Rescue

RENEWABLE SMART COOLING FOR URBAN EUROPE

GUIDELINES

WITH IMPACT CALCULATOR

Co-funded by the Intelligent Energy Europe Programme of the European Union

This report was elaborated in the framework of the RESCUE project co-funded by the Intelligent Energy Europe Programme of the European Union

Report prepared by:

CCO CAPITAL COOLING

DISCLAIMER

CONTENT

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 took place from June 2012 to May 2015.

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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 fewer than 1 % of the total current 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 district cooling 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 CO_2-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.

3 NOMENCLATURE

Abbreviation	Description
ABS	Absorption (chiller)
AC	Air Conditioning
BREEAM	Building Research Establishment Energy Assessment Method
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CoM	Covenant of Mayors
COP	Coefficient Of Performance
DC	District Cooling
DCS	District Cooling System
DE	District Energy
DH	District Heating
DHC	District Heating & Cooling
ΔT	Delta T, temperature difference between supply and return of the system
EC	European Commission
ECI	European Cooling Index
EER	Energy Efficiency Ratio
EPC	European Project Centre
ETS	Energy Transfer Station, installation in the building where the DC is supplied to the building
EU	European Union
FM	Facility Management
HEX	Heat exchanger, equipment in ETS that separates the DC primary side from the building's secondary side
LA	Local Authorities
LCC	Life Cycle Cost
LEED	Leadership in Energy and Environmental Design
LG	Local Government
PE	Primary Energy
PEF	Primary Energy Factor
RES	Renewable Energy Sources
Rescue	REnewable Smart Cooling for Urban Europe
SEAP	Sustainable Energy Action Plan
SGBC	Swedish Green Building Council
SSEER	System Seasonal Energy Efficiency Ratio
TPA	Third Party Access
USGBC	US Green Building Council
WG	Working Group
WP	Work Package

4 INTRODUCTION

The purpose of this report is to provide practical information related to start-up of a District Cooling system and District Cooling business. The focus is on the very beginning of a District Cooling scheme. Target groups and main stakeholders for this report are Local Governments (LGs, meaning urban planners, local decision makers), as well as top management and employees of local energy companies.

The main purpose is to create practical guidance for the key issues that have to be taken into account when building a District Cooling system and starting a District Cooling business:

- Crucial Success Factors
- The most common failures (or barriers that have to be overcome)
- Other major issues

The main idea of District Cooling is to use local sources for cooling that otherwise would be wasted in order to offer the local market a competitive and high efficient alternative to the traditional cooling solutions.

This sounds quite easy but is a little harder in practice. To be able to introduce a successful District Cooling scheme, it is needed to use local cooling sources. Local legislation and permission requirements needs proactive work on ensuring that the business case gets access to use these resources. Thereafter these resources can be transformed into a competitive cooling product that attracts the local market users (buildings with cooling demand).
A successful District Cooling system is a system that is more energy efficient than other local alternative solutions and profitable for the society in the long run.

The recommendations given are partly based on the experiences from cities like Paris, Stockholm, Helsinki and Vienna which have already created successful District Cooling systems. (Tvärne & Frohm, 2014)
Growing interest in developing energy resilience and reducing carbon footprint in communities and their reliance on sources outside the region is making local solutions for heating and cooling supplies more attractive to communities across Europe.
Different project actors have different objectives, opportunities, resources and levels of understanding of the way to make it happen. This package contains guidance (the information needed) to roll out new business opportunities for DC, recognizing the opportunities that will best meet different parties' main objectives.
A local municipality could decide to go forward with actions to develop and establish a district cooling infrastructure scheme and cede some or all of the stages of development to third parties. Local municipalities can become an energy utility in their own right. This presents a unique opportunity to generate new income and fund wider objectives. It is crucial that public sector initiators understand and adopt a commercial approach to District Cooling projects, more commonly associated with private actors.
Although district energy projects can deliver a number of societal and environmental benefits, they must be financially viable and economically sustainable over the long term. Therefore, a pragmatic commercial approach needs to be adopted.

Private sector actors include different type of companies, which are able to offer a range of approaches, from contracting to deliver specific elements, to total project development, operation and ownership.

Each of these players may play more than one role in a project and there can be numerous points of entry into the different stages of development. For example, a municipality may set an area-wide energy vision and play the role of a project sponsor for example for energy mapping and feasibility studies. Equally, a municipality may wish to invest in developing projects themselves. Municipalities and other public sector actors may be the key to the viability of a project simply by making access to their own buildings' demand for cooling. Major builders and building operators can also profit from energy projects and play a key role in providing major parts on the demand side.

Institutional buildings like universities, hospitals are often used to be connected to energy networks that could supply heating and cooling to entire campus areas and can, by their nature, be important starting points for a market buildup.

5 METHOD

This report will provide a recommended methodology to follow in the decision making process for developing a District Cooling scheme. Data for this task are collected from the local companies and municipalities in the cities that have already created a cooling system. Feedback from other work packages in the Rescue project (roundtable workshops) will also be included.

Involvement of local governments/utilities that are interested but do not have any District Cooling scheme yet has also been sought.

Project partners interviewed local authorities and utilities in cities that have developed District Cooling systems. Deep interviews were conducted with representatives mainly from utilities in Stockholm, Gothenburg, Helsinki and Paris. Representatives from Vienna and Copenhagen were also interviewed (Interviews, 2014).

The interviews were conducted during the second half year of 2012 and in the beginning of 2013. The questionnaires were coordinated with the rest of the work packages so that synergies between the work packages prevent double questions to the different stakeholders. The interviews were also organized in a way that stakeholders could give answers to different work packages at the same time.

5.1. HOW TO MANAGE THE BUSINESS PROCESS

There are needs to take the development in steps in order to understand and evaluate options and make right decisions in the progress of a District Cooling project. Clear understanding of the opportunities and risks underpins the development of a successful project.
It is also important that the project actors appoint a body that becomes an authorized representative to take the necessary lead to develop the District Cooling project forward. It is often easy to delegate key parts of the process, or even the whole job, to consultants or companies that are specialized in energy projects. However, it is important that the authorized representative has a sufficient level of knowledge and time to understand and assess the recommendations made by consultants.

Here is an example how the project phases could be developed:

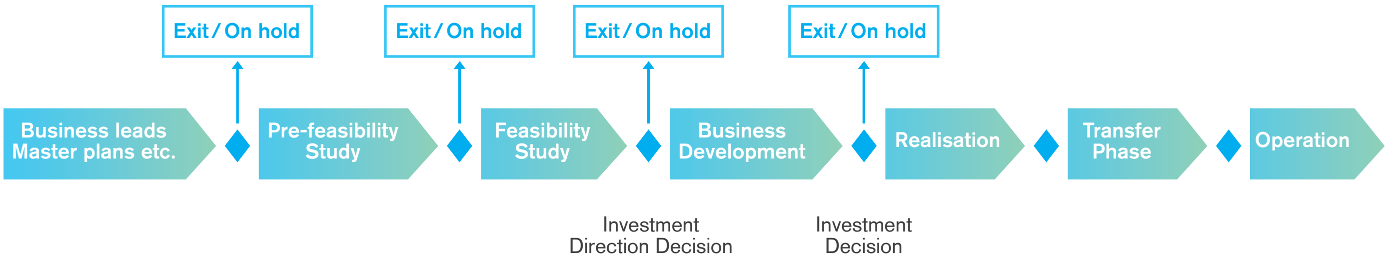


Figure 1. The development process for District Cooling. Source: (Capital Cooling)

This describes the whole development phase from the first idea to a District Cooling scheme in full operation. This report will describe in detail the first three phases of the process in chapter 9.

5.2. AN OVERVIEW OF THE BUSINESS PROCESS STEPS

Business Lead – Energy Master Plan

As part of a community, Energy master plan for DC infrastructure solutions is identified as a possible contributor to organize sustainable energy solutions which are needed in the real estate market. Some geographical areas are mapped to be suitable for this community solution: a District Cooling product to be offered in the defined local market area.

Pre-Feasibility Study

Actors organize an evaluation study to clarify if there is a viable business opportunity in specified geographical area/s focusing on customer demand. They search for a competitive and accessible technical concept, critical success factors, and map out the stakeholders that need to declare their commitment. The district cooling actors decide if the timing is right and if the business case is strong enough. If the study shows that District Cooling is an option, the process continues. If not, the process is stopped or put on hold and no further development resources have to be allocated.

Prior to taking the next step at the feasibility stage, there are a number of organizational issues that need to be addressed and solved.

When the actors have decided that the business case has the right caliber and/or that it is the right timing, it is wise to assign a project manager and an authorized partner to take the lead and responsibility for the continued development process. At this stage it could be considered to establish contact with the key customers and prepare some kind of common ground for the business case.

Feasibility Study

The Feasibility Stage should clarify the business case, and possibilities to finance infrastructure investments. It should ensure to get clear commitment to find financial commitment to run activities to financial closure, i.e. when the formal investment decision will be done. If the business case has the right features and the decision makers (normally equity providers) take an alignment decision, which means that the development process can be financed to reach a formal investment decision, a number of organizational issues need to be fixed. Now, the focus on excellent performance management is essential.

Business Development

The project reaches Business Development status. The conditioned assignment is appointed to the Business Manager to organize and develop the business case including contracts with customers, initiate the entity for the operations (SPV or similar entity unit), make partner contracts, pre-investments and secure access and permit contracts. The system's design needs to be defined and the procurement planning and execution be conducted. The proposal for the Business Development phase should ensure that the project will be a long term profitable district energy business. The proposal should also include different fallback scenarios including the worst case scenario that at least has a business value equal to the cost related to execute this phase.

Business Project Realisation

The conditions for full scale investments are reached, i.e. the project is bankable. An Investment Decision is made by the Investment Board, the Business Manager is assigned to organize a full scale Business Project Organization and the project is entering into the Realization phase.

Transfer

Through the Realization phase the project is ready to be transferred to the long-term operator to be responsible for the operation & maintenance day-to-day business. At the end of the transfer phase, the Business Project Organization will make an exit and the project will be closed.

Operation

The operator takes care of operating and maintaining the system.

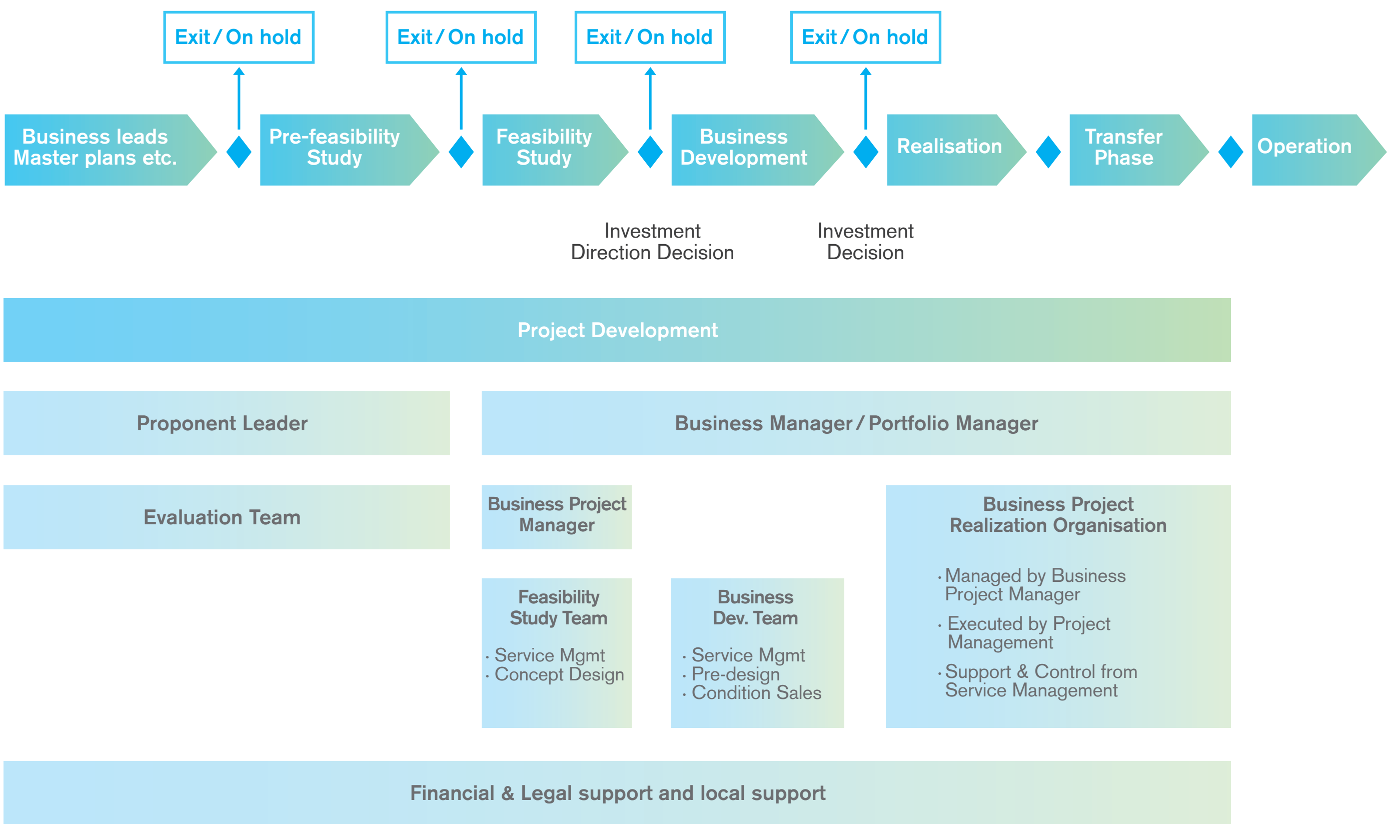


Figure 2. The development process for District Cooling. Source: (Capital Cooling)

6 IMPORTANT STAKEHOLDERS AND THEIR ROLES

There are many stakeholders in a District Cooling scheme such as the District Cooling owner, operators and their employees, municipal authorities, national policy-makers, district cooling / district heating associations, educational institutions, investors, real-estate owners and their tenants and building owner associations.

