF and CO\textsubscript{2}-emissions from DC systems with some examples of cooling production mix. (SOURCE: Rescue-report /REF 22/)

A district cooling system utilizing absorption chillers with heat from a district heating production would have similar PEF and CO\textsubscript{2}-emissions as the one with natural cooling shown above. If the district heating is based on waste incineration and biomass the PEF for district cooling would be around 0.15-0.25. With a district heating system using more fossil fuels the PEF for district cooling would still be very low and around 0.25-0.35.
DC systems will, due the possibility of using natural cooling sources and having high efficiency, use less PEF. The cooling technologies for DC systems or individual solutions will with their PEF lead into differently levels of CO₂-emissions. Table 5 is showing that the growing air-conditioning market in EU27 will lead into significantly higher CO₂-emissions. The magnitude of the raise of the CO₂-emissions will depend on the type of chillers (efficiency dependent) that will be installed in each building. The results are therefore presented with estimated maximum and minimum figures. In chapter 6.2 different scenarios for the future DC market was presented. Scenario 1 – Rescue will the target countries/cities initiate 10 new DC systems, scenario 2 - Rescue will initiate a “snow-ball effect” and each project initiate 10 new DC systems each and scenario 3 – the DC market in EU27 will grow similar to the historical experience in Sweden’s DC-market growth. DC which use less PEF can then reduce the CO₂-emission growth for the expanding air-conditioning market.

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU27 cooling market</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mton CO₂</td>
<td>Mton CO₂</td>
<td>Mton CO₂</td>
</tr>
<tr>
<td>Individual AC</td>
<td>DC</td>
<td>DC share</td>
</tr>
<tr>
<td>(TWh)</td>
<td>(TWh)</td>
<td>(%)</td>
</tr>
<tr>
<td>year 2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>297</td>
<td>3</td>
</tr>
<tr>
<td>year 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>297</td>
<td>3</td>
</tr>
<tr>
<td>year 2030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>397</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 5: CO₂-emissions from the expanding cooling market in EU27 countries with different levels of DC penetration.

This shows that regardless of district cooling technologies utilized a district cooling system will generally provide considerable environmental benefits compared to local on-site solutions, saving primary energy and therefore contributing to the actual target of the EED. This holds true whether or not the system in question fulfils the requirements of the efficient district cooling definition of the EED. For instance a system that uses 45% renewable energy (for example natural cooling) and 55% electricity (industrial chillers) it would still be more efficient and consume less primary energy than alternative solutions.

We can therefore conclude that

- the definition of efficient district cooling in the EED does not reliably indicate the actual primary energy efficiency of a district cooling solution;
- nor does it reflect the complex reality of local framework and circumstances and economic reality and
- the definition of efficient district cooling should therefore be amended to reflect the actual target of the EED in a better way while also providing flexibility to incorporate local solutions and incentivize development.
However, this definition is just a factor within the EED and has therefore not to be taken into consideration outside of its scope. Following the findings above the environmental benefits should therefore be calculated on the basis of the actual target of the EED, namely reduction of primary energy consumption. That way the impact on the 2020 targets can be quantified and the systems in question are put into the corresponding context.

9. OPPORTUNITIES, TRENDS AND CHALLENGES

9.1 INTRODUCTION

The cooling market in Europe is huge and is currently dominated by on-site installations based on electricity. DC is not yet a fully recognized energy efficiency solution in the European market. A DC system can reach an efficiency rate typically 5 or even 10 times higher than traditional on-site electricity-driven equipment. Switching away from fossil primary energy for cooling production is an essential consequence of the fundamental idea of DC. The environmental benefits of DC are obvious. There is a cooling market out there. What is needed is a corresponding framework that rewards energy efficiency and that customers are attracted to environmental cooling solutions. DC supply must be competitive. DC can be a win-win concept for customers and energy providers alike. In order to achieve a market expansion of DC the following 4 points should be simulated:

- Political determination
- Corporate determination
- A market driven approach, respectively the right framework for addressing possible market failures
- Energy companies recognizing and utilising synergies

This chapter is based on results from interviewing key stakeholders in European countries, local energy companies and national associations in Austria, Belgium, Denmark, France, Finland, Germany, Italy, Poland, Portugal, Spain and Sweden.

- What opportunities do the companies see
- What are the trends
- What are the challenges

This can give useful indications on the level playing field in order to start development of DC or further expansion of existing DC.

9.2 OPPORTUNITIES - RESPONSES FROM INTERVIEWS

9.2.1 AWARENESS OF POSSIBLE SYNERGIES

In a city where real estate owners already have buildings with DH supply it is naturally easier to present the DC option. The customers are already familiar with the benefits of the district energy concept. They already are familiar with the simplicity, convenience, high availability and reliability.
For a utility company the synergies of providing both DC and DH to customers resemble a win-win situation. It is simpler for the customer to only deal with one supplier. The utility company can utilise and optimise the production efficiently by using heat pumps or waste heat for absorption chillers.

Securing DC customers reduces the risk of losing existing DH business. DH customers could switch to heat pump solutions and then utilise stand-alone heating/cooling operations. This could lead to disconnection of DH.

9.2.2 ECONOMY

Customers appreciate predictable and stable pricing with a known structure and with long term contracted agreements. DC has an appreciated production mix and is therefore not fully exposed to the electricity market fluctuations. Own local building chillers lead to a full dependency on the electricity market pricing.

Handling of refrigerants plus service contracts on chillers is a business that can be totally eliminated for the customers after DC connection.

9.2.3 PERMISSION AND LEGISLATION

Sweden was one of the countries pursuing an early phase-out of refrigerants CFC and HCFC. The development of DC was an excellent opportunity for customers to get rid of their problems linked to refrigerant handling in their own buildings.

In France Ammonia is banned for use as a refrigerant. This has had a positive impact on customers to choose DC, which is simpler than having to deal with different refrigerants.

In Paris preservation of the cultural heritage is important. Beautification of building facades without a lot of condensers from “wall-rattlers” has had a positive impact on the development of DC. Figure 12 shows an example from Asia on the possible effects of a lack of regulation on AC installations on the facades.
9.2.4 AVOIDING ELECTRICAL GRID AND POWER PRODUCTION INVESTMENTS

Many old cities (especially the inner city centres) have limited electricity distribution capacity. The residential buildings in the city centres often have switched to office usage, which requires cooling. The expansion of cooling supply from chillers in each building will lead to a need of upgrading the local electricity distribution system. When customers use DC instead there is no need of upgrading the electricity grids. DC also has a higher COP compared to stand-alone chillers in each building. Therefore by investing in DC investments in new power production and higher capacity of electricity transition grids can also be avoided.

On a society level the introduction of DC will therefore lead to cost reductions. The avoided costs for upgrading electricity distribution grids and new power production is actually higher than the necessary investments in DC systems.

One example from Stockholm illustrates the benefits of a large DC system. In Stockholm there is no natural gas available. The inner city does have an old town gas system. The town gas is expensive to produce. It was therefore planned to replace the gas used for cooking with electrical alternatives. However that would have also led to a very expensive up-grading of the local electrical grid. Now with to the success of the large DC system the electricity peaks have been cut and reduced the need of electrical grid investments has been reduced.