To be able to develop a District Cooling scheme, three stakeholders are essential:

The three key players

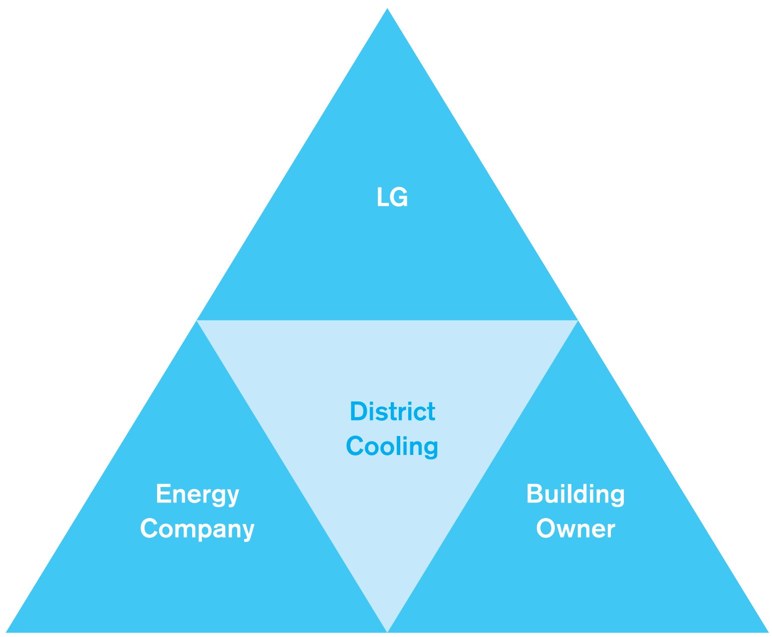


Figure 3. Key players in District Cooling Schemes

Building owners: cooling consumers of the District Cooling services. These stakeholders also include process industry facilities with high process cooling needs and large cooling users.

Local Government: policy makers, making a level playing field for District Cooling, easements and permits for the development of District Cooling.

These stakeholders include:
• City development / planning department
• Building department (standards)
• Energy department
• Environmental department
• Public Building and Facility Management

Local utility company / energy company: the developer and/or the operator of the District Cooling scheme. This stakeholder can be Local DC companies; infrastructure providers, ESCOs or other companies, which can take the mandatory role of developer and energy supplier of District Cooling.

6.1. USERS OF COOLING SOLUTIONS – BUILDING OWNERS

Naturally it is needed consumers for the cooling. This is the most important stakeholder. Without interested developers, building owners and end-users there will be no market for the product called District Cooling. In order to attract the building owners, the product must be economically attractive and, ideally, sustainable. Competitive pricing of the product and the awareness of the consumer using the product with the best features in terms of environmental impact must be stressed.
The typical DC consumers are public and commercial buildings such as offices, governmental and public buildings, hotels, universities, hospitals and airports. A lot of process cooling is also needed in data centers, medical and process industries.

Typically, there are one or two (or a number of) large cooling users in the city centers or municipalities. It is essential to attract them by finding a proper solution for their cooling needs and they can be understood as a great hub to expand from.

6.2. LOCAL GOVERNMENT/AUTHORITIES AND DECISION MAKERS

In general, local authorities or local decision makers do not have the expertise to start a successful District Cooling scheme. Their role rather concentrates on general and strategic decisions to undertake energy planning such as fulfilment of the national transpositions of the nearly zero energy building (NZEB) requirement as outlined in the Energy Performance Building directive and the new Energy Efficiency Directive, but also in increasing the efficiency of the energy supply and the renewable energy share in their SEAPs.

Many LA do not have a clear picture of what District Cooling is and of the possible benefits for a municipality or city.

While a local government/local authority has the overall responsibility for infrastructure services in each municipality/city, these services are usually carried out by or in partnership with private or public sector operators, sometimes through concession agreements. In some countries it is more common than in others that the LA owns a local utility or energy company, i.e. Stadtwerke. This includes local distribution of electricity, gas, water and treatment of sewage. In many cities, District Heating systems are already established and in a very few cities there are also District Cooling systems in operation.

Every local authority is obliged to define how they can contribute to and facilitate the development of programs for reduction of energy usage within their jurisdiction. One of possible steps towards fulfilling current regulations and directives is the establishment of a District Cooling system.

Once the local authority has taken the initiative to trigger an initial investigation, which is carried out either by the authority itself assisted by consultants or by the local energy company, the authority should agree on the business model and ownership issues.

The cooling market is rapidly growing and is dominated by the conventional technology with local electrical chillers (Tvärne & Frohm, 2014). These chillers have a low coefficient of performance (COP). Without intervention by LAs or other authorities, the use of production and distribution of electricity will expand substantially, which will result in a need of investment on stronger power distribution grids. LAs can take the lead in optimizing energy infrastructure investments (often across several owner/operators) thus avoiding additional investment.

On top of pure infrastructure interests and responsibilities, local authorities are responsible for larger societal objectives such as creating a safe and healthy community. The production of electricity, mostly in power plants, leads to production of higher amount of CO_2-emissions. Measures on reducing greenhouse gases emissions are therefore a part of the local authorities' agenda. Additionally, cooling towers are hardly appealing visually and the noise of the split system air-conditioning units has also influence on the quality of living in cities.

These are two very strong incentives for authorities to raise the awareness of the local utility companies to look into District Cooling.

The important role for the local governments/local authorities is providing political commitment. A local authority can initiate the mapping of buildings which can be of different detailed level, pre-feasibility or feasibility study. The main challenge after that is linked to the development stage, where financing is the major issue. In order to implement a District Cooling business, usually a partner such as an energy company is needed. This partnership can take several forms: mostly, the task is taken on by a local enterprise in the form of a municipality-owned energy company. If the municipality does not have the possibility to manage a local energy company with the necessary know-how and/or financial strength then a liaison with an experienced energy provider can be an option.

6.3. ENERGY COMPANY

The energy company acts as a local enterprise taking the role of developer of a District Cooling scheme and cooling supplier. Normally, it is the future operator of the District Cooling system that is in charge of the design and execution of the construction of the system. Sometimes the DC business is split between a company that owns the DC system and another one that operates the system. The local energy company shall be aware of taking steps to create a District Cooling system and a District Cooling business. Therefore, they are eager to have information related to the start of the system and the start of the business. This report provides simple answers on how to roll out a DC scheme. Answers are based on the knowledge of establishing other existing cooling systems.

If it already exists a District Heating system in the municipality/city, there is already a local knowledge on district energy. Many of the potential District Cooling customers are then familiar with District Heating technology. It is easier to sell-in new services like DC when the customer already has the knowledge of the founding principles and benefits of district energy. An already established customer relation is naturally valuable.

However, it is important to understand the differences related to cooling systems; District Cooling systems are even more sensitive to a temperature differential (ΔT) of supply and return water than District Heating systems. Every degree of lower return temperature normally corresponds to 10% higher flow demand. It is therefore essential for the DC supplier to have knowledge of the cooling usage and technical installations inside the building to be able to discuss connection to District Cooling systems so that as high ΔT as possible can be reached for each building. This will lead to lower investment cost and lower pumping costs that both the customer and the DC supplier will benefit from.

The developer and DC supplying company can be owned by a municipality or a private entity. If the utility company operates as corporation, it will operate the system in the same way independently of ownership. But with a municipality-owned company, there is a tighter link of the corporate board to the local authorities.

An examination of the ownership situation in Germany shows that it reflects the situation in Europe quite well. There are relatively few District Cooling schemes in Germany based on an extensive cooling network as opposed to general sale of cold as a third party (contracting) or heat delivery for cooling production (via absorption chillers). There is no difference for private or public companies. For instance, the District Cooling grid in Hamburg is owned by a private company, whereas the one in Munich is municipality-owned. There are schemes that are owned by private companies with a German state as majority owner. Unfortunately, no conclusions can be drawn from this, due to the small sample size. The question about whether a DC scheme is developed is more about the local circumstances and in general the economic viability of the project than about how the scheme is owned. While, in theory, municipality-owned companies are more willing to invest in energy efficiency technology, even at uncertain outlook due to the environmental benefits, in reality municipality-owned companies have to operate in an economically viable fashion, in order to satisfy the dividend distribution expectations of their owners (the municipalities).

The most comprehensive database of District Cooling schemes currently lists more than 130 DC schemes in Europe (EHP, 2014). However, there is no data available on the distribution of publicly and privately owned schemes. From general experience it can be said that none of the two can be perceived as better than the other. It depends very much on the market conditions and the regional setting as well as on the capabilities of the municipality or the private utility.

At an early stage of the investigations of the feasibility of a District Cooling system, it is important to have a picture of the ownership of the system. There are different options available. If there is already a company that operates a District Heating system, it is likely that the same company will be the carrier of a possible new business like District Cooling. If there is no existing District Heating company, the ownership options need to be evaluated further. The consequences of different ownership structures should then be considered.

There are two main types of ownership, public or private, plus a number of mixed solutions. Some mixed solutions can also be hybrids that are set up for a limited period of time as well. Each type of ownership will have a different level of possibilities and control to develop the DC business. The general main objectives for development of district energy systems are economical viability or profitability, security of energy supply and environmental aspects.
One of the first considerations is to figure out whether there is an in-house knowledge or some partnership is required. The hybrid solution can be set-up for the development phase with the intention of handling over to the future owner at a suitable timing. Examples of hybrid ownership are temporary arrangements like a joint ventures (JV) or Special project vehicles (SPVs – a shared project among the shared stakeholders).

BUSINESS MODELLING – DIFFERENT DISTRICT COOLING ENTITIES

Public Project Development Companies

Many municipalities own and operate public local distribution companies for purposes of distributing electricity. These public electricity distribution companies often serve the buildings and citizens only within the community borders of their city or town.
Local governments can form municipal utilities for the purpose of building, owning, and operating DC schemes as well.

Building developers, building owners and end-users are inclined to sign long-term agreements with municipal owners than with private actors as they have confidence in the municipality.
Long-term agreements depend on the conditions and may be achieved by both municipal and privately owned companies.

Examples from Sweden and Finland show a number of municipal district energy companies owning and operating District Cooling networks.

In Poland, utility companies exist in different shareholder structures. Some have been sold to multinational companies such as Dalkia and Vattenfall, others are still owned by the municipality. Usually, municipalities have their say in the companies' decisions.

It is possible to establish a municipal utility or a special purpose entity with a defined business plan separately from the municipality; this can be done by setting up a separate entity company owned by the City council. Utilizing a project-financing strategy, it can also finance against its assets and revenue streams. However, any debts are likely to be consolidated into the municipality's accounts, meaning it carries the financial risk. Thus, the business case should be solid and show acceptable levels of profitability and present minimum risks. Publicly owned municipal utilities may be subject to restriction in completion to access to publicly owned buildings.

Although the ownership may be with the municipality, the technical design, construction, and operation can be organized by involving different private specialist companies.
It is crucial to build a sales organization that can secure necessary income cash flow streams.

The strengths of this approach are:

- Municipal ownership and control ensures close alignment with municipality's social and environmental policies
- Municipal ownership provides covenant strength in obtaining finance at a lower cost than loans for the private sector;
- Possibilities to access low cost infrastructure funding
- It strengthens customer confidence and willingness to sign long-term contracts
- Dividends can support the delivery of other services
- Future expansion can be coordinated and controlled by the municipality.

Weaknesses are:

- Company is reliant on financial strength of the municipality and it will remain on the municipality's balance sheet
- Municipality must be rated as fair or better if municipality carries the financial risk
- Organizational skills must be built-up

Private companies

There is a number of private companies being active in the energy services market, with specialized expertise in the design, construction, operation, and optimization of central plants and district energy networks. Around the globe, these companies provide energy management services to municipalities, governments, institutions, and other private sector entities as part of a concession arrangement. Recently, larger utility companies have entered this market, either directly or by buying or taking a stake in a specialist company, thus providing solid financial backing. These entities are organizations based on making profit.
To interest them, projects must be sufficiently scaled and many risks have to be handled in the form of some kind of guarantee on future cash flows.

The strengths of this approach are:
When a private company invests, it brings substantial expertise specific to the technology, with extensive project management and operational skills, enabling them to carry the technical risk; they continue ownership and operation over the long term.

Weaknesses are:
Higher rates of return are required and energy charges may be higher;
Public sector sponsors lose control and are unable to direct future development, particularly for projects with a low rate of return. Customers may get impression of being tied to a private company that holds a dominant position.

Public/private partnership (PPP) arrangements

A PPP company may be established in order to share risk between the public and private sectors and to allow it to access financial resources at lower cost. These entities could be structured as joint ventures or as special purpose vehicles in which the different parties hold their shares.

It is important to think about the different roles necessary for the development, market and sales activities and operation of a District Cooling project and to assign these to responsible parties with appropriate skills or outsource them to external parties.
No examples of PPP schemes of DC are known in Europe.

Establishing a joint venture company or a so-called special purpose vehicle (SPV) requires specialized legal assistance. The purposes for the company and its structure will need to be defined in the memorandum of understanding.

Additionally, there will be a number of contracts stipulating relationships necessary for the provision of the energy services.

The strengths of the PPP scheme are:
- Close alignment with the socio-environmental aims of the public sector
- Greater flexibility than wholly public or private approaches
- Accessible capital at lower cost

Weaknesses are:
- Some risk remains with the public sector;
- Liabilities are consolidated into public sector accounts;
- Founding the business has to comply with public sector procurement procedures.

Stakeholder-owned special purpose vehicle (SPV)

Similar to the special purpose vehicle but open up for more and flexible ownership as shared amongst a variety of stakeholders.

These stakeholders can be:
- The customers purchasing energy, for example major building owners within a defined location;
- Strategic bodies, such as the municipality, communities or cooperatives.

It may also offer greater accountability and transparency:
- Advantage of having access to public funding and grants, and to foster a cooperative-like business model.
- Owning the network reduces the risk of monopoly abuse and may also provide a useful way of gaining acceptance and buy-in to a project, by offering residents or communities a stake in the project.
- In reverse, municipalities can develop projects as public-owned ventures and once they are well established and costs and revenues stabilized, they sell them to private sector investors or energy companies, private companies or take an equity stake in order to increase their strategic control of a District Cooling project within their areas.

As the developers (SPV initiators) have reduced the project's risks during its vulnerable development phase, it will be worth considerably more than the initial investment and consequently they can expect a premium.

Considerations regarding ownership

The stakeholders in a city / municipality have some considerations for the evaluation of ownership and they can be the following:
- financial situation and levels for IRR
- level of control
- willingness for risk-taking

If there is no local energy company operating a District Heating business in a municipality, starting District Cooling from scratch and without financial ability seems to be one of the main obstacles.

7 REGULATIONS AND DIRECTIVES

7.1. CREATING A LEVEL PLAYING FIELD

As existing EU legislation shapes the legal framework for all, it is crucial for LG/LA to have an appropriate level of knowledge of these laws. Depending on the type of the file, those legally binding documents are either regulations with a direct effect themselves or directives that must be transposed into national legislation. In any case their aims and targets can only be achieved and their measures only be implemented through actions on the local level. With its actions, the local authorities are supposed to create a level playing field for all involved stakeholders to live up to the text of the primary legislation. This is also a case for (District) cooling.

The following list gives a short overview over the most important political files on the EU level which concern District Cooling. There are many more accompanying or deriving from those:

- SET Plan – The European Strategic Energy Plan (2009)
- Energy 2020 – Strategy for competitive Sustainable and European Economic Recovery Plan (2009)
- Eco design directive (2009) – The directive is aimed on energy using products including heating and cooling.
- RES directive (2009/28/EC). The directive on Renewable Energy Sources for making a framework on 20% renewable a reality for transportation, electricity, heating and cooling.
- EPBD Recast (2010/31/EU). Energy Performance Buildings Directive.
- Energy Efficiency Plan (2011)
- Energy Road Map 2050 (2011)
- Renewable Energy Communication (2012)
- The adopted EED 2012/27/EU – Energy Efficiency Directive: Member states should provide the national heating and cooling potentials and estimations of District Heating & District Cooling (DHC).

Of course those dossiers contain a vast number of details that do not concern District Cooling.
As an overarching momentum, it can be summarized that District Cooling has been recognised as one of the possible solutions for reaching the key objectives in the EU 20/20/20 goals until 2020.

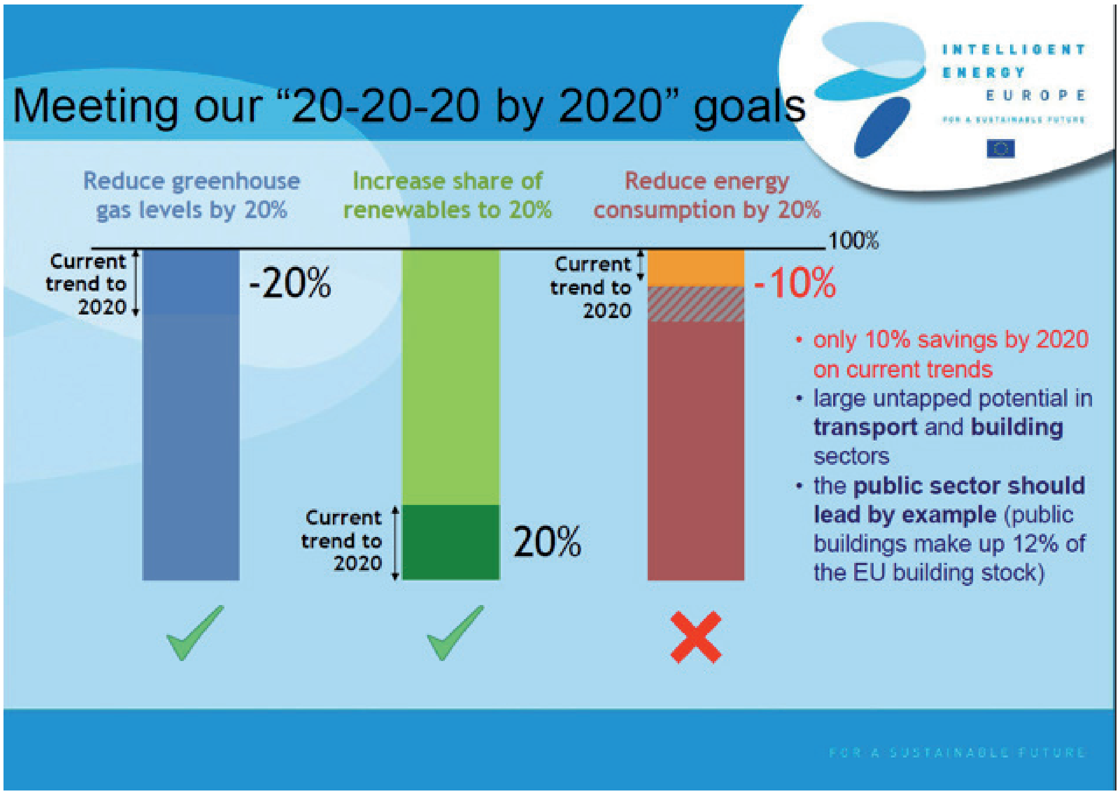


Figure 4. The 20/20/20 goals. Source: (Intelligent Energy Europe)

Those 20/20/20 targets were to be translated into national targets and legislation. Local authorities are now supposed to explore their options, including district cooling.

7.2. EUROPEAN DIRECTIVES, ENERGY EFFICIENCY DIRECTIVE (EED)

The directives of the European Union gain legal standing in Member States' national law only by being transposed into national law by each Member State's legislation.

The directive having the most direct influence on the development of District Cooling yet is the **Directive 2012/27/EU on Energy Efficiency (EED)** (which repeals the earlier directives 2004/8/EC on cogeneration and 2006/32/EC on end-use energy efficiency and energy services). The EED was adopted by the European Parliament and the Council of the European Union in October 2012, and it had to be transposed into national law by the Member States by 5 June 2014.

The EED specifically acknowledges the Covenant of Mayors initiative and the role of local authorities in achieving significant energy savings, and calls for **Member States to encourage municipalities and other public bodies to adopt integrated and sustainable energy efficiency plans.** Exchange of experience between cities, towns and other public bodies should be encouraged with respect to the more innovative experiences (Preamble (18)).

The directive also requires Member States to provide data on public buildings and their energy performance (Article 5 (5)), and to encourage public bodies including regional and local government to adopt an energy efficiency plan (Article 5 (7)). Data on energy performance of buildings is an essential input into modelling future District Cooling systems during the scoping or planning stage.

Article 7 (9) allows for alternatives for Member States to setting up an energy efficiency obligation scheme under Article 7 (1), which includes “regulations or voluntary agreements that lead to the application of energy efficient technology or techniques and have the effect of reducing end-use energy consumption“ (Article 7 (9(c))). While this obligation aims to introduce energy efficient technology, the focus on reducing end-use energy consumption rather than primary energy consumption is the weakness of the Directive and it may hinder the development of primary energy efficient District Cooling.

The directive also asks for the provision of individual time-of-use metering where possible for electricity, natural gas as well as District Heating and Cooling (Article 9) and requests that final customers receive their billing and energy consumption data for free (Article 11 (1)). This article impacts on the metering requirements for serving District Cooling customer.

While articles in the now repealed Directive 2004/8/EC on Cogeneration already obliged Member States to identify the whole potential for useful heating and cooling demands, as well as the availability of fuels, (Article 6 (2)), these articles have now been strengthened in Article 14 of the EED:

Article 14 requires Member States to comply with the following main obligations:

- Carry out and notify by 31 December 2015 to the Commission a comprehensive assessment of the potential for the application of high efficiency cogeneration and efficient District Heating and Cooling-based, on a country-wide cost-benefit analysis, following a given methodology. The assessment should be updated every five years, if the Commission asks for this at least one year before the due date (Article 14 (1) and (3)).

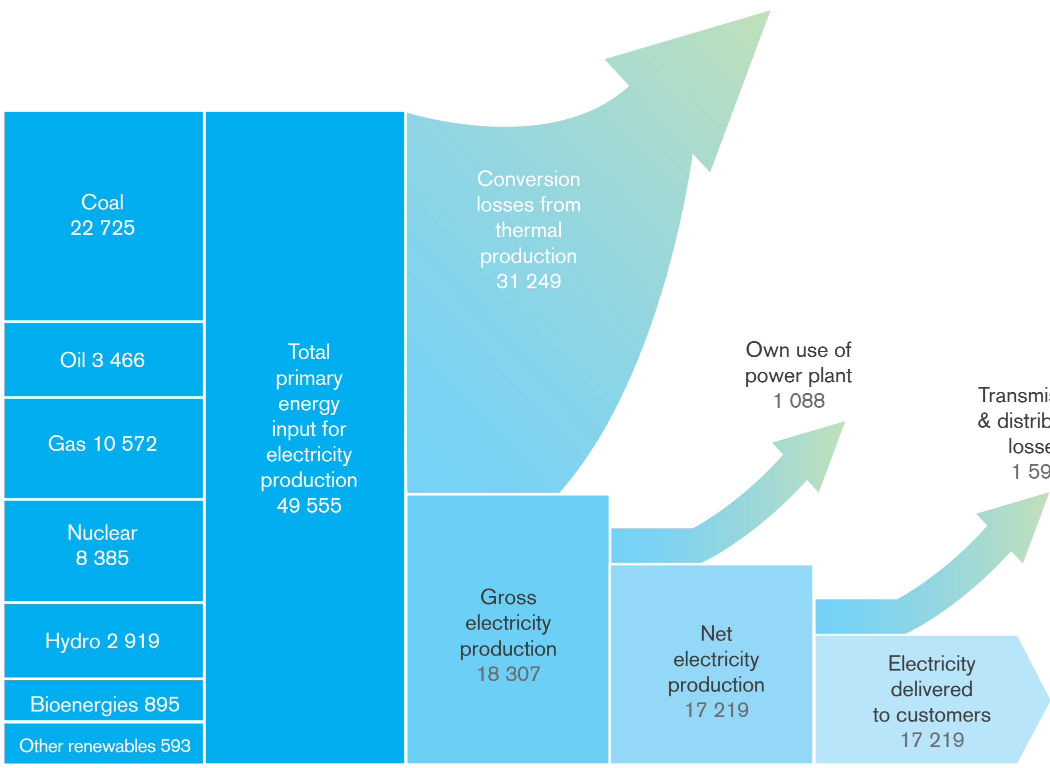
- Take adequate measures for efficient District Heating and Cooling infrastructure to be developed and/or to accommodate the development of high-efficiency cogeneration and the use of heating and cooling from waste heat and renewable energy sources, where the comprehensive assessment identifies a potential whose benefits exceed the costs for the application of high efficiency cogeneration and efficient District Heating and Cooling (Article 14 (4)). These assessments should provide an essential foundation on which to develop and shape the energy supply options to be considered in any local authority’s sustainable energy efficiency plans.

- Adopt policies in relation to local and regional levels that encourage the due taking into account of the potential of using efficient heating and cooling systems, including the potential identified in the comprehensive assessment (Article 14 (2)). These policies to be adopted will have a direct bearing on the development local authority’s sustainable energy efficiency plans. Adopt authorization or permit criteria and procedures for operators of electricity generation installations, industrial installations and District Heating and Cooling installations ensuring that they carry out an installation-level cost-benefit analysis on the use of high-efficiency cogeneration and/or the utilization of waste heat and/or connection to a District Heating and Cooling network when they plan to build or refurbish capacities above 20 MW thermal input or when they plan a new District Heating and Cooling network (Article 14 (5)). These criteria and procedures will directly influence how operators of energy plant have to evaluate and consider District Cooling as a possible option in their planning processes.

7.3. ENERGY IS NOT ONLY ELECTRICITY

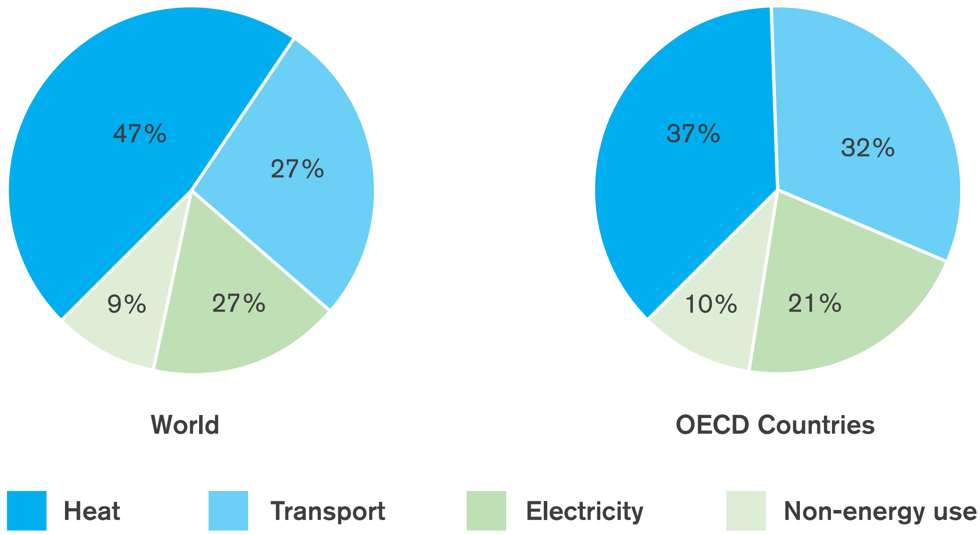
District Cooling as solution is not that well-known amongst local authorities. This is not so surprising when looking back on general surveys on future energy supply. Many reports do define energy primarily as electricity. This wrongly leads to the impression that a) climate change issues can be overcome by solely dealing with electricity and b) electricity is the only sector to be dealt with. First, heating and cooling account for 50 % of Europe's energy demand. Without focusing on sustainable heating and cooling solutions, nothing can be won. District Heating and Cooling are such sustainable solutions because they have a large potential in reducing the need of separate production of electricity. But to get there, a paradigm shift must take place in order to recognize the possibilities of District Heating and Cooling.
First, it must be acknowledged that energy demand does not equal electricity demand. Then, it must be underlined that DH/DC can utilize surplus energy that otherwise would be wasted. The aim should be on replacing electricity with energy savings. District Cooling is one of the possibilities.