9.3 TRENDS - RESPONSES FROM INTERVIEWS

9.3.1 ENVIRONMENTAL PERFORMANCE FACTORS

The EU targets for 2020 include key figures for the environment on CO₂, renewable energy sources (RES) and primary energy consumption (which can be measured using
primary energy factors – PEF). But how have these targets influenced the behaviour of the real estate sector in terms of their energy supply? Most DC suppliers have so far registered a low interest on the environmental performance from their customers. Some customers do ask for information on the DC supply regarding CO₂ and COP, but rarely on RES or PEF. There are a few examples of real estate developers such as Skanska, ECM and Trigranit who have shown a clear interest in sustainable supply.

Another system for mapping building performance is the use of certification system for buildings. There is a clear trend towards a growing interest for certification, especially for new buildings.

9.3.2 CERTIFICATION SYSTEMS FOR BUILDINGS

The responses from interviewees that were contacted show a rather low interest from DC customers on environmental performance. However as mentioned above, a global trend towards certification of buildings does exist.

Globally real estate owners and developers are now more interested in environmental aspects than a few years ago. An example for this development is the environmental certification of buildings. A reason for this development is the growing demand of end-users for certification, which was not the case a few years back. It is a trend now to have more environmental awareness during the construction of both new buildings and refurbishment of existing buildings. It is therefore important to ensure that DC will be evaluated correctly in the certification of buildings.

A few energy companies report that real estate owners and developers request information on environmental performance of DC and district heating. Real estate owners state that buildings which are certified are easier to lease out.

A number of certification systems for buildings exist: GreenBuilding, LEED and BREEAM etc. Certification of a building can unfortunately result in different labelling depending on which certification system has been used. LEED does not give any clear deviations between many solutions of the energy supply. Used definitions of the score system and in-data for the electricity mix have a major impact on the results. In LEED the buildings are validated based on energy performance and energy costs. From a Swedish point of view the use of energy costs as a parameter for energy performance is not considered relevant. Results will be very dependent on the comparison between alternatives. LEED is based on American conditions. In USA DH/DC is not common at all. SGBC has developed a proposal where the building’s performance is set by climate impact, energy efficiency and resource efficiency. USGBC has now approved the SGBC proposal.

See appendix 10.2 for a short description of the most common building certification systems, plus examples when applied to DH/DC office buildings.

9.4 CHALLENGES - RESPONSE ON INTERVIEWS

9.4.1 PRIMARY ENERGY USAGE

Utility companies mention that some customers have a poor knowledge of chiller technologies and their environmental impact. Examples are required for explaining why absorption chillers are better than electrical chillers, where the electricity production comes from etc. If this basic information is lacking, it will be impossible to communicate the
differences in primary energy use or even the concept of primary energy use. This shows that customer meetings and communication are very important aspects in order to raise the knowledge of the environmental benefits of district energy. Simple, clear and understandable messages and material is essential.

Environmental certification of buildings is a positive trend towards more sustainable solutions for buildings. However the models or examples of a building it is compared with could suffer from a non-transparent situation regarding district energy supply. District energy is in most cases world-wide not normal practice for buildings. Requirements stated in the national regulatory framework can be based on comparisons of solutions within the building envelope and may not provide a system perspective all the way up-stream. It is therefore essential to make sure that framework for cooling is based on a holistic primary energy perspective.

9.4.2 LEGISLATION ISSUES AND PERMITS

Swedish building regulation lacks a system perspective. Building regulation in Sweden focuses on reducing purchased energy to the building. Under such a framework on-site solutions within the building envelope are incentivized, disregarding overall system efficiency. Heat pumps and chillers which use fossil fuel for instance are benefitted by the Swedish building regulation compared to district energy, which is based exclusively on bioenergy and/or industrial waste. Therefore it is of utmost importance that the legislative framework focuses on primary energy. Primary energy is technology neutral and considers the global impact no matter where the energy transformation takes place.

The time and resources needed to access natural cooling sources should not be underestimated. In Stockholm there were plans to add more natural cooling from sea water to the existing sea water resources in the DC system. A deep sea water resource exists in Lake Mälaren, which spans from central Stockholm 120km to the west. However a very small, rare worm, almost invisible to the human eye, living in the bottom region of the lake complicated the permission process. The long permission period with appeals in the end lead to the abandonment of the project. The further expansion of the DC system was delayed and more primary energy will now be necessary compared to the foreseen solution of using Lake Mälaren as a natural cooling source.

Allocation of production sites has been an obstacle for many systems. In the in worst case it can result in completely stopping the implementation of planned projects. Finding space near the market is generally very troublesome. If no suitable site in relative close vicinity can be secured expansion plans for systems can be blocked completely due to the need of an excessively long transition network or local bottlenecks in the distribution system that limit the flow capacity.

9.4.3 UNFAMILIAR PRODUCT

Experience from establishing DC in some cities is that many real estate owners do not know what DC is. This could even happen in cities where DH is already established. It should not be taken for granted that DC is well known. Before a product is presented and the benefits are accepted it will be harder for the market to grow. Many utility companies report a longer sales process and delayed schedule in regards to DC. Local reference cases in a city or nearby city are very valuable.
References from other countries tend to be not sufficient enough to convince potential customers. Having role model systems in each country is therefore valuable. Very often discussions on the feasibility of DC in a city will revolve around the local conditions. In these discussions the experience from reference systems will often be disregarded, attributing the success of DC to special local conditions in other countries and cities, which are not met in the situation at hand. In general the discussion process should not be started by focusing on technical solutions. It is important to first identify a market and a cooling demand suitable for a possible DC system. After this crucial step the flexibility of DC and the experience and creativity of the involved stakeholders will find a possible and feasible solution for the implementation of DC.

9.4.4 ECONOMIC ISSUES

In order to succeed with a DC system it must be a win-win situation for the involved parties. The utility company must find profitability in the DC business or by securing the DH business (synergies with the heating business etc.). The customer must find DC as a product attractive. Experience suggests that potential customers request a price for DC first and then compare this price with their own cooling production more or less based only on the electricity price. This is a major obstacle that building owners do not know and have control over the whole cost for cooling. However, instead of relying on the electricity price alone, the alternative costs for cooling are split on many different accounts, for instance:

- First and foremost the electricity consumption for cooling is not known or even attainable. In most cases no separate metering of electricity for cooling exists. Normally only the electricity demand for the whole building is measured. In such a case electricity demand for cooling can only be estimated by extrapolating the figures provided by AC equipment manufacturers, which may not be accurate for the implementation under local conditions.

- Operations for own staff on cooling systems and chillers and service contracts are often not taken into account.

- Depreciation of the equipment has to be considered.

- Re-investment needs are often forgotten, etc.

In order to improve sales and marketing for DC it is therefore essential to initially spend time on finding out the customers total cooling costs. This will take time and therefore precious resources. Only after assessing the total cooling costs is it possible to negotiate against the alternative cost, and the pricing of DC will be attractive enough when compared to the actual total cooling costs. While DC is a sustainable product with higher quality it may not be possible to put a price on the added values. It is essential to have a good dialogue on presenting the DC offer and pricing with the customers.

One historic perspective is that many developments of DC start with people focused on technology. However in order to start DC, a sound business plan is needed. Discussions should start from the market possibilities and with a focus on business. Only then the best technical options can be investigated taking these assessments into consideration.

In order to succeed with a DC scheme it is essential to obtain a high density of customers locally before investment decision on expansion or construction of a system. For all district energy systems it is important to get a high connection density along the distribution grid. If
potential customers choose alternative solutions the economy for the DC system will suffer. The same applies for investing in production before a certain market is secured. A system not achieving reasonable economic success in accordance with set up plans can create lower interest from the utility company’s perspective to further develop the DC business. Then DC penetration will stop.