As the figure shows even the primary energy used for electricity production only ends up at the user to one third.



Source: IEA, CHP: Evaluating the Benefits of Greater Global Investment (2008).

Figure 5. Primary energy demand for electricity in the world. (IEA, 2008)



Source: IEA, Cogeneration and renewables: solutions for a low-carbon energy future (2011)

Figure 6. Heat demand. (IEA, 2011)

As can be seen in Figure 6 the global heat demand is three times larger than electricity but still all the focus is on electricity.
Surprisingly, District Heating, combined heat and power or District Cooling have been largely overlooked in many of the reports, published by the European Commission, WEC, ECF (European Climate Foundation), Stanford University, WWF and IEA. Focus is often only on electricity and how it is produced. The heating and cooling sector is very large and it provides substantial low carbon solutions. The Heat Roadmap Europe is one of the studies where DHC and combined heat and power were not overlooked.

Also, the IEA figure above does not include any separate information on cooling. This is unfortunately common. Cooling is dominated by electrical chillers. There is no separate statistics on used electricity for cooling. However, it is known that the world electricity usage is to a high extent for cooling. For this reason the EU obliges Member States in the Energy Efficiency Directive to assess the potential of DHC and based on this obligation local authorities should explore District Cooling as an option.

Although the heating and cooling sector is very large in size and already provides low and no-carbon solutions, it has largely been overlooked in all scenarios exploring the energy future towards 2050. The **Energy Roadmap 2050** published by the European Commission rightly acknowledges that **renewable heating and cooling is vital to decarbonisation** and that **a cost-optimal policy choice between insulating buildings and systematically using waste-heat** needs to be found. Yet, the Roadmap omits a thorough analysis of the heating and cooling sector.

Source: (European Climate Foundation).

7.4. LOCAL AND NATIONAL REGULATIONS

Local governments are the frontrunners of mass movement towards a vision for the whole community by setting policies, strategies and related regulations. If there are no regulations on District Cooling in the municipality, local governments should use the possibility to adopt supportive regulations on District Cooling development.

Examples of supportive regulations:

- Using existing regulatory framework for buildings and adapting them to encourage District Cooling development or even in some cases putting some obligations for new buildings to connect to District Cooling networks
- Coordinating and facilitating permits for major road excavation works – laying District Cooling pipelines – are the best supportive measures with that local governments can ease the whole process.

Where applicable, local governments should support the right to use water for natural cooling (i.e. rivers, sea water, lake water) and support land use applications for cooling plant, bearing in mind the needs of the environment. Local governments can ensure a smooth deployment of district cooling by introducing the feed-in-tariff or a district cooling bonus.

Supportive regulations are not restricted to regulations that directly promote or facilitate the uptake of District Cooling but can also include regulations that restrict the use of alternative actions or technologies. For example, restricted permissions for building local cooling towers and dry liquid coolers on rooftops do not only support District Cooling but also have benefits for community health by reducing risk of legionella disease and have benefits for the environment by preventing dust and also reducing leakage risk of refrigerants. Another example could be restricting the use of split-units on facades which drives the building owners towards District Cooling options. Also placing a carbon tax as a burden on carbon intensive technologies directs the market to low carbon emissions solutions such as District Cooling.

Once a network is established and buildings have got access to district cooling, a requirement for all new cooling installations within the reach of the network to connect to the system rather than to install own capacity assists that maximum advantage is extracted from the network investment.

Since DC networks and a cooling plant are major capital investments, long term (20-30 years) concession agreements are required by any third party investor/operator in order to have investment certainty.

Any regulations on maximum energy use in buildings should be based on primary energy use, rather than metered energy use into the building. The latter method disadvantages DC, since the opportunities provided by DC to supply cooling energy into the building with a much lower use of primary energy are not captured in the comparison.

8 ENERGY MASTER PLANNING AND SEAPS

How do project initiators go about identifying suitable projects or approaches to serve the local market with energy supplies? Energy maps are commonly used by European community planners in conjunction with community energy planning processes. Many communities already have Sustainable Energy Action Plans (SEAP) or Energy Master Plans, and revising those by integrating cooling and heating considerations can open up a range of new opportunities. In cities, with a comprehensive plan or a plan for new development, or redevelopment of specific areas, municipal leaders may be able to consider plans in the context of local energy generation potential or carbon footprint reductions. Many cities are planning new development areas that would benefit from concepts with District heating & cooling.

Although energy maps energy maps are not a prerequisite to project development, they can contain a basic information on demand and outline suitable technologies and approaches to new ways to fulfil future energy demands.

They can also support planning policies and become the base for energy strategies for new developments, revitalization projects, and to highlight priorities for projects.

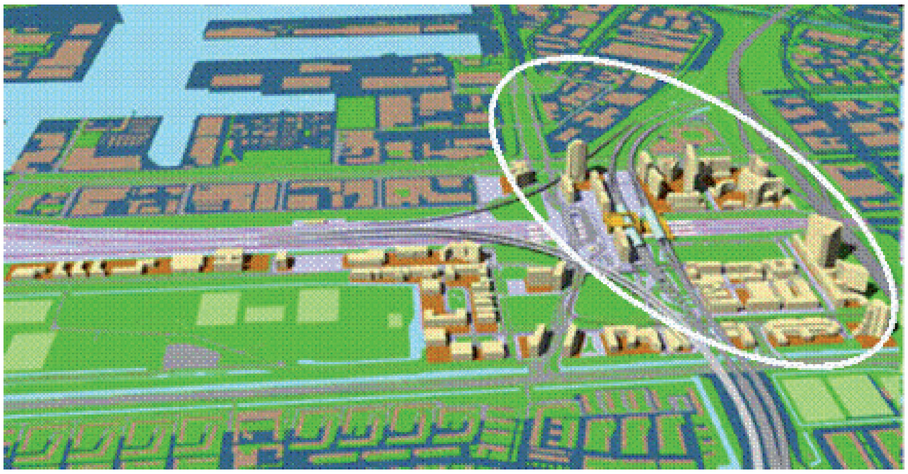


Figure 7. Energy mapping. Source: (City of Amsterdam, 2007)

Other reflections that can support District Cooling energy infrastructure solutions in the planning process are:

Local authorities:

- Encouraging compact development; it will improve the efficiency of district energy systems while reducing capital costs.
- Consider district energy-ready buildings by ensuring that proposed building design and systems are compatible with district energy.
- Green building standards that focus on primary energy.
- New buildings in a specific district energy zone could be required to demonstrate a higher standard to reduce its carbon footprint.
- Standards that set an electricity conservation target could discourage the use of power-driven systems.

Local energy Company:
In order to reach high return temperatures, district cooling operators must possess the technical expertise of the cooling systems inside the buildings. A higher temperature differential (difference between supply and return temperatures) reduces the flow of the medium in the distribution system. Then smaller pipe dimensions can be used in the District Cooling grid. Additional aspects of this include more efficient production and using less primary energy resources. The District Cooling system will be affected on how the on-site building cooling system performs.

8.1. INCLUDING DISTRICT COOLING IN A SUSTAINABLE ENERGY ACTION PLAN (SEAP)

The idea for Sustainable Energy Action Plans was born by the Covenant of Mayors. The initiative aims at reducing their CO_2-emissions by 20 % and more. Signatories to this initiative, i.e. cities, towns and regions, outline their plans on how to reach this target in specific documents, the Strategic Energy Action Plans. The dossier transform the long-term strategy, i.e. to decrease emissions into a project. The documents explain the concrete measures to be taken, time frames and responsibilities. However, the SEAPs are not static documents but can be developed and adjusted in line with future regulatory and technical developments. As heating and cooling account for half of the EU's primary energy consumption and an even higher share in the cities' energy balance, they play a crucial role in the signatories course to achieve their targets.

Sustainable energy action plans are documents of a certain form that the Covenant of Mayors (CoM) has defined. Covenant signatories have to develop such a plan to state how they intend to reach their CO_2 reductions targets, which have to be a reduction of 20 % or more. It is therefore voluntary to develop such a plan. Apart from these SEAPs elaborated as part of the application process for the CoM , there are similar documents in other cities that contain similar information.

Once enacted these SEAPs (or similar documents) should be a consistent guideline for the municipality's actions.

These plans cover all sectors: industry, mobility and domestic and business houses.

The Sustainable Energy Action Plan (SEAP) is a key document that shows how Local Governments will reach their energy commitment by 2020. It uses the results of the Baseline Emission Inventory (BEI) to identify the best fields of action and opportunities for reaching the local authority's CO_2 reduction target. It defines concrete reduction measures, together with time frames and assigned responsibilities, which translate the long-term strategy into action.

Source: (Covenant of Mayors, 2013)

A SEAP is a formal planning document created by and for a Local Government (LG) to outline a pathway to a community's sustainable energy transition and how to reduce greenhouse gas (GHG) emissions, in particular carbon dioxide (CO_2) and methane. It maps how the municipality and community intend to achieve emission reduction by changing the way energy is used in the whole community within a specific timeframe.

Source: (capaCITY, 2013)

SEAPs are valuable tools that can be used to plan and monitor progress in all areas or sectors where energy is produced and used. District Cooling is one of the important sectors that will help a community to reach its sustainable energy goals, which are set in SEAPs. For that reason, including DC in a SEAP not only facilitates the planning and implementation process of DC systems but also ensures the involvement of key stakeholders at appropriate times, thus acting as a powerful communication tool between stakeholders.

Including District Cooling in SEAP is meaningful from the perspective of the implementation in the community. The reason is simply that a measure included in a SEAP needs, a political consensus and a decision in the local council, which implies that there is a political will from the local decision makers. Secondly, it can be used as a guidance document for the municipal staff who needs to act as a transfer medium between technical experts and citizens, businesses and industry.

In any cases described above some key elements are common, which may be summarized as:

- set a target for District Cooling implementation in Local Government premises and/or for the whole community, i.e. within the city geographical borders as a clear vision of the emission reduction potential and aim,
- define actions and measures to implement to reach the set target for District Cooling.
  Those actions should define:
  - more detailed explanation of what will be done, also including soft measures like information sharing and awareness raising,
  - who will lead the action,
  - which actors will be involved in the action, i.e. stakeholder screening,
  - allocated staff capacity,
  - foreseen financing of DC projects and possible sources,
  - timeline for planning, implementation, monitoring, evaluation and reporting.

These should be identified and included in any SEAP.

District Cooling should be included in any Sustainable Energy Action Plan (SEAP) irrespective of the development stage of DC in the community. The concrete actions to be suggested depend on the stage of DC investigation or implementation in the community.

Where no District Cooling system exists or has been investigated before, the first scoping study of the feasibility, attractiveness and commercial viability of a DC system should be made part of the SEAP. The tool developed within the RESCUE project provides a valuable source to assist this process in the first scoping study. It should be borne in mind that a staged process of starting with a relatively small DC system and expanding the system at later stages would be the most likely approach.

In cases where a District Heating system is already in operation in the community but no District Cooling, the feasibility study of developing DC in connection with the District Heating system should be suggested as an action in the SEAP. The operator of the DH system, in this case, is the key stakeholder to work together with, in order to be able to fully exploit the technical and operational synergies available in operating the DH and DC systems together.

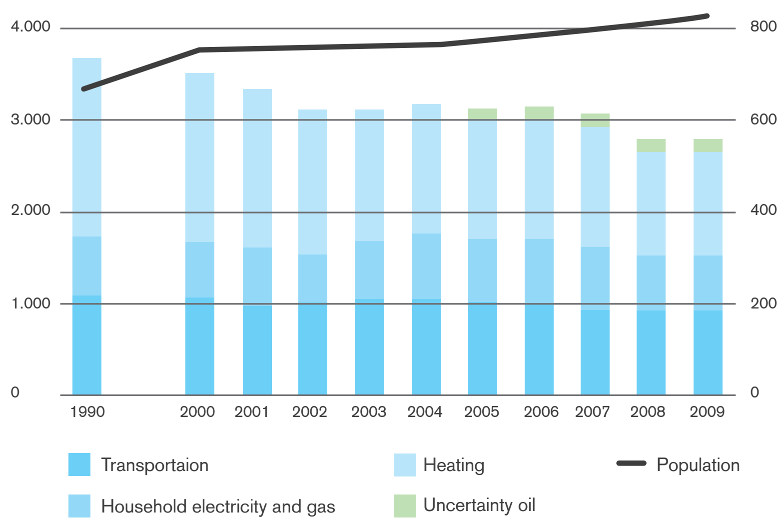
[1]SEAPs listed on the Covenants website: http://www.covenantofmayors.eu/actions/sustainable-energy-action-plans_en.html

In a municipality where an energy master plan has already been conducted and has shown encouraging results, a more detailed and in-depth feasibility study should be conducted as part of the SEAP. This step is to be taken to be taken in extensive cooperation with internal and external stakeholders as described above, and would also include a full investigation of ownership and financing options.

Where a small cooling system supplying a cornerstone cooling load already exists, the commercial viability of a network extension to supply more customers should be investigated, likely in connection with introducing favorable regulations.

In municipalities where a mature cooling system is already in operation, any actions in the SEAP would be more targeted at improving the operation and efficiency of the system, assessing the opportunity for network extension and for further connections on the existing network, e.g. by encouraging further connections through favorable regulations.

SEAP cannot limit the content on the existing market and possible changes. Infrastructure on energy supply requires long term-commitments. An important perspective is given by the scenario for population growth in the municipality. Are there trends of people moving into the city area? Will this lead into more people working in the city areas? More buildings and space utilized for offices is a sign for higher future cooling demand. If traditional local cooling solutions are to be used, this will lead into higher electricity demand and also risking that the existing local electricity grid becomes a bottleneck. In the context of such a trend, DC can reduce the need of investments on electricity infrastructure. The Figure 8 is from the Stockholm SEAP and can serve as an example that population growth does not automatically lead to higher CO_2 emissions. In Stockholm, District Heating has a strong market position and the use of waste energy and biomass is rather high. During the same period, the expansion of District Cooling has been strong and the use of electricity for cooling has been limited substantially.



Graph 3: Reduction in the emission of greenhouse gases over the period 1999 – 2009 divided sector, and the population trend throughout the same period. The figures for 2008 and 2009 are preliminary. „Uncertainty oil“ is a statistical error that has been adjusted and reported separately.

Figure 8. Reduction in emissions of greenhouse gases.
Source: (Stockholm Stad, Environment and Health Department, 2010)

The extent to which it is possible to influence the local utility or other suitable stakeholders to investigate potentials for a District Cooling scheme in the city depends on the shareholder structure. Usually, a city will hold at least a minority of the shares of the utility, possibly coupled with extended participation rights.

Cities in Germany that already have District Cooling in one way or another are for example Munich, Hamburg, Frankfurt/Main, Stuttgart, and Berlin, although only Berlin mentions District Cooling as a way to reach the Covenant of Majors targets. This is hardly surprising though, since most SEAPs generally do not address cooling. In Berlin, there is no energy mapping or anything similar; District Cooling is simply addressed in mid-term measures in conjunction with District Heating.

Common reasons why District Cooling has not been included in the SEAPs include (Interviews, 2014):

"The content of a SEAP does not have a defined formula. There is no Statutory stating on that District Cooling should be included in a SEAP. It is more a matter of having the system knowledge and seeing all the options available on the market that can facilitate the process of a local authority on reaching sustainable energy targets."

"As SEAPs are voluntary agreements, they do not put any pressure on cities to investigate District Cooling. In many cases, cities were already too far in the process of drafting their SEAPs to still include DC in the first version."

9 CONTENT AND DECISIONS IN THE DECISION PROCESS

9.1. BUSINESS LEADS FOR MARKET AREAS APPROPRIATE FOR DISTRICT COOLING

Different ways to collect information should be done and new sustainable and economically sound solutions evaluated: e.g. cooling mapping or other ways to evaluate modern energy solutions for the local community.

Interesting areas for District Cooling should be found in the SEAP or energy master planning process.

9.2. "PRE-FEASIBILITY STAGE"

In order to define whether the selected specific geographical areas are suitable for a new market area for District Cooling, it must be looked into a concrete business case in some more detail where the demand profile, a feasible system concept and the financial estimations together with critical success factors are thoroughly analysed.

The main fundamental idea of District Cooling is to use local sources for cooling that otherwise would be wasted, in order to offer the local market a competitive and high-efficient alternative to the traditional cooling solutions. We need to collect the basic in-data for the evaluated business case, and indeed put most effort in understanding customer demands and preferences.

What should be considered:

- Strong demand, combining strong local real estate development within commercial real estate with a population of building area per geographical area.
- Flexible sourcing with possible access to natural cooling or waste heating/cooling.
- Key customer needs.

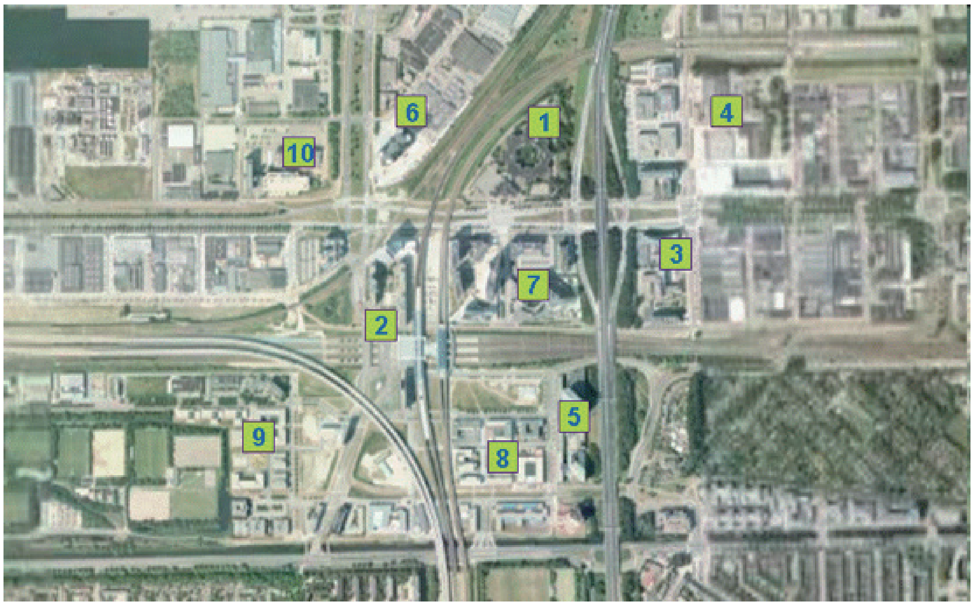


Figure 9. Energy mapping. Source: (Capital Cooling)

Time for the decision prior to a feasibility study

At the stage where local key stakeholders have a common platform for the business project, it is time to formalize it with a mandatory body that will define the project process for the development phase (i.e. until the start of construction). When the business case has been identified it is crucial to establish a leader actor for the project development process possessing District Cooling knowledge and ability to handle the financial issues for the development phase before the construction phase. Local understanding and relations in the local market and regulatory systems are also important.

When we look into existing District Cooling businesses today, these chief actors are already present by (existing) local energy companies or utility companies that identify themselves as the actor that can take the development work all the way through the operating utility phase. Other examples are local governments that have been acting as an initiator and at an early stage have invited industrial partners to join them on the basis of long-term concessions.

Regardless of chosen organizational set-up, focus first on the issues in the business process prior to construction. This is particularly critical in the case where a project actor has choices of different procurement, financing, and operation models etc.

Figure 10. Management focus for development of District Cooling. Source: (Capital Cooling)

A well-defined business process – with clear governance and decision stages

District cooling business requires relatively high investments. It is crucial to find the right path that can give the balanced development where investments in infrastructure are made step by step with revenues from customers connected to District Cooling.

The development period includes the feasibility study phase and business development phase before financial closure. The toll-gate between the feasibility phase and the business development phase is defined as investment direction decision (soft financial closure).

Set a project management & governance scheme

In order to have a clear decision process and ability to steer the project over time, it is wise to organize the project by designating a project manager.
Overall, the cost prior to the construction phase can amount to a significant proportion (between 10 % and 15% depending on project size) of the total capital cost of delivering the project.

Each stage has to be financed, of course, and costs increase progressivelya at each stage, see Figure 11. However, the risk of project failure declines as the process progresses. An appropriate sequence of steps avoids spending large amounts of resources without any effect.

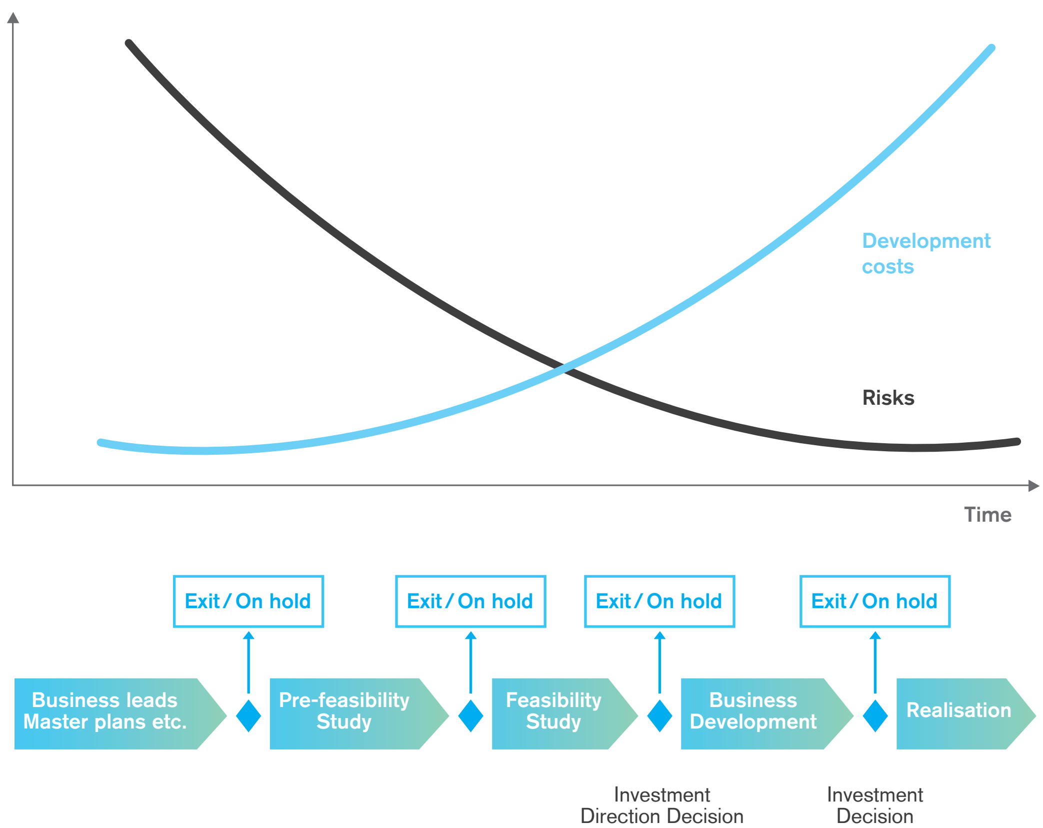


Figure 11. The early DC development phases with its costs and risks. Source: (Capital Cooling)

The diagram in Figure 11 also describes a Business Management Process. This process ensures operating efficiency with the least possible capital expenditure.
The Business Management process consists of seven stages with defined toll-gates upon the conclusion of each phase. It is important to safeguard Time, Profitability and Performance in each step.

A successful process requires genuine knowledge in respect to the following issues:

- Organisation understanding
- Market
- Technology & Engineering
- Finance

The following are key skills for the business project:

- Knowledge on and experience with Customers in the professional real estate market and the way to perform in this field
- Knowledge on and experience in Business management including TPP and risk management
- Project management of complex infrastructure projects
- Knowledge on and experience in designing, engineering, construction and operating and maintaining production of District Cooling, including environmental impact, energy market effects and DC technologies

When developing business projects there are issues that need to be managed through planning with "built-in" flexibility:

- Development of the District Cooling system needs to be synchronized with the schedule of new energy solutions realized by real estate stakeholders.

To manage these issues, the use of "Temporary Solutions" can be implemented to avoid major investment in the large infrastructure scheme and at the same time offer a customer an alternative solution when demand otherwise would force the customer to invest in his own cooling solution. A number of European municipalities have undertaken energy mapping studies as part of broader community energy planning initiatives. By identifying areas of existing thermal demand, future growth and density, municipalities can strategically direct their thermal energy infrastructure investments, for example:

1. Small networks developed around one initial customer, often linked to new development served by a small heat source
2. Networks expand and larger cooling sources start to emerge to meet growing demand
3. Networks begin to link to each other to share excess cooling capacity.
4. Original cooling sources are replaced as they reach the end of their lifecycle. A transition main pipe will carry large volumes of chilled water over long distances.

The capital, operational, and maintenance costs, along with likely revenues from heat, cooling, and electricity sales, should be roughly estimated at this stage, too. It should be noted that financial models for district energy projects are particularly sensitive to revenues and therefore they shall be well-defined.

It is appropriate to use a more sophisticated financial appraisal methodology. For example, discounted cash flow that takes into account future cash flows and discounts them to present-day values; and life-cycle costing that identifies avoided future costs such as reinvestments. This will help while analyzing the economic viability of the project and its affordability for customers.
Internal Rates of Return can be calculated and reviewed based on a variety of sensitivity analyses, including debt-to-equity ratios, weighted average cost of capital, and various forms of capital resources. Capital resources include bonds, loan guaranteed etc.
Public sector organizations or non-profit organizations generally view investment in infrastructure as a means to an end of achieving broader objectives and are willing to accept a longer-term payback.

9.3. FEASIBILITY STAGE

The next step is to address many of the key *How* issues and describe the most appropriate business model. Here it is essential to appoint a Business Manager at the earlier stage of the project.
This is very much to identify the right combination of skills, financial capability and how to organize these in a mandatory body that can take command of the development process to a construction phase.
Energy infrastructure is capital intensive. Developing local sustainable District Cooling scheme involve initial capital investments, where the upfront capital costs are high in comparison with traditional energy arrangements in the buildings where investment costs to some degree have been paid off. Consequently, the next stage has to involve an understanding of how innovative financing mechanisms and a smart infrastructure built up can overcome the high capital threshold and spread the costs and income side as efficient as possible. The financial approach will also need to address the lag between investment made during the project's construction and the commencement of revenue flows.
Many commercial building owners accept upfront payments when they enter a long term contract with a trustworthy delivering partner.

At this early stage it is also crucial to understand the project mandatory exposure and attitude to risk.

This determines the most appropriate business model in respect of the availability of capital (including the assessment of reasonable return) and of the operating risks. This, in turn, will provide the most appropriate method by which affordable energy can be delivered.