There are DC systems in Europe where statistics indicate a stagnant business for the past 10 years. Here it would be recommended to review the DC schemes in question. Experience shows that a second opinion of a business often leads into new solutions and a restart could be fruitful for the expansion of the DC market.

Market conditions, legal and general framework differs from Member State to Member State, so possible market failures and issues related to the legal framework regarding DC have to be taken into account when discussing economic issues. If DC is not able to bring its benefits for the society level to fruition on the business level due to the such problems (see for example above, 7.4.1.2), it will be almost impossible to present a feasible business case.

9.4.5 COMPETITION AND THIRD PARTY ACCESS

For district heating systems it can be observed that some organisations and real estate owners voice displeasure in regards to only having access to one heat supplier. However unlike gas and electricity DH and DC alike, are strictly local businesses that compete on the corresponding heating, respective cooling markets (in exceptional cases it may be mandatory to connect to a DH system, interacting with the market forces). Therefore measures derived from the experiences in gas and electricity may not be transferred to DH or DC. Unlike for instance in the electricity market, where basically all premises in Europe are connected to an over-arching distribution grid DH suppliers cannot sell heat nationally or even internationally since heat distribution is limited both by technical and economic factors. A regulation of Third Party Access (TPA) would therefore neither bring benefits for the district energy supplier, nor the district energy customer. This analysis is backed by a memo of the Swedish Ministry for Enterprise, Energy and Communication (/REF 20/), based on an inquiry on TPA in district heating (/REF 21/). This inquiry was spurred by on-going discussions, which can be related to the fact that DH has a very strong market position in Sweden compared to other, non-Scandinavian countries. The memo states that “unbundling” generation from transmission in DH would lead to a price increase of 10 to 15 \%, mainly due to an increased administrative overhead and sub-optimal DH production. The ministry also states that there are no signs for inflated profits, which is especially important since DH has achieved such a strong market position in Sweden. Therefore the ministry does not propose a TPA regime but rather a more regulated approach to incorporating industrial waste heat, where an authority is overseeing negotiations and equal treatment of customers according to customer categories among other things. In Sweden 7\% of the DH supply consists of waste heat from industry. There is a growing potential interest from the industrial side to utilize more waste heat. However the memo clearly states that negotiations have to be based not only on technical criteria such as feasible temperature and pressure levels but also delivery commitments. Industrial waste heat usually needs back-up capacity since its availability relies on economic needs and not the heat demand of the DH system and therefore its availability is below 100 \%. For DC systems a similar interest to provide waste energy cannot be observed. This probably linked to the fact that availability of waste cold is limited. The current exceptions are liquefied natural gas (LNG) terminals.
Another aspect which has to be taken into consideration in the TPA discussion is that even though customers can choose different electricity suppliers, the price for electricity is dominated by distribution fees, taxes and other charges, which cannot be negotiated. In Germany distribution fees make up 20% of the electricity price, taxes and other charges 45.6%, amounting to almost 70% of the electricity price (2012 figures; Source: BDEW). That means that even in the international electricity market separating generation from transmission has only a limited and theoretical cost-cutting potential.

In terms of DC, the customer benefits from the same flexibility of all district energy systems. DC system operators can and will utilise a mix of different cooling sources. DC systems are a level playing field where natural cooling, electricity and heat driven absorption is competing. The DC supplier is flexible to use what is the most competitive production mix. This is the benefit of having a large scale system. The customers can benefit from this flexibility by not being solely exposed to the variations on electricity prices and taxes. The totally pre-dominant solution and alternative to DC for end-users is an on-site cooling solution based on electrical chillers. Possibilities of utilising natural or other forms of cooling are in reality very limited.

In conclusion it can be stated that TPA is not beneficial for DHC system operators as well as DHC customers since it will raise costs with little to no possible benefit. Due to the flexibility of the systems the customer already benefits from diversified mix of different heating and cooling sources and a corresponding balanced cost development.

9.4.6 MARKET BARRIERS FOR DC EXPANSION

DC is one of the best solutions available for reaching the EU 2020 targets for energy efficiency (primary energy consumption), CO₂ emissions and RES. The main objective of the Rescue project is promoting and supporting the development of DC in the following 10 target countries; Austria, Denmark, France, Finland, Germany, Italy, Poland, Slovenia, Spain, and Sweden (Table 6). Rescue has through an extensive and wider contact net with ICLEI Europe sent out invitations to co-operate with Rescue.

Considering floor space area and ECI our market analysis shows that 65% of the EU27 cooling market exists in the five largest countries; France, Germany, Italy, Spain and UK. The best possibilities for achieving an expansion of DC then linked naturally to these countries. However the environmental impact from an expansion of DC is of global nature. Rescue has therefore made a quick scan of the status of DC in each of the EU27 countries and the barriers for the DC growth.
Table 6: List of main Rescue target countries.

The following country by country status descriptions are based on a mix of interviews and the District Heating and Cooling – Country by country 2011 survey with contributions from the respective country’s DHC association representatives /REF 12/. The order of describing findings for the countries is chosen by

- The 5 largest cooling markets
- Other Rescue target countries
- Remaining EU27 countries

Market barriers for DC development related to energy regulations are not covered in this report. It will however be included in Rescue WP3, where both existing regulations barriers and regulation recommendations for advancing DC further will be included.

Germany

#1 largest cooling market – Rescue target country

The energy political agenda in Germany is at the moment focused on the decision on re-phasing out the nuclear power plants and all implications around that decision (“Energiewende”). Huge development programs are on-going in renewable electricity
production in terms of wind and solar. CHP is also on the agenda, including DHC grids as heat sinks for CHP heat.

The awareness that the cooling market is growing seems to be a well hidden secret. This will raise the need for increased electricity production even more. This is coupled with ambitious plans to electrify other sectors such as transportation as well (“electro mobility”). The energy debate is thus very production oriented and focused on electricity. That DC can achieve a very high COP and can reduce the need of investments on electricity production and distribution is currently not very high on the political agenda even though cooling is incorporated more and more in the legal framework and is named in the same breath as heating in a lot of cases.

The DC market in Germany has not experienced any significant development for many years. The historic establishing of cooling supply has been absorption chillers located on the customer’s premises, operated with heat from the DH networks and institutional small systems like airports, universities and industrial factories. Not all possible benefits associated with DC can be realized with only a heat exchanger (HEX) on the customer’s premises. Local absorption chillers require the possibility of dumping the excess heat, normally in the form of cooling towers. Examples of larger scale DC networks are few. All DC systems have not yet been developed according to the cities theoretical market potential. Compared with other cities of the same size in other countries very few customers are connected to each system.

The contacts Rescue have had with utility companies (mainly local utilities; “Stadtwerke”) results in these conclusions:

- Costs for DC pipelines are high, especially in densely populated areas, which are best suited for possible DC supply. Large scale flexible DC systems also require further investments for cold production (reserve/peak capacity, natural cooling etc.). Such high initial investments are not favoured by current market conditions.

- Potential customers usually have no overview on the total costs and environmental impact associated with cooling. Therefore alternatives to established solutions are not in high demand. This means further resources in terms of sales and marketing activities need to be considered when contemplating the implementation of a DC system.

- The barriers for utilizing natural cooling are high due to existing thermal load of potential cooling sources such as rivers and lakes, environmental concerns and the costs associated with it.