Market intelligence on the potential customer buildings is strategically important and should be a high priority for all the work being conducted during the Feasibility study stage; this would need special knowledge of functions and requirements of building installations of Heating, Ventilation, Air Conditioning (HVAC) systems.

Understanding of right timing

It is crucial to understand when it is the best timing for offering a new District Cooling infrastructure product in an area, development site, or building. A few examples of right timing are listed below. Obviously this timing will be different for various prospects that could see District Cooling as a preferred solution.

For example:

- when the on-site cooling system in an existing building is approaching the end of its lifetime and needs to be replaced;
- when a building is being refurbished, or a brownfield environmental clean-up development is being undertaken, and there is an opportunity to upgrade the energy system of a building;
- when a new building or greenfield development is being planned, particularly transit-oriented developments;
- if stakeholders in the real estate market locally have concerns about energy security, price volatility, long-term cost, or simply want to make a difference;

In order to get access to (parts of) cities and natural resources, it is important to focus on processes such as getting access handling permission that often require relatively long calendar time before getting permits in place.

The following relevant issues should be considered in order to be successful:

- Goals of the public authorities involved
- Relationship management and networking with relevant parties
- Communicating the good message on District Cooling and attitude towards relevant issues regarding environmental issues etc.
- In depth legal knowledge about relevant legislation and procedures accessible.

It is important to remember that the major infrastructure investment cannot be made before boundary conditions are met, i.e. permissions are granted. On the other hand, investments should not be made if they are not inducing enough positive cash flow right after the investment in comparison with alternatives. Steering on getting the main investments “Right On Time” are a large contributor to the project’s success. Other investments will be made in accordance with customer connections and are generally covered by the connection fees.

Steering and control

In all phases of the project it is useful to steer the business project on Time, Performance and Profitability.

- Time: Plan the activities in the project and make sure that they are performed on time. Not too early, not too late. Time and planning are guarded actively.
- Performance: All activities, deliveries and assets must have the right quality. District Cooling must be delivered as it has been promised. Striving for quality improvement of processes, deliveries, assets and service. Communicating pro-actively and openly with all stakeholders of the project.
- Profitability: Steering on maximum profitability of the project. Profitability is improved by spending less money and spending it later in time and receiving money more and earlier. Guarding and benchmarking budget and spending. Seeking for cost cuts, keeping in mind that spending is a prerequisite to earning. Project results (net present value) are more important than annual results.

In order to maximize the technical feasibility and financial viability of the project, especially for District Cooling systems, where a critical mass of demand is essential, it is decisive to gain commitment from partners and potential customers to participate in investigating the opportunity further. If sufficient number of commitments can be collected, then the outline of the project can be defined well enough to take it to the next stage.
A commitment could include a memorandum of understanding (MOU) or a letter of intent (LOI).

Different approaches to implement new District Cooling infrastructure business is to build a nodal network that involves development of smaller, localized district energy systems sized to meet the demand of the chosen area. Ultimately, these smaller systems would be linked together as market penetration allows and system interconnection merits.
This gradual approach is in line with energy strategies adopted by a growing number of cities for the emergence of extensive District Cooling networks over the long term. Meanwhile, developments need to be designed to be ready to connect when they are able to do so.

Risk and objectives

The financial model will be vulnerable to a variety of risks. Therefore, a risk assessment must be developed. Ideally, the risk assessment is drawn up with other stakeholders in the project as they may identify risks the project developer has overlooked. The risks need to be evaluated in terms of how likely they are and how significant would be consequences if they were to take place. Divided into categories such as high, medium, or low risk, they are allocated to the party best placed to manage them. For risks that remain with the project, strategies must be developed to manage them.
At the end of this exercise, there will be still risks that have to be handled. These will be monetized in the financial model, subjected to a sensitivity analysis of these risks.

The importance of the project actor's attitude to risk and the desire for its controlling needs to be established between the participating parties. Most organizations wish to minimize their exposure to risk but, as a general rule, risk should be assigned to the parties that are best able to manage them. However, transferring risk can have financial implications. Risk will be monetized and this could add to the financial burden carried by the stakeholder who accepts it.
Public sector project actors can generally accept a lower rate of return than private sector ones. They can also probably access capital at lower rates than private companies as debt providers can be more certain of getting their loan back. Consequently, if a project is transferred from the public sector to a private company, the weighted average cost of capital is likely to increase and this may affect the viability of the project. Furthermore, if the ownership of a project is transferred to a private company, then the host organization for a project may relinquish operational control over its future direction. This may not be a problem unless the primary objectives are long-term social or environmental benefits. For example, a municipality may want to develop a District Cooling project as part of the refurbishment of a run-down area. Low-cost energy may add to the pace and viability of an urban renewal program and generation package. As such, the municipality may be willing to take a comprehensive view as it knows that if the refurbishment is successful, it will stimulate economic activity, building developers will invest in refurbishment or new construction, property values will raise, and business sales and tax revenues will increase. However, a private company has more difficulties to take such a long-term view. The primary purpose for the property developer is to comply with planning obligations, build out the property for lease, and prepare it for sale and subsequent exit. They may somewhat be resistant to have a continuing relationship with the occupants through supplying them with energy. On the other hand, a longer-term operating arrangement may be an attractive solution giving building developers and the occupancies a flexible and reliable solution over time.

The system concept

At the feasibility stage a Pre-Design is conducted, which is aimed to become the main basis for the conceptual design.

This conceptual design should include:
- Overall description of the district energy system.
- Energy demand map of the area in the future.
- Principle drawings of main trace of transmission and trace of distribution network to the prospect buildings.
- Initial sizing of transmission network and one distribution system. This includes requirements for temperatures and pressure.

- Description and principle drawings of one Energy substation. Initial location of sites of Energy Substations.
- Description of the energy supply possibilities including supply requirement from the potential sources.
- Mapping of location of energy supply plants.
- Assessment of sourcing to qualify and quantify potential cooling sources.
- Description and principle drawings of end-user installation for typical new built buildings and for existing buildings.
- Identify requirement for permits and the like as well as associated costs and time need for receiving approvals.

9.4. INVESTMENT DIRECTION DECISION

The steering board or the board of directors takes the decision on further steps of a district cooling scheme.

At this point the development starts to drive costs so the following criteria should be reached for a decision to continue:
- A significant cooling demand in some area/ areas
- A DC solution that can be made in reality
- Profitability and the risk analysis
- Economical and/or environmental benefits for the society
- Budget for development
- Time and activity plan
- Next step

9.5. PROJECT DEVELOPMENT PHASE

This phase covers the period of developing the business case towards the construction phase.

Market and sales

Once the general project has been defined, even with preliminary project schedules and maps, it is important to develop the market stance project. It does not matter whether it is a municipal actor; a public-private partnership, or a third-party private investment, customers in the marketplace need to understand the benefits with District Cooling and why they should be connected. An elaborated market and sales plan for the local market is to be written, with the business proposal on a new cooling solution, which also outlines when and where the option planned will be available. Establishing a sales process and educating personal should be conducted within this early action.

Develop new customer contracts. Throughout the project development phase, it is important to build relations with potential end-users and frequently get input for their planning and at the same time inform and clarify your proposal. National, provincial, and municipal buildings serve as anchor customer demand and their energy requirements need to be fully understood, including timing of major renovations, equipment replacements, or adaptive re-use.

District Cooling is a business service that fulfils the cooling needs of the customers and therefore a successful District Cooling business development requires a strong focus on relations with customers as they constitute the core of the business, without customers the organization cannot exist.

District Cooling business depends on its customers. Hence, it is vital to strengthen the customers' loyalty and satisfaction in view that District Cooling service is a long term service and not simply a one-off transaction. District Cooling is a relatively new product on the market and therefore it requires an effective communication and marketing process to be implemented by the District Cooling provider in order to educate potential customers and provide them with deep understanding on the essence of District Cooling as a business as well as a technology.

Promote District Cooling as an option that brings an exceptional mixture of different benefits and the overall greatest total value highlighting more the values and performances than the actual cost.

Marketing and selling the idea of District Cooling (the presentation of the total value of District Cooling and the comparison with the costs of other cooling technologies options) plays an important role. In general, if these values are not well presented and understood by customers, they will be very reluctant to connect to the District Cooling. No District Cooling provider can afford to take this risk.
On other hand, other District Cooling benefits cannot be fully quantified in financial benefits to customers, for example the space gained from non-existent air conditioning equipment at the customer's premises can be converted into an extra rentable space. Obviously the revenue generated is the function of the type of activities that the customer wishes to undertake in this newly created space, e.g. commercial, office and it also depends on the location of building and market price for the rentable space. If local roof-top installations can be avoided on the customers' buildings and the space can be used for a lease or some sports activities, the added value of District Cooling is substantial.

Due to the nature of the business and in order to ensure that the business case is well understood, the information process is to be treated as a case by case process as there are a number of aspects which require to be addressed individually.
These different aspects are not limited to technical, financial or timing issues, which vary significantly from one customer to another, thus not allowing a mass scale marketing program that can reach out multiple customers and hence create a platform that could be more effective and timesaving. This reflects the fact that there are different types of customers, those who have their own air conditioning installation as well as a different type of cooling technologies and those who do not have air conditioning already installed as in the case of new construction development or a renovation program in existing buildings.

For clients who have already installed their own air conditioning units, it is very tricky to present the business case as an interesting alternative solution: their building electricity bills do not provide transparent information on the cost associated with running their stand-alone units. Clients often do not have a clear figure of the associated costs including O&M contracts and the necessity of re-investment planning. It is always harder to negotiate a DC connection with a customer who already invested in new chillers. However, there are options on a negotiation into a compensation agreement for acquisition of the existing chillers.

The district cooling company needs to decide what amount of budget shall be allocated for the development of marketing strategies reflecting financial targets and long-term business vision.
To this end it is essential that District Cooling business allocate enough resources, time and budget for marketing, sales and communication activities.

From a strategic development prospective marketing strategies should focus on the areas where District Cooling infrastructure has already been installed and/or in a position for future network expansion. Potential customers should be engaged as soon as possible with a given priority to specific customers located in strategic locations.

The energy utility should conduct a deep marketing research, contact all the possible clients located in an area in which a new structural pipework is to be installed in order to intensify the network as much as possible. It is not always recommended to search for clients far away from the location of the existing network or intended route of network developed as costs rise significantly for installing extra meters of pipework.

By keeping records and obtaining valuable information from customers (status of air-conditioning installations, the year of installation etc.), the organization can easily identify the transaction window opportunity. The transaction window opportunity refers to the period of time when customers are faced with the need to replace the air conditioning units, effectively creating an energy mapping per zone which – combined with information gathering – provide the accurate potential cooling load in the area.

The purpose of the marketing strategy is to identify potential customers such as building developer, banking institutions etc. that may own multiple properties in the area of the district development. As for any other product a repeated business will benefit the District Cooling business in multiple ways, these are clients who have understood the full benefits of the District Cooling product thus saving the DC provider time and sales effort.

The market and educational process requires a full engagement of the District Cooling provider to tackle the technical client's connection issues. Customers are to be informed about of the importance on performing the operational temperature differential ΔT of the District Cooling network in order to ensure maximum efficiency of the District Cooling production as well as for optimal building internal comfort in buildings. Development of technical requirements for the connection to District Cooling and approval procedures before connecting to DC supply are essential in order to affect the future system ΔT. Reaching the design ΔT is not to be expected automatically. Preparation of an action plan for paying attention to this issue is recommended.

Customers often do not possess the technical knowledge to deal with this issue and it is therefore recommended that the District Cooling supplier support the clients in this process.

The new customer's connection often requires modification to the building's air conditioning units in order to meet the District Cooling network requirement. Therefore, it is essential that this issue is dealt with during the marketing process.

It is important that customers understand that ΔT requirement and the fact that its neglecting will correspond to extra costs for customers as the energy provided to the clients' physical points is a function of ΔT. The lower delta will correspond in an increase of water supply thus increase their billings.

Amendments in national policies have an effect on the market with air-conditioning installations and -indirectly- a serious impact on the success of district cooling. For example if a new law is approved by local or national governments, such as the change or ban of a specific type air conditioning refrigerant, it obliges the clients to modify or even replace their air condition units and thus providing a unique marketing opportunity.

There is a number of marketing strategies that can be implemented by the District Cooling provider as follows:

- Production of guidebook for customer's information covering aspects such as schemes of installation, issues and procedure and advice for optimal client's connection into network.
- Statistics analysis of customers energy usage providing valuable trends that can help the District Cooling provider in decision making and to ensure the improvement of quality of service.
- Marketing Satisfaction questionnaire -valuable feedback in regards to the quality of services provided and the customers' level of understanding of the product. The questionnaire can also provide valuable input for to better response to their needs and therefore put in place proper action that can keep the customers. This also shows the organization cares about the customers and gains their loyalty.

There are many variables that are required to be taken into account that it is impossible to get it simply with a quick phone call. The utility company is required to inspect the proposed route for the pipe connection, both underground and above ground, the availability of capacity that can be delivered in the area with the existing network i.e., if capacity cannot be delivered from the existing pipework, the structural extension structural extension of the network will then be necessary in order to be able to provide new customers with the requested capacity.

Sales process

Sale is the backbone of the District Cooling business, as it is the source that generates revenues and therefore it is essential that the organization ensure its correct implementation. The sales of District Cooling product differs from the common process and procedure currently used from the other utilities companies as it is not the product that can be purchased off the shelf at any given time according to customers wishes which to some extent follow short of customers expectation emphasizing the need of the educational and marketing strategy.

As for an internet, telephone, electricity connection most customers are used to obtain a quick response regarding estimation prices and connection time, they take for granted the availability of service. This is due to the fact that of difference in the level of infrastructure, these utility services cover most of urban areas whereas District Cooling network is situated within the boundaries of a city district.