- This means that due to the current framework there has not been found a business potential for an increased adoption of DC.

**Italy**

**#2 largest cooling market – Rescue target country**

The low penetration of DHC in Italy can be tracked back to the energy policies developed in the 70’s and 80’s, which have steered people into autonomous heating and cooling systems per single flats. During these periods single flat gas boilers became the dominating choice.
The interest for district energy in Italy is dominated by DH and not DC. A higher interest on DH can be linked to waste management and the growing interest of utilising waste incineration plants is one possible explanation. In 2009 DH represented 4 % of the heating market demand.

At least 10 cities report that they have cooling supplied by absorption chillers from DH networks. The DC business has not experienced any real growth for many years.

As mentioned above the DH market share is limited. District energy is still an undeveloped concept in Italy. There are no municipality owned service companies that can build DHC systems in Italy. They existed in the past but were privatized. The largest utility company in Italy is A2A, which originates from AEM, which historically started with electricity and gas services. A2A have district energy business only in a limited number of all potential cities in Italy.

Since there are no municipality owned service companies establishing DHC systems need to find financial solutions that can be feasible with the private company’s possibilities and limitations. Financing of DHC systems is therefore one of the main issues to solve in order to achieve a growth of DHC.

Italy is one of the countries in EU27 that is changing governments frequently. Under these circumstances energy supply is not on top of the political agenda. Furthermore it takes years to establish district energy systems. Operating district energy systems is a long term commitment. A strong political determination will be needed on creating a sustainable and level playing field.

SEAP can serve as a good instrument for perpetuating political determination on setting up environmental targets regarding district energy. Good examples are for instance the city of Genoa, where a 10-point master plan on sustainable growth is being set up.

Why it seems to be hard to establish DHC in Italy, a possible explanation may be found in the situation on the real estate market. In most cases apartments in blocks of flats are owned by its occupants. All services are then mainly served on an apartment level. When apartments are served with autonomous heating and/or cooling there are no joint service systems inside the buildings so single flat solutions prevail. It will then be complicated to identify a stakeholder for the whole building to discuss district energy solutions with.

One identified option of starting DC systems is to identify stakeholders of local heat pumps. If interest can be raised for co-operation with new natural cooling a SPV could be developed for a larger DC system. The market is there and the smaller local heat pump solutions are by themselves too small to develop their own natural cooling from deep sea water.

France

#3 largest cooling market – Rescue target country

The French DC market is totally dominated by the achievements in Paris. Any real development of new DC in other cities has not been registered during the past 10 year. The market development in Paris has had a good support of the political determination of keeping the architecture and building facades free from split-units hanging on walls.
DC in Paris has in parallel been developed by two separate companies.

- Since 1991 Climespace operates the central DC system under a concession agreement. The system has nearly 500 customer connections. In 2009 the installed production capacity was 325 MW. REF 16

- Climadef started operations in 1989 in the business area of la Defence. Now it is operated by SUC, a subsidiary of Dalkia. Capacity of the plant in la Defence is 75.5 MW. Plans exist of doubling the capacity until 2015.

In Paris the Climate Plan is an important tool for recognising the benefits of DC/DH. Since the central DC system in Paris is operating under a 30 year concession agreement the focus will be restricted to the defined concession area. Expanding outside of this area is presently and naturally not high on the agenda. The expansion within the concession area is steadily growing each year.

On a regulatory perspective the implementation of energy efficiency measures is not progressing. A stronger action could lead to larger interest from real estate owners in DHC. For utility companies this could also support the promotion of DHC solutions and lead into a larger development of district energy.

In 2009 DH represented only 5% of the heat market in France. DC has an even lower market share. There is need to raise awareness of the benefits of using more DHC. The potential to expand these markets is substantial.

Rescue has from an invitation to a contact net with over 3000 addresses not registered a single positive response from any city in France. Possibly it can be linked to the language barrier.

Climespace though are in a phase of investigating opportunities for DC in some cities in France. However due to the nature of the business it is now not possible to reveal the plans or locations.

Spain

#4 largest cooling market – Rescue target country

Apart from the DC system in Barcelona no successor systems or plans of larger new DC systems have been registered.

The situation on the financial markets, the real estate market and the expected timeframe before the recovery of the European economy has affected Spain very hard. The situation in the real estate market has led to decreasing market values.

Due to the risk on low connection rate of district energy systems and a high rate of empty floor space in existing buildings there is low interest in developing new DC systems in Spain.

UK

#5 largest cooling market
The district energy market in UK is underdeveloped. Today approximately 4% of the buildings are connected to heat networks, mainly in the residential sector. According to CHPA (The Combined Heat and Power Association) there is an economic potential of supplying 20% of the buildings with DH. Incentives for using RES are expected to raise the interest in DH. Historically heating solutions have been implemented in each individual dwelling.

The UK development of DHC can be defined as small scale or islands. No large scale systems for a whole city have been developed. Existing island hubs can be a good starting point for developing full scale systems. The historic development has less been steered by market analysis of the demand in a city. Many schemes have been shaped and limited by financial restrictions, available investment support subsidies and the limitations of special purpose entities (SPE), which are set up exclusively to fulfil such a scheme.

References on DC systems in UK are limited to rather small solutions with a limited number of connections in each city’s system. Institutional DC systems for Heathrow and the 2012 Olympic Village exist in London. Ownership or operations of DHC are often exercised by French companies like Cofely-GDF Suez, Veolia or Dalkia. Some examples of district energy networks are Sheffield, Southampton, Birmingham, Leicester, Woking etc. The capacity of the DH systems is fairly low in respect to the sizes of the cities. That means there is a good potential for expansion. The existing established systems could then have a very positive influence on the expansion of sustainable district energy both locally and in other cities as well.

Since the awareness of DH is very low in the UK it would need a strong incentive or assistance in project development on district energy to develop the DC market in the UK. With the low experience in DH synergies with DC are hard to achieve.

Austria

Rescue target country

The DH sector corresponds to 20% of Austria’s heating market. DH is labelled as a booming industry thanks to the raised interest for RES and CHP. With DC in Vienna as a good example and the DH experience the conditions on developing the DC market are generally good. The rising growth of cooling demand would lead to a higher demand for new electricity production in Austria, which would pre-dominantly be based on fossil fuels. DC which uses less electricity is therefore positively recognised. Expectations for a growth of DC in the coming 10 years are fairly positive.

Denmark

Rescue target country

The only DC system established in Denmark is in Copenhagen. The system started operations in 2010. The system is now being further developed. In other cities the only cooling supply is limited to separate small projects under special conditions. There will be no more real development of DC in Denmark by DH utility companies due to the existing legislation. The legislation is aimed at on protecting heating customers. Income from heating is not allowed to be used for other purposes than in the heating business. DH utility
companies in Denmark operate as non-profit organisations and cannot fund developments from their own cash-flow.

Therefore the highest ranking obstacle for establishing DC in Denmark is the legislation. However this is not the only problem. The utility companies do not see a clear business possibility. One reason is that the alternative to split-units etc. is having no cooling installation at all. There is a high tolerance of letting the room temperature rise.

For the moment the only possibility for development of DC in Denmark is related to companies separated from the DH business. The synergies with having both DH and DC will be limited in such a case. Establishing and financing a DC business will be tougher. Especially for systems in small and medium sized cities. Copenhagen is the exception due to the fact that it is Denmark’s largest city by far.