Customers should understand that the process of connecting a client into the network takes time and resources and it cannot be always guaranteed. Before connecting a new customer, the District Cooling provider needs to investigate a number of issues, such as the availability of capacity to be delivered to the clients and the availability of space in the intended route in which the pipework is to be installed.

This is a process that requires time and that can greatly affect the sales process. An example in the case that for technical reason a longer route is required thus installing extra length of pipework which results in extra cost or in the eventuality of finding trace of asbestos that requires special removal procedure, adding extra costs.

The need to deal with the above mentioned issue results in a significant time delay before the cooling provider can provide an estimation cost to the potential clients. Sales opportunity is missed if time delay of connection does not meet requirements of customers.

A transparent and accurate billing system will ensure the trust and loyalty of the customers in regards to the level of services provided. The last thing the provider wish is to have customers that feel that they have been ripped off which will affect their reputation and thus affecting sales.

Some suggestions can be for example:

- 24/7 customer services
- Creation of client customers service space to have a real time consumption supervision access
- Inform clients that delivered supply temperature to customers is lower than the contractual and that this has created savings to clients due to the increase in ΔT (lower volume flow rate).
- Create an accurate billing system procedure and to provide different types of payment method to the customers, this creates flexibility and it will better respond to customers' needs.
- Telephone and email customer services and support

Once again the type and number of measures depend on the organisation decision of the budget available and budget that wishes to allocate.

Permitting related issues

Permitting processes can be exposed to a high risk and cause delays, thus generating additional costs if it is not addressed in the format and formal procedure, which is valid in the specific country.

In some countries this can be an issue regarding natural cooling. For example, in Germany, rivers may already be too polluted by thermal energy and thus no additional permit may be granted. The same applies for using ground water that may be protected. Necessary permits need to be addressed and the permission procedure and granting's secured prior to the next construction phase.

Due to the nature of the work required in installing pipe network in the city streets and in building DC plants a number of permissions are to be acquired before work can be commenced as for example:

- Excavation work in public road will cause disruption to the local community and business activities.
- The delivery of heavy equipment, it might require road closure for an extended period of time
- Permit to use cooling source.

These permitting requirements can vary significantly depending on the location and local / national policy and it involves a communication channel with municipal and national agencies dealing with a DC plant, District Cooling water distribution pipes and system water discharge back into natural sources or city water systems.

In order to ensure a smooth development operation, the utilities' clear vision on the associated requirements and constraints enables engaging as soon as possible in transmitting all the required documentation to the relevant authorities.

Water is a key component of the District Cooling technologies as it is used for the different processes of cooling energy production and therefore utilities are obliged to guarantee the quality of the different usage of water and also sewage and effluent to the air.

Procurement

The procurement process can follow the following steps described below

Figure 12. Procurement process. Source: (Capital Cooling)

Procurement preparation
In the first phase, reviews and identifications are made for the overall objectives of the procurement project such as category strategies, key requirements (technical, project, operational commercial, etc.). Conclusions of request for information/pre-qualification report and a preliminary procurement plan are set up.

The Request for Purchase (RFP) package is prepared and finalized taking into account the procurement objectives and all essential requirements. Appropriate evaluation models and tools are defined.

At this stage it could also be wise to run activities necessary to submit and follow up the Request for Purchase, e.g. answer / respond to supplier questions regarding the submitted RFPs. An evaluation model is developed and evaluation instructions, evaluation tools and report instructions are produced and agreed with the project team.

Tender evaluation

Once the suppliers have submitted quotations fulfilling the requirements of the RFP, all evaluation activities are performed, such as technical evaluation of the quotations as well as their project related evaluation, operation evaluation, price/cost evaluation, commercial evaluation and compilation of the preliminary evaluation report including a negotiation short list.
This phase includes preparation of the forthcoming negotiation phase, including the preparation of a Negotiation Plan (which includes negotiation objectives, negotiation strategy and tactics, etc.).

Negotiation phase

During this phase, all necessary clarification sessions, initial and final negotiations are performed. Negotiation results are documented in commitment letters, updated tender documents and protocols or similar. The objectives of said negotiations are to be found in the agreed Negotiation Plan.

Once all necessary negotiations are completed, the result of the negotiation is evaluated and documented in the form of a final evaluation report (including a supplier recommendation, recommending one or more suppliers). This phase also includes the drafting/preparation of legal documents i.e. Letter of Intent etc.

Contract finalization

The purchaser awards the contract to the selected supplier(s), at its own discretion, based on the Procurement Team's negotiation evaluation and supplier recommendation. The award may be conditional if so desired by Purchaser.

This phase may include the release of a Letter of Intent (or similar) by the procurement team to be signed by the purchaser to the selected supplier(s), in the event that an interim agreement is deemed needed.

Execution

After the contract award, the actual contract is finalized and prepared to be ready for execution. The result of the negotiations is properly integrated with the agreement(s).
The contract(s) are duly executed by the purchaser and the contractor. If required (i.e. if the initial order is not automatically triggered through the execution of the framework contract) a separate initial call-off through a purchase order may be issued simultaneously, or at such later time as may be desired by the purchaser.

Securing financial solutions

Challenges in obtaining the funds require carrying out the planned investments. Financial institutions and TSOs generally believe that the planned investments in the period to 2020 can be financed, given suitable regulatory frameworks. However, raising the required capital on the debt and equity side to meet the increased annual investments requires substantial efforts.

If there is no municipality or local energy company or a large international infrastructure company that can finance the DC scheme, only private equity or venture capital can step in and they often want very high return rates, 15-25%, and they want to put in as little equity as possible so that it is hard to get the other part, the debt lenders wanting a large part of equity to decrease their risks. The debt lenders also only step in when the project is financially closed, i.e. when all the major risks are managed and all customers are on board. Therefore the problem of financing the early stage remains the issue.

9.6. INVESTMENT DECISION

Here, the steering board or the board of directors takes the decision whether they want to invest in the DC scheme or not.

At this point, the real investments start so it requires a good decision analysis containing:
- Permits to use local cooling sources
- Permits to build a DC network
- Permits for a production plant
- Contracts with key customer or a certain percentage of the market already contracted
- Investment resources
- Profit and risk analysis
- Organisation
- Business and market plan

10 PRACTICAL ADVICE FOR UTILITIES

10.1. KEY REASONS WHY DISTRICT COOLING HAS BEEN DEVELOPED

There are many reasons why utilities or energy companies have started up District Cooling schemes but here is the summary of the most common reasons from the interview DC providers, Rescue report WP5.3 (Tvärne, 2015).

- Top management who believes in the District Cooling business
- Competition – be able to sell both heating and cooling
- New interesting product on the market
- Outlook of a potential profitable business
- Sell more district heating and to be able to produce electricity in the CHP installations in the summer period
- New Environmental product
- Demand from building owners (these serve as key customers then) possibly caused by restrictions from the municipality (concerning facades and re-cooling devices)

All reasons were listed from energy companies that already operate a district cooling scheme. The meaning is that a business- and market-driven approach and the environmental aspect of District Cooling will assist creating the the environmental image for the whole energy company. In Sweden and Finland, a strong driving force has been the competition between District Heating and heat pumps‘ sector and the ability to produce more electricity during summer period using excess heat.

In Germany, there has not been much development in the sector, due to a lack of strong driving forces for the development of District Cooling. Some companies look into District Cooling in order to make better use of the existing production facilities in District Heating but mostly do so based on absorption chillers at customers’ premises. Another option is also desiccant cooling (adsorption), where sorption rotors are used in ventilation units. By adding or removing water from the air, its temperature decreases or increases respectively.

10.2. KEY SUCCESS FACTORS

There are a lot of reasons why a successful District Cooling scheme has been developed but according to the interviews, the main critical success factors are:

- Top management that believes in DC and is prepared to take risk developing it.
- Dedicated and specialized personnel with the expertise to develop DC
- Good local conditions for district cooling
- Strong market focus and right pricing

Top management

To be able to develop DC, the top management must believe in creating new business.
Developing DC means making big investments comparable to developing district heating. The investments are high and the ROI is rather low but when the DC system is in operation the revenue is secure.

Strong focus on market issues

This is one of the most important key success factors to get a successful DC scheme. As for any other business, the DC system's financial profitability (or at least stability) must be assured for it to be attractive and to last over time. All successful DC systems have had a strong focus on market issues.

Potential market
Identification of potential customers and their demand is critical for a successful project. The first step is the investigation of a rather large area in order to get an general overview. By investigating a large area, the most interesting sub-areas can then be identified.

An interesting sub-area is characterized as following:

- A number of customers with a steady cooling demand.
- Possible to connect into a distribution cooling network.
- Not too far from the intended cooling production plant location.

The first step can be taken by potential customers who initiate the first contact. However, it is more likely that the project is initiated by City officials, the local district energy provider or another major energy supplier.

In all cases, for example in Sweden the city/municipalities register of refrigerants gives valuable information on machines using refrigerants. Since this register also includes heat pumps and other machinery using refrigerants in addition to chillers for cooling, further investigations are always decisive.

Potential customers
Potential customers within the most interesting sub-areas are characterised as following:

- A stable, high demand for cooling.
- All year round cooling demand is an advantage, a high base load demand also during the winter season makes a potential customer especially interesting.
- Companies with focus on environmental awareness and sustainability are often interested in District Cooling.

- Companies, such as data centres, medical industries and research centres, with extra demand for backup systems can keep existing internal system for backup while using District Cooling as their primary cooling supply.

For many customers with office spaces in existing buildings, cooling demand gradually increased; a more frequent use of computers and a higher "employee per square meter" rate due to growing business etc. are factors resulting in higher cooling demand.

Customers' cooling demand
An essential part of required preparations for the start-up of a District Cooling project is to define potential customers' cooling demand. Both overestimation and underestimation of the cooling demand will be harmful to the project's economy.

Overestimation of the cooling demand may lead to an oversized cooling production plant and therefore too high investment costs. A project based on overestimated demand figures may be never feasible.

Underestimation of the cooling demand may lead to lost opportunities since new customers must be rejected.

Competition – Customer's alternatives
District Cooling system's competitors consist of on-site cooling systems installed locally by each customer. The most basic and also most common individual customer systems show rather poor performance and are usually not competitive with District Cooling.

Examples of basic types of customer's alternatives are:
- Direct cooled "rooftop" type of chillers.
- Chillers cooled by dry coolers.
- Chillers cooled by wet cooling towers.
- Individual, small wall-mounted coolers.

Other more advanced systems with better performance are competitive with District Cooling under certain conditions.

Examples of more competitive alternatives are:
- Aquifer systems
- High efficiency chillers cooled by wet cooling towers.
- Other geothermal systems
- Natural cooling systems with a river, the sea or a lake as cooling source.

The potential customer will compare its existing solution with the offered District Cooling solution. Even though "soft" advantages with District Cooling, such as sustainability and improved local environment are important, most customers in the end go for the solution showing the best total economy. Therefore, the District Cooling supplier must play an active role in the customer's calculation of his existing on-site cooling production costs. Many times a customer is not aware of the total costs attributed to his cooling system; costs for maintenance, spare parts, overhaul and operation under part load conditions tend to be neglected.

Correct pricing

Correct pricing of the cooling product is essential, both from a sales perspective when it comes to assign the customer and from the income perspective when it comes to create a profitable DC system. In general district energy providers (District Heating, electricity, gas, etc.) are used to tariff structures equal for all customers within a certain group, size, demand, etc. for pricing their products.

Legally, this is also the only allowed pricing structure in many countries. However, District Cooling is usually not included in applicable laws or regulations. With exception from a few countries (Denmark, etc.) pricing models for district cooling services are free to choose. Based on this, individual pricing has shown to be the best principle since it takes each customer's situation into account. By careful inventory of each customer's existing internal cooling system together with information about costs for electricity, consumables, maintenance, age of equipment, financial data, etc. it is possible to calculate the customer's "own costs" for his on-site cooling system.

In order to attract the potential customer it is often necessary to present a price lower than the own costs but the price must not be too low posing the risk to the economy of the district cooling system.

System perspective and not building oriented (Low Primary Energy)

The importance of keeping a system perspective cannot be emphasized enough. This applies on market communication as well as communication with authorities and other stakeholders. District Cooling means that resources that are very difficult to exploit for a single building can be utilized at a wider level.

Without the system perspective it is too easy for a single building owner to regard District Cooling as any type of "purchased energy". With green building validation systems like LEED and BREEAM, it is possible to classify the input energy.

In general, the single building owner needs information about the Primary Energy Factor including the background, the importance of a low Primary Energy Factor when different energy conservation methods are evaluated and the differences in the Primary Energy Factor between various energy sources.

Organisation – small dedicated organisation

Utilities should form the small group of employees dedicated to the task rather than asking employees of taking care of district cooling now and then. Experiences show that it is difficult for, for example a department manager or another person in the line-organisation, to take the responsibility to run a District Cooling project; he or her will simply not have the time available. A better solution is to appoint a person (internal or consultant) as project manager and driving force to get to project going. Internal managers at in-line positions are often perfect for decision making and receivers of information, but a certain dedicated small team for the actual running of the project is the best.

Market and technical know how

The know-how that is needed is how customer use cooling (and heating) in their buildings and processes both from a technical and business perspective.

When the potential customer begins to understand the simplicity and robustness of District Cooling he often starts to compare it with existing system. Often the clients are not fully aware of the complexity of their existing cooling system; the good understanding of conventional cooling systems is fundamental in order to inform the client about the differences between District Cooling and more complicated conventional cooling systems.

Clear roles, utility and municipality

The role of the utility company, which is developing the new DC-system, is to push the project forward. The utility company must have knowledge of the development steps required and an understanding of the time it takes for each step. The municipality must be constantly informed and updated on the progress of the project. The municipality's most important role is to be supportive and facilitate the utility company's actions such as permit applications, and public information. It is almost a must that buildings owned by the municipality, which are suitable for connection to the planned DC-system, also become connected. The opposite would be very negative from the Public Relations-point of view; if the municipality does not believe in the new DC system, why should then private property owners do so?