Finland

Rescue target country

DH has a position of 20 % of the heat market in Finland. The usage of CHP for the heat production is high. The market growth for DC in Finland is very positive, especially with the Helsinki DC system as the leading example.

One barrier of using absorption chillers exists. Waste heat that otherwise not would have been used is affected by the high heat tax when used in absorption chillers.

A positive market development of DC in Finland is still expected. Cities in Finland are not so densely populated. Like in all Nordic countries the investment for DC distribution systems will therefore be high in relation to the energy demand. Despite the challenges on distribution DC will keep on growing in Finland. The started interest and development of sustainable DC will continue. The synergies of providing both services DH and DC are very positive.

Poland

Rescue target country

In Poland the market for DH is decreasing, mainly due to reducing over-consumption caused by inefficient systems. This refurbishment and conversion from hard coal to natural gas or biofuels will be the top priority for the energy companies.

Examples of DC exist, mainly for mine and steelwork industries. Introduction of new modern buildings is leading to a raised demand of cooling in service buildings. Estimations by the Polish District Heating Association indicate a positive DC market possibility. The market development of DC will be dependent on sources for financing possibilities.

Slovenia

Rescue target country

The DH share of the heating market is currently 15 %. Coal is the dominating fuel for CHP and DH. Natural gas and RES have approximately a share of slightly over 10 % each.
National legislation is supporting development of DH and the use of RES, increased energy efficiency and reduction of CO₂ emissions. Regulations determine the methodology for tariffs and also the formation of prices. Operators have to obtain a licence for producing and/or distribution of heating and cooling when the capacity exceeds 1 MW.

The market in Slovenia sees no business opportunities for DC. There is one example of cooling supply by absorption chillers utilising heat from the DH pipe system. However this is only a small pilot project. Cooling for buildings is solved with on-site solutions like split-units etc. The capital expenditure (capex) is low. There are no considerations taken on efficiency, sustainability or operational expenditure (opex).

The on-going economic crisis has put new investments for DH on hold, due to higher borrowing costs. The updated Energy Act and new National Energy Act are expected to limit the previous legislative barriers.

Under prevailing conditions there are no indications of executing any market or feasibility studies for DC. It is therefore not possible to indicate any estimation on a possible DC market development.

Sweden

Rescue target country

DH has a strong share of 55 % of the heating market. The tradition of DH is long. DH has made it possible to use waste energy that otherwise not would have been used and the very high share of bio fuels. The tradition and experience of DH has made it easier to introduce DC on the Swedish market.

Sweden is the only country in Europe that already has 33 utility companies with a DC business. Almost all large and medium sized cities already have started DC cooling supply services. At the moment there are a few more cities looking into new DC systems.

The main focus on DC development in Sweden is an expansion of existing systems with more connections along the networks. A trend is that the market, from the feasibility stage when developing the system, is under-estimated. When actually starting the development more interested customers are identified. Experience is also that the cooling demand for many customers is under-estimated. A high base cooling load with long duration exists. It is estimated that DC has reached a market share of 50 % in Stockholm.

All systems developed do use a mix of different sources for the DC production. Sweden did in the 80ies have an over-capacity of electricity from nuclear power. DH companies did build large heat pumps. CHP production was then very limited. An important source for starting DC was then the availability of natural cooling sourcing and utilising the cold side in existing heat pumps. Initially very few companies did use absorption cooling. With higher market prices on electricity absorption cooling is now also more interesting to include in the DC production mix.

Due to low COP on absorption it is necessary with low price on the heat for the absorption chillers. Most of the DC systems using absorption do have waste incineration in the DH mix. With the high fees for waste treatment the fuel price is close to zero or has a negative price. With high CO2-taxes bio-fuels became almost the only political accepted fuel
for DH. The market price on bio-fuels was stable and low in the 80-90ies have been raised during the last decade. Many cities now have built or are planning for more waste incineration capacity.

An over-capacity of waste incineration plants has been warned for. There is now a completion on the waste fuel market in Sweden. The strong incentive for using waste and having a competition on the fuel market has led into a huge interest of importing waste fuels. Sweden do compared to most countries in EU already have established DH-networks. Until countries in Europe have built up capacity for waste incineration Sweden will continue to import waste fuels. Which then is a good source for cheap heat production that is a needed for absorption cooling.

Note that the imported waste is sorted fractions and not unsorted household garbage. There is EU regulations on what type of waste fractions that can be exported and imported. Secondly treatment of waste that can be recycled and not suitable as fuel need to be considered and trends need to be analysed.

The use of absorption chillers for DC is in Sweden is limited. DC systems always use a mix of different sources. The risk in respect to over-capacity of waste incineration plants and dependency on imported waste fractions is therefore not considered to be too high.

There are also examples of using bio-fuels as a source of absorption cooling. The bio-fuel is then used in CHP plants. In Sweden there is an incentive, green certificates for electricity production in new CHP plants and RES. The EU emissions trading system has not enough influence.

Based on trends, market achievements, new prospects under development and depending on business conditions a doubled or tripled DC market share is estimated to be feasible. The Swedish DC market does not include any cooling for residential buildings.

Belgium

Belgium is Europe’s most underdeveloped country in terms of district energy. Existing supply of EU buildings consists of stand-alone solutions only. The market is dominated by on-site solutions.

There is no national association which could report on plans regarding district energy. The possibilities of smarter energy solutions and improving sustainability are probably high.

It would be a good market initiative if the EU and Belgium take action on developing district energy. Having references, with site visits “in the backyard” a possibility would be very valuable for all the decision makers. It would also strengthen the credibility and have a very positive influence on other EU27 countries to take required actions.

Bulgaria

No known market descriptions or plans for DC have been identified. Best estimations are:

- No existing plans for DC supply
- DH supply has probably a higher priority
- Financing of development of DC systems is a challenge

**Cyprus**

The financial turmoil in Cyprus does naturally have a negative effect on the investment climate. This barrier inhibits the interest for investors on both real estate and energy supply development. It is therefore not possible to see any positive signals on development of a DC market.

**Czech Republic**

The Czech Republic has a long tradition of DH. In 2009 DH represented 40% of the heating market. The sales have decreased due to actions on reducing inefficient overconsumption. Refurbishment and fuel conversion of existing systems is on-going. The share of CHP is rising.

Even if DH is a matured technology the utility companies do not recognise any business opportunity with DC. The knowledge level is also limited and a barrier for developing DC. Today only a few smaller pilot projects exist.

AC earlier on was only implemented in hotels and airports. Modern new buildings in both the service and industrial sector are now normally equipped with AC. Individual solutions for cooling are dominating the market completely. Limited driving forces or existing interest for DC is registered from the energy companies today.

In the real estate market in the Czech Republic and especially in Prague we can see a strong general business development. Overall Prague’s real estate market has rarely been stronger with a vacancy level below 10%. About 2000000 m² floor space have been constructed in new commercial buildings during the last years. All new commercial buildings will have a cooling demand. Real estate developers such as Skanska, ECM, Trigranit and many other developers are interested in sustainable energy supply.

**Estonia**

Estonia has a long tradition of DH and it is the dominating source for heating. The use of natural gas is expanding. Regulation of DH prices exists. Refurbishment of systems is delayed in order to maintain the price level affordable for the consumers. Incentives for investments are low due to the regulation of prices.

The association for DH and CHP is active and respected. However no activity on DC has been registered. It is therefore not possible to see any positive signals on development of a DC market.

**Greece**

During the present financial difficulties experienced in Greece it would be very hard to raise interest on establishing DC systems. Other topics are higher on the agenda.
**Hungary**

No official statistics or market descriptions on DH, CHP or DC have been registered. It is therefore not possible to identify any specific barriers or see any positive signals on development of a DC market.

**Ireland**

No information on full or smaller scale systems for DH or DC is registered from Ireland. Existing solutions are only institutional DHC, often in the form of a tri-generation plant for one customer/building.

It is therefore not possible to see any positive signals on development of a DC market. One main barrier for developing DHC is the lack of district energy tradition, local experience and good examples.

**Latvia**

Latvia has a long tradition of DH and it is the dominating source for heating. The use of natural gas is expanding, and is totally dominating in the growing market for CHP. DH prices are linked to natural gas prices. The prices of DH have not increased as much as natural gas. However the economic situation has caused problems regarding the price for energy in general. Natural gas is imported and more use of biofuels is expected. This will be an important tool for the RES targets.

No activity on DC has been registered. It is therefore not possible to see any positive signals on development of a DC market.

**Lithuania**

Lithuania has a long tradition of DH. The use of natural gas is expanding and is totally dominating the growing market for CHP. Biofuels are currently cheaper than natural gas. Financial support for biomass in the energy sector has had a positive effect. RES is expected to increase substantially for DH and CHP. The DH sector has survived the transition from planned to market economy with external support and is now being considered as a good example.

Renovation and modernisation of the building sector and refurbishment of DH systems has reduced the high fuel and energy consumption.

No activity on DC has been registered. It is therefore not possible to see any positive signals on development of a DC market.

**Luxembourg**

The DC system in Luxembourg was established in 2004. At the moment there are no plans for its expansion. Higher on the agenda is developing DH.

**Malta**

No official statistics or market descriptions on DH, CHP or DC have been registered. It is therefore not possible to identify any specific barriers or see any positive signals on development of a DC market.
Netherlands

The share of DH in the Netherlands is small and only around 4% of the heating market. DH is slowly increasing. On the positive side the potential is then huge. The competition with natural gas distribution is tough.

The energy playing field is moving towards conglomerates through mergers, including services of electricity, gas and heating, where DH is small in comparison to the other two.

There are potentially good examples of DC in the Netherlands. The market development has progressed rather slowly though. Customers are still unfamiliar with the product. One explanation is that DH still not is that spread yet.

Small scale solutions like heat pumps with aquifer storages or micro CHP with gas engines are very popular, which proves to be a barrier towards development of district energy. It will be harder to achieve a high connection percentage feasible for a district energy distribution system.

There is a good market potential for DC in the Netherlands. However there are no indications that energy companies presently are focussed on this.

Portugal

No official statistics or market descriptions on DH, CHP or DC have been registered. A DC system initially was developed for the World Expo in 1998 for a new area of 500,000 m² floor area in Lisbon. After that no real development has followed. The Portuguese economy and the real estate market are also in a situation where the financial market is very cautious. This creates a tough climate also for investments in DC systems. The financial barrier is right now the biggest challenge for developing DC. Local knowledge and experiences on developing a successful DC business are also limited.

Support in the form of “good practices” from other systems and cases could play an important role. There is a need for more local reference cases “pioneers” in order to initiate new projects.

Romania

Since 1997 many flats have been disconnected from DH in favour of natural gas. Some towns still have maintained a positive DH market, but they are dependent on EU funds for the refurbishment of old systems. Due to inefficient systems and the status of the building standard the energy consumption per m² was almost the double compared to EU15.

The disconnections of DH and low environmental performance of old plants have led to lower CHP production, which is now approximately only 10% of the power demand. Earlier coal was the dominating fuel. In 2008 the first natural gas combined cycle plant was introduced.

One main barrier for the introduction of DC is the bad reputation and conditions of the old DH systems. DC would need a special marketing program. The second barrier is of course the financial situation. It is hard to identify any positive market indication for DC until the modernisation of the DH systems has progressed further.
The DH companies also struggle with the problems of unpaid bills from customers.

_Slovakia_

Modernisation of inefficient systems and energy savings have led to a decrease in DH energy demand by 30% in 2009 compared to 2002. One more explanation is disconnection of DH in favour of individual natural gas supply.

Legislation on energy savings and supporting CHP is expected to change the negative trend for DH. Many new CHP projects are in the initial starting phase.

Some new developments for shopping centres, luxury residential projects plus in the industrial sector and the IT sector have started the development of DC. It is expected that new opportunities for DC will continue in the residential sector. However this is a rather limited sector. It is foreseen that legislation will have a positive impact on DC for the service sector.

9.4.7 CONCLUSIONS ON MARKET DEVELOPMENT

It is not possible based on the results from available statistics and the Rescue interview material to make any clear and secured conclusions on how the market of DC will develop. We are convinced that even with an extended one on one contact with more stakeholders and interviews it will not lead to a clearer picture. How the market will develop does depend on many different aspects. There is no doubt that the potential market for developing sustainable DC is huge. The benefits in respect to the EU 2020 targets are clear. The global political framework is clear. The transition of global targets into ownership of local action for fulfilling the targets is low. It is not possible to sit and wait for somebody else to do the work. The following needs could be identified:

- **EU/Member States:** Political determination
- Holistic primary energy approach in all legislation
- Framework that benefits energy efficiency in cold supply
- Framework that balances possible market failures
- Framework that transfers the benefits achieved on a social level to the company level (avoided investments in electricity supply and distribution etc.)
- **Municipalities:** Political determination
- Dedicated people that have visions
- Transfer of global targets into national/local legislation
- **Energy companies:** Corporate determination
- DC higher on the agenda, determination of handling more than DH and CHP
- Business focus instead of technical solutions
- Dedicated people that have system knowledge
• Utilising synergies with DH/DC
• On markets with low district energy matureness seek co-operations
• Building owners: Meet the requirements with a market driven approach
• The market in different countries. The energy companies do need to understand each local market’s specific needs and requests
• Financial market collapse has had a huge impact on almost all markets in EU. It has also spilled over on developing DC. DC must offer a competitive pricing.

9.4.8 WHY IS DC MARKET GROWING SO SLOW IN EUROPE

DC is still an undiscovered possible solution in most of Europe. DC is not as well-known as DH. The whole industry is very production oriented. The solution for achieving environmental targets is strongly focused on renewable electricity production. If we look into the production of electricity in Europe it is totally dominated by coal and natural gas. CHP, wind power and solar panels will lead into reduced emissions of CO₂. However what is forgotten is that cooling demand is growing rapidly. It is important to give more focus on energy efficiency and the use of primary energy. DC can play a significant role here.

The leading countries in Europe on developing the highest DC penetration per capita are the Nordic countries, Sweden, Finland and Norway. These all have a colder climate. Still the development of DC is on-going there. However in terms of reaching the EU 2020 environmental targets this will not leave any real impact since too few people are living in these countries. The knowledge is there, now it is a matter of also using it in other countries.

In Ecoheatcool /REF 1/ the net heat demand in 32 European countries was calculated to 21.7 EJ. The heat demand in Europe is then 5 times higher than the cooling demand. Supply of heating has a very strong social political link, since heating demand is dominated by the residential sector. District heating has a low penetration in most EU27 countries. The cooling market and specifically the part that is interesting for DC is in the commercial sector.

Countries from the Eastern Europe have a high penetration of DH. However top priority there is to modernise old systems, reduce losses and meet the competition from the gas sector. Developing and financing DC is lower on the agenda.

Many cities do develop SEAPs. The contents of the SEAPs are very variable. Many actions are of rather general nature. A SEAP is a first step only. It sets up a vision. It now takes dedicated determination and the right framework of converting plans into real actions. Small scale cooling solutions will not have a market impact. It takes large scale DC systems in order to achieve the EU 2020 targets.

The largest cooling market in EU27 exists in the five largest countries, Germany, Italy, France, Spain and UK. In these countries we have not been able to identify a strong determination on developing DC. Under the current framework there seem to be no market drivers for accelerated development of DC. There are various possible explanations but in general the benefits of DC such as reducing the need of huge investments on electrical power production and distribution pay off on a society level but not necessarily for the company/business level. There are also possible market failures due to a lack of
internalisation of external effects and a framework that incentivizes on-site solutions for instance due to a lack of a holistic primary energy approach.

Many reasons for the slow progress on DC can be identified. The following conclusions on this apply or sometimes partly apply on many EU27 countries:

- Implementing DC on a not mature DH market is not easy. In most countries DH is still under-developed.
- General knowledge on the costs and environmental impact of cooling is poor.
- The benefits of DC such as reducing the need of huge investments on electrical power production and distribution pay off on a society level but not necessarily on the company/business level.
- Lack of internalisation of external effects.
- Framework that incentivizes on-site solutions.
- DC is still an undiscovered product.
- Modernisation of old DH systems and struggle with not losing DH customers to the gas market takes up all the attention.
- Mistakes in earlier attempts may have led to a hesitation of exploring DC further.
- Linking the feasibility of DC to access to inexhaustible resources of natural cooling, like in Nordic countries, whereas all systems developed have a mix of natural cooling and chillers.
- Lack of DC knowledge of all involved stakeholders.
- Language barrier and the hesitation of using experience from other countries. It is easier to develop DC projects in the Middle East, South East Asia and China than in different European countries. This is not depending on high cooling demand in the building stock compared to in Europe.
- Lack of knowledge that cooling demand is growing. Both the AC penetration in EU27 is very low today compared to USA and Japan. There is a misconception that cooling is only needed due to outside ambient temperatures when the cooling base load during the whole year is actually created by heat inside the buildings.
- In buildings in general heating and electricity consumptions are more significant than cooling consumption and therefore this can be seen as another reason why less emphasis is given to Cooling and consequently DC.
10. REFERENCES


/4/ World Air Conditioning Market Reports. BSRIA. www.bsria.co.uk


11. APPENDIXES

11.1 DESCRIPTION ON COOLING MARKET PROGNOSIS 2020 AND 2030

Both Ecoheatcool /REF 2/ and Common Vision for the Renewable Heating & Cooling Sector in Europe /REF 5/ did earlier estimations of the European cooling market to have a potential energy demand of approximately 1.4 TWh.

A thesis from Chalmers University by Eoin Ó Broin – Energy Demands of European Buildings: A Mapping of Available Data, Indicators and Models /REF 8/ gives a good picture on mappings of total floor area per country from sources like; Odyssee, HSEU, UNECU, EnergyC, Enper T, Ecoheatcool, IEA 30 and ECH. For the residential sector quite comprehensive and detailed statistics exist. However for the Service sector the information is significantly less comprehensive and detailed. This can be explained by the fact that housing is a social need that has a political necessity to monitor and plan for. This political motivation is not that evident for the service sector. The lack of detailed information for the service sector is unfortunate for the Rescue project, since DC is mainly focused on the buildings in the service sector.

There are very few studies that can be used for estimations on the cooling market and the saturation of cooling. Most studies focus on cooling equipment and information on sales figures of number of units or cooling capacity.

For instance BSRIA produces annual statistics on AC equipment sales for a number of countries in the world. However it does not exist for all the EU27 countries, so that means trends and estimations are still necessary. Furthermore these reports are not open sources, and the Rescue budget only allows use information from free open sources.

The project ECODESIGN /REF 9, REF 10, REF 11/ is dealing with regulation of ventilation products. It is dealing with identifying possibilities with for instance standards leading into improvement on energy efficiency. For this purpose a very comprehensive sales statistics is produced and also a extensive prognosis of future sales of AC for EU27. ECODESIGN includes many reports and the purpose is targeted on regulation for ventilation equipment design and/or labelling measures on ventilation products. The detail level of information is very good and we have used the sales information for cooling market estimations in the Rescue project.

Within ECODESIGN there are two “lots” focusing on ventilation products; ENER Lot 10 ("domestic ventilation") and ENTR Lot 6 ("non-domestic ventilation").

LOT 10 “DOMESTIC VENTILATION”

Lot 10 covers sales and estimations for air conditioning; movables, reversible splits and cooling only splits. Figure 13 is showing the ECODESIGN sales trends prognosis for 2005-2030 for domestic ventilation products.
Figure 13: Sales of AC in EU27 in GW (cooling capacity) (SOURCE: ECODESIGN Lot 10)

Figure 14 is showing the ECODESIGN prognosis of the 2005-2030 trend of stock for domestic ventilation products.

LOT 6 “NON-DOMESTIC VENTILATION”

Lot 6 covers sales and estimations for air conditioning; chillers, VRF, multi splits, ducted splits, single splits above 12 kW and rooftops. For the market saturation analysis in Rescue we allocate all these products to the service sector. The ECODESIGN estimated sales for non-domestic ventilation the period 1990 to 2025 is shown in Figure 15.
Figure 15: EU27 Estimated sales of central air conditioning products in cooling capacity (GW).
(SOURCE: ECODESIGN Lot 6)

The ECODESIGN estimated stock trends of central air conditioning products in EU27 are shown in Figure 16:

Figure 16: EU27 Stock trends in (cooling capacity GW) of central air conditioning products.
(SOURCE: ECODESIGN Lot 6)

MARKET SATURATION OF COOLING IN EU27

For Rescue the market development of cooling can now be estimated by using the ECODESIGN Lot 10 plus ECODESIGN Lot 6 information. The following assumptions apply:

- AC cooling market consists of the sum of Lot 10 and Lot 6 ventilation equipment sales and stock.
- Additional DC statistics. (can only lead to a minor over-estimation, since DC actually is a mix of natural cooling, absorption chillers and electrical chillers)
- The capacity includes all sales but does not state how high the actual peak demand is. We reduce the capacity by 25% in respect to what we estimate to be a representation of reserve capacity.
- What are new installations and what are replacements is a subject that also needs estimations. When looking into sales estimations it can be observed that in the beginning of a market penetration most sales are new but later on when the market
is matured the sales will transfer into replacements. Since the saturation of cooling differs between countries this will be a rather complex trend analysis. We here simplify it with an assumption that it is a constant proportion of 50/50 of new units and replacement units during the whole period.

The total cooling market in EU27 has now been estimated to correspond to 1220 TWh per year, as shown in Figure 17 split per country. The market saturation for cooling in EU27 is significantly lower than in USA and Japan. For 2012 we have estimated the saturation to be 8% for residential floor area and 41% for the service sector area.

![Figure 17: EU27 Estimation of total potential cooling market in EU27 (TWh)](image)

The market saturation has now been estimated based on market stock and sales estimations of AC products. Estimations in earlier projects like Ecoheatcool /REF 2/ or Energy Technology Platform on Renewable Heating and Cooling /REF 5/ has so far not reached their prognosis. The implementation of AC products has been influenced by the prevailing financial market conditions. This has led to a slower growth. However for the long term estimations periods of slow market development will be recovered over the following period. The following conditions have been used for the Rescue potential cooling market analysis:

- Capacity figures from many consultants or suppliers have historically showed an over-estimation of the corresponding real demand. Our analysis therefore when transforming capacity figures into energy demand uses low figures for full loads hours.

- In the ECODESIGN Lot 6 Task 6 report design options are studied. There is a definition of “equivalent active hours” for three conditions cold (Helsinki), average and warm (Athens) climate. The average 600 h has been used for transferring stock in GW to annual energy in TWh.

- ECI for a country is represented by an average city chosen

- Specific demand information with the ECI=100 corresponds to 82 kWh/m² for service sector and 37 kWh/m² for residential buildings
• As can be seen on the earlier presented sales statistics estimation in Figure 13 and Figure 15 an attenuation of the market growth is foreseen. The annual market saturation is estimated to grow with the following annual percentage:

- Residential buildings 0.35% annually until the year 2020
- Residential buildings 0.25% annually in 2020-2030
- Service sector 2.3% annually until the year 2020
- Service sector 1.7% annually in 2020-2030

This analysis results in a cooling market saturation in the EU27 countries for residential buildings of 11% (78 TWh) in 2020 and 13% (95 TWh) in 2030 and for the service sector 63% (321 TWh) in 2020 and 80% (408 TWh) in 2030, see Figure 18.

![Figure 18: Rescue prognosis on cooling market development in EU27 – 2005 to 2030](image)

11.2 CERTIFICATION SYSTEMS FOR BUILDINGS

11.2.1 GREENBUILDING

The WorldGBC (World Green Building Council) was established in 2002. In each active country there is a national member council.
The requirement level for achieving a green building certificate for a building is that it will use 25 % less energy than earlier or in comparison with the requirements set by the building regulations. Here an obstacle is that energy use does not necessarily reflect the primary energy use. For instance building regulations in Sweden lack the system perspective. A building with a heat pump may use more primary energy than with DHC but if the primary energy efficiency of the heating supply is not taken into consideration this will not be reflected in the assessment of the building. It is therefore important that building regulations are based on primary energy and not energy use inside the buildings wall.

Today globally 100000 buildings and almost 1billion m² of green building space is registered. It can also be observed that green buildings are getting more popular.

According to Green Building Trends – Smart market report /REF 17/ from 2013, a shifting of business toward green buildings can be observed. The report 5 years earlier stated that the top driver was more of a conscious “doing the right thing”. However now the study reports a business focus:

- 76 % reports that green building lowers operating costs
- 38 % reports a higher value of green buildings
- 38 % reports quality assurance
- 36 % reports future-proofing assets (i.e. protecting against future demands)

A clear trend from the survey was that 51 % of the respondents are planning for more than 60 % of their work to be “green” by 2015, which is significantly higher than what was reported in 2008.

11.2.2 LEED

LEED™ Green Building Rating System is the best-known and wide spread rating system, developed by the U.S. Green Building Council. The first version came out in 1999. LEED is based on the American ASHREA standard 90.1. It is then also natural that the foundation of the certification is based on American conditions. Only Canada, India and Cuba have so far made local adjustments to the system. All other countries must go through a certification process with the U.S. Green Building Council.

LEED is mostly used for commercial properties and assesses the building’s environmental performance based on the following areas: Local environment, water use, energy use, materials, and indoor air quality plus bonus points for innovation in project and regional considerations.

Since DC and DH only exist in a few large scale systems in the US there were not any good alternative buildings to compare with. Buildings with DC and DH were then miss-
credited. The Swedish real estate and construction company Skanska works with certification of buildings and wants to use district energy. The reason for this is that they measure the energy use with primary energy. DH is in Skanska’s opinion the best heating system for reducing the primary energy use. The Sweden Green Building Council has, in a working group (WG) where both Skanska and Svensk Fjärrvärme participated, developed an international LEED regulation for DH and DC connected buildings. The work is now being approved by the U.S. Green Building Council. Acceptance as an international LEED certification for DH and DC supplied buildings remains to be seen.

11.2.3 BREEAM

BREEAM is a British certification system firstly used in 1990. It is developed by BRE (Building Research Establishment). BRE Environmental Assessment Method (BREEAM) is also known under the acronyms BREAM and BREEM.

BREEAM has been used for certification of 115000 buildings, most of them in Great Britain. Approximately 500000 buildings are now also registered to be certified.

BREEAM has developed various evaluation tools and manuals for various types of buildings. A building's environmental performance is assessed in a number of areas. There are minimum requirements for achieving points in terms of project management, building energy, indoor environment such as ventilation, lighting, water management, waste management, and land use and the impact on the local environment. Extra points can be achieved for innovative buildings.

Apart from the UK manuals with local versions and adaptations only exist in Norway, Netherlands, Sweden and Spain.

11.2.4 EXAMPLES OF APPLYING CERTIFICATIONS ON A SERVICE BUILDINGS IN SWEDEN

A not yet published report from the Swedish District Heating Association R&D program Fjärrsyn has studied certification of buildings with DH and DC compared to using heat pumps. /REF 18/

Energy corresponds to on third of the potential score for the examined labelling systems in the study. In the study a service building is represented by an office connected to the DHC systems in the cities of Gothenburg, Linköping and Solna. The certification systems; Environmental building, BREEAM and LEED are applied on the standardised buildings.
The international labelling GreenBuilding only deals with energy. The Swedish labelling Environmental building also includes material choices and inside environmental aspects in the score system.

For an office building the in-data on what type of mix for electricity is used has a major impact on the result. If a building is purchasing “Green labelled electricity” the scores will of course be high and the same applies if the energy company is approved for their electricity consumption accordingly. Since electricity corresponds to 50% of the office buildings’ energy consumption the choice of electricity labelling is the single most important factor. This approach lacks a systemic approach and holistic view. Due to the influence of heating demand and solar radiation the use of electricity will be somewhat evened out.

- All studied cases gives label Gold when using green labelled electricity. (Energy usage only)
- All studied cases gives label Bronze when using Nordic electricity mix. (Energy usage only)
- Cases in Solna and Linköping gives label Bronze when using green labelled electricity (Total Energy factors)
- Cases in Gothenburg give both label Silver and Bronze. (Total Energy factors) There is a threshold factor linked to ambient climate conditions compared to Linköping and Solna.

**BREEAM**

All DH/DC buildings in the 3 cites score 3 points on energy efficiency. However with heat pumps in the building the score is 10 points. All depending on the Swedish building standards definition specific energy performance on reducing purchased energy instead of minimising energy use. The progressive scaling enlarges the gap substantially.

The easiest way to achieve high scoring is the installation of a heat pump. Then the building will be labelled as an electricity building. The COP of the heat pump results in lower energy usage than the comparison to other forms of electricity based heat supply.

**LEED**

All alternatives give highest scoring. The reference case is a building with an oil boiler. Buildings according to present Swedish building standard use less energy than the defined reference case building. Due to the defined reference case building the choice between DHC and heat pumps or how the electricity is produced has no impact.
Conclusion

By applying the 3 alternatives of building certification methods it can be concluded that it not results in a uniform answer. Depending on what reference case the building is compared with different alternatives do not lead to a significant difference in the rating. The rating will then be similar. It can therefore not be answered if the certifications are suitable for DHC buildings. Answer can be both yes and no. Development of the systems and more experience with adaptations of the certification systems for district energy is needed.