Decision Power - Access to top management

After the first feasibility analysis where the main customers have been defined, a channel to their top management needs to be opened. Pay attention to getting in touch with the top management of your clients as well as with your own top management.

In the case District Cooling is introduced as a new product in the actual utility and/or area, the top management must be aware of the plans and prepared to make decisions, sometimes in an early phase. For example, there is often at least one customer customer thinking about replacing his existing chiller, because of age or that the machinery is worn-out. In such a case there is a "sales window" for the District Cooling provider since customers with brand-new cooling equipment are much harder to get and often to unsatisfactory prices. This sales window might be used to sign with the customer and based on cooling delivery from a new temporary chiller located outside the customer or that the District Cooling company takes over the client's chiller and is responsible for the operations until the building is connected to the District Cooling network. Both situations mean that an obligation and/or investment are required. A decision is also needed quickly; the client needs a clear answer and a fixed date for the cooling delivery, otherwise he might feel that for safety reasons he needs to invest in new equipment on his own.

Secure land for production facilities at strategic locations

A survey regarding appropriate locations for production facilities needs to be launched in an early phase. Try to place your facility as close as possible to the largest customer or in proximity of natural cooling sources, e.g. a deep lake, a river or a sea. Avoid complicated barriers between the production facility and the customers or the natural cooling source, such as railway, highway areas protected from excavation works, etc.

In general; if a choice has to be made, priority is a good access to the natural cooling source since this pipe system is often non-pressurized and difficult to install to avoid high points. A too far distance from the largest customers or natural cooling sources might kill the project.
The master plan and other development plans for actual areas are important guidelines also including regulations.

Allocation of resources for permission issues
The different kinds of permits required for a new District Cooling system varies in different countries and for different purposes. In general a building permit is required for the production facility and some kind of excavation permit and rights of way / utility easement for the distribution network. These kinds of permits may take some time to get but they are not show stoppers in normal cases.
However, for District Cooling systems based on natural cooling sources such a lake, river or the sea the permit process is much more complicated. In these cases also establishment of an Environmental Impact Assessment (EIA) is required together with the application for the Environmental permit. The total process can take more than one year therefore engage persons with the right qualifications for handling of the process. The EIA of too low quality takes a risk of failing totally to fail totally with consequences of a serious delay and increased costs.
To sum up: pay high attention to the permit issues already from the beginning of the project, engage qualified persons and be sure to define what kind of permits are required for the project.

Risk management process

All projects include risk of various kinds and the establishment of a risk management process helps determine and quantify risks. The goal is to eliminate risks, if possible, and for those risks that cannot be eliminated establish strategies to handle upcoming situations.
Secure reference solution - Right solution – high performance.

As for any other type of business, it is vital that risks are identified, assessed and managed in the most appropriate way. The District Cooling company should decide which types of risks it is willing and able to accept based on their available financial resources and financial objectives.

There are a number of risks in District Cooling business, these derived from the financial investment, these derived from the development process and these derived from the daily operational of cooling production activities.

The development of a District Cooling system requires a large amount of capital investment; these costs are front loaded during the early stage of the development due to the high costs associated with the construction and installation of the essential plant infrastructure, such as pipework, chillers etc.

At this stage a fundamental risk that can affect the district cooling company is the unbalance of projected customers load in relation to the installed capacity of the plant.

Due to the slower than predicted build-out, in the case of new development area or as results of wrong marketing strategy in the case of District Cooling development within the city, it can result in very high early cost, but delayed incomes, which can put stress on company's cash flow and the projected returns.

On the other hand delay in customer's connection may be caused by clients who must adapt their system to interface with the District Cooling loop resulting representing another reduced revenue risk for the District Cooling provider.

Another important risk to consider is the event of lowest than expected building occupancy that will result in an oversized system and therefore representing a loss of revenue for the District Cooling business. These risks may be avoided by providing an effective communication and technical assistance to the customers during the marketing and connection stages.

Piping distribution is a key element of District Cooling systems that represent a very significant risk in the unforeseen events of congestion and obstacle in the underground services already installed in the street in which it may require modification of initial piping installation route thus adding important extra costs. These risks may be reduced by obtaining an update underground services map by local authorities, and by conducting survey as early as possible as well as obtaining information in regards to planned development work intend to be undertaking by the city such as an extension of an underground train systems. The nature of these activities results in disruptions to local communities, it also affects the daily business activities which, can create negative feelings towards the District Cooling company.

There are unforeseen risks associated to the actual construction of the energy plant such as delays, contract performance, accident etc., which can lead to higher costs. Hence it is fundamental that they are treated like the any other construction project however these risks may be reduced by following construction best practice and quality project management.

An energy metering system should be implemented as this could represent a loss of revenue to the provider and an excessive charge to the customers. It is therefore critical that these risks are properly identified, assessed and evaluated so that corresponding safety margins can be taken into account.

Strong product positioning

It is essential to develop a DC product that is competitive in the local market including problem solving, economy, environmental gains, risk allocation and added values. Only competing with price will hardly be successful.

Connection speed

District Cooling schemes have very high up-front investments. Delayed customer connections means later income and the overall profit will decrease. By smart tariff structures late energy incomes can be compensated by early access fees.

Securing the correct price

Customers are usually not aware of the costs of cooling for their building as they are hidden in the electricity bill and other separate accounts on O&M, service contracts and investments etc. A key selling point will therefore be to make the customer aware of possible costs and in the same moment show the possible savings with DC.
System developers should be aware of potential price regulation in the heat market, which might be applicable for cooling as well.

10.3. BARRIERS THAT HAVE TO BE OVERCOME

There are many barriers that have to be overcome before a District Cooling system can be realized.

Here are the most common and main barriers that have to be overcome:
- Lack of interest from the LA and top management
- Fixation on energy production instead of smart usage of energy (Low Primary Energy)
- Financial issues
- Building regulations/ building code
- Experience on district energy

Lack of interest from the local authorities and top management

One major factor why DC is not developed is a lack of political or corporate will to develop DC.
The familiarity with district cooling is limited or non-existing. Many LG and energy companies have no experience and insight of DC and therefore did not investigate the potential of District Cooling.

As one of the DHC associations expressed:

"People are scared away by high investment costs, business cases are hard to find and to find them a nameable amount of money has to be spent."

Low prority for District Cooling from Local Authorities

A District Cooling system will usually comprise of a production mix and the business case is naturally not based on revenues on electricity. District Cooling grids are very capital intensive. If there are other projects yielding a faster return on investment these projects will be favored.
The utility or the energy company has had an interest and made a feasibility study but after that nothing more is done. The main mistake is that the feasibility study has had a technical approach and not the whole business potential and skipped the whole idea for various reasons as listed:

- Authors of studies cannot see "enough" business value (DC tends to be a small part of the business portfolio)
- High initial investments
- No local free cooling sources
- Perception of lack of customers for District cooling

10.4. FINANCIAL ISSUES

Financing a DC scheme is a main barrier if there is no utility or local energy company able to finance the DC scheme with its own cash flow or equity as a base. The initial investments are high and this is a major obstacle that has to be dealt with.

Almost all DC development in the Nordic countries has been done without any subsidies. One important aspect why DC has been so successful in the Nordic countries is because there are many strong local energy companies in the cities that have had the economical strengths to develop a DC scheme and many has used EIB loans for the development. Generally these local energy companies already have an established District Heating business. Only two cities in Sweden have got subsidies to develop DC.

It is expected that Cohesion Policy Funds will be main drivers for investments in District Cooling over the next years. The European legislators agreed on a compromise for the funding period 2014-2020 in 2013. The Cohesion Policy Funds are part of the European Structural and Investment Funds. The funds aim at reducing economic and social disparities and promoting sustainable development. They are also used to support the implementation of other policy dossiers. In the framework of the Energy Efficiency Directive Member States and regions are urged to utilize funding in order to trigger energy efficiency improvements.

The European Commission expects more than 23 billion euros Investment in sustainable energy measures. This is mainly expected to be realized by the European Regional Development Funds (ERDF) and Cohesion Funds (CF). Within the ERDF the programme secured 20% of the total available amount for more developed regions (15% for transition regions and 12% for less developed regions respectively) for the thematic priority 'Supporting the shift towards a low-carbon economy in all sectors', which includes energy efficiency, renewable energy, smart distribution systems and sustainable urban mobility.

The Cohesion Fund Policies are implemented by the Member States through Partnership Agreements (PA) and Operational Programmes (OP). The PAs and OPs have been submitted to the European Commission by April 2014 and are in the revision process. The PAs have the purpose of outlining the Member States' funding priorities; the OPs explain how to realize the various priorities. So far three PAs between the European Commission and Germany, Greece and Poland have been signed with the OPs still being revised.

As the PAs and OPs include measures that concern DC, project proposals can be submitted to the responsible Competent Authority (CA) in order to request funding. However, the specific requirements in the respective country/region need to be investigated properly.

The example of Germany

The German Partnership Agreement was amongst the first to be signed by the European Commission.

In the considerations on the priorities of ERDF, three points are mentioned under theme 4 (Supporting the shift towards a low-carbon economy in all sectors):

- Support for sustainable production and distribution of energy from renewable sources
- Support for energy efficiency and utilization of renewable sources in companies
- Support for applied energy research as well as pilot and demonstration projects for energy efficiency, storage, distribution, renewable energies and measures to strengthen CHP

District Cooling falls under all three points. Therefore, DC projects in Germany are generally speaking eligible for funding. However, it is necessary to assess the OPs when published.

The example of Poland

Also the Polish OP was amongst the first to be signed by the European Commission. In the considerations on the priorities for the ERDF, under theme “Supporting the shift towards a low-carbon economy in all sectors”, District Cooling is mentioned as a chance for District Heating companies to increase their production and sales. Cogeneration installations using surplus heat to produce cooling with absorption chillers are eligible to receive financial support. District Cooling infrastructure is also eligible to receive support. In fact, development of cogeneration and District Heating and Cooling networks is mentioned as the most wanted activity that should be undertaken by District Heating companies (PI 4e., PI 4v.). Efficient distribution and production of heating and cooling is carried out under theme 4 and in coordination with energy modernization of buildings to decrease the heating and cooling demand.

EIB (European Investment Bank) gives loans to DC development and this have been used for example in Stockholm. The EIB finances up to 50 % of the development costs. This means that they finance not only 50% of the investments but also 50 % of the development costs that are not capital expenditures.

One pricing model that has been used with success in Sweden for example is that DC schemes may have used “market pricing” or “alternative pricing” to help financing the district cooling development. The alternative to DC is that the customers (building owners) invest in their own cooling equipment, which is, for the customers, upfront payments that they have to make to be able to get the service. On the other hand, if they choose DC, they can choose to pay a high upfront fee to get lower yearly fees in the future. With this approach, the suppliers receive higher income the first years to meet the high investments that have to be made when they are building out the DC system. This means that they get a better cash flow and do not have to take so high loans as they would have been if they had not used upfront fees.
The Figure shows the cash flows of a DC system with an investment need of around 46 M using up-front fees or not. In the example the up-front fees are 13% of the total cooling revenues and that will decrease the capital need with around 18%.

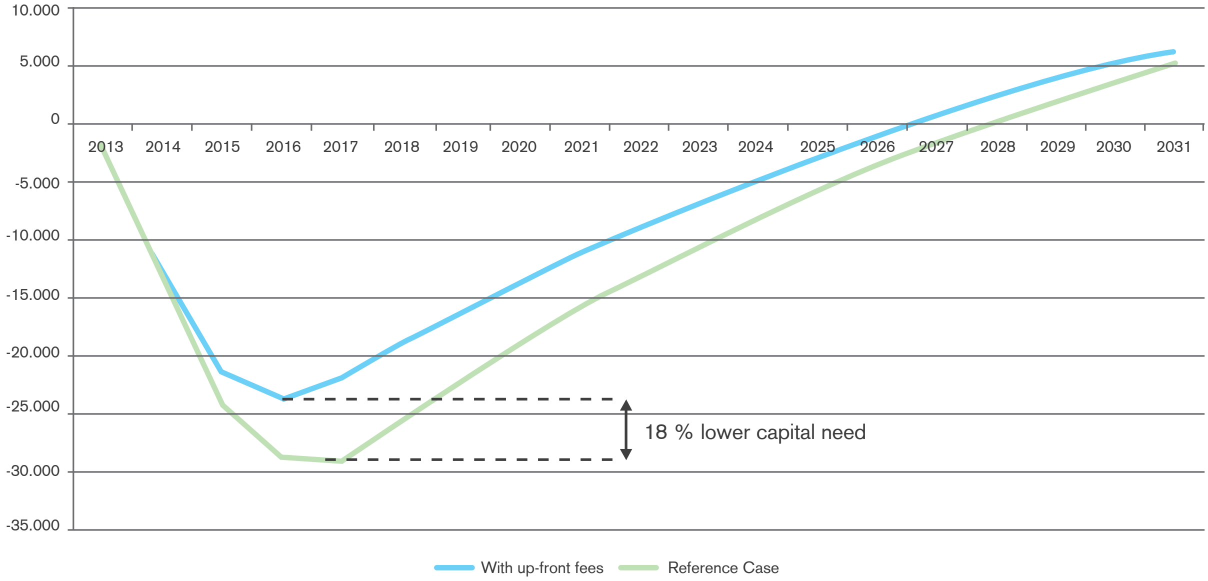


Figure 13. Cash flow for a 60 MW DC scheme with and without up-front fees. Source: (Capital Cooling)

Figure 13 shows the example of a DC system with an investment need of around 46 M€ and showing accumulated cash flows for the system using up-front fees or not. In the example the up-front fees are 13% of the total cooling revenues and that will decrease the capital need with around 18%. Some Nordic DC schemes have used even higher percentage of up-front fees, up to 33%.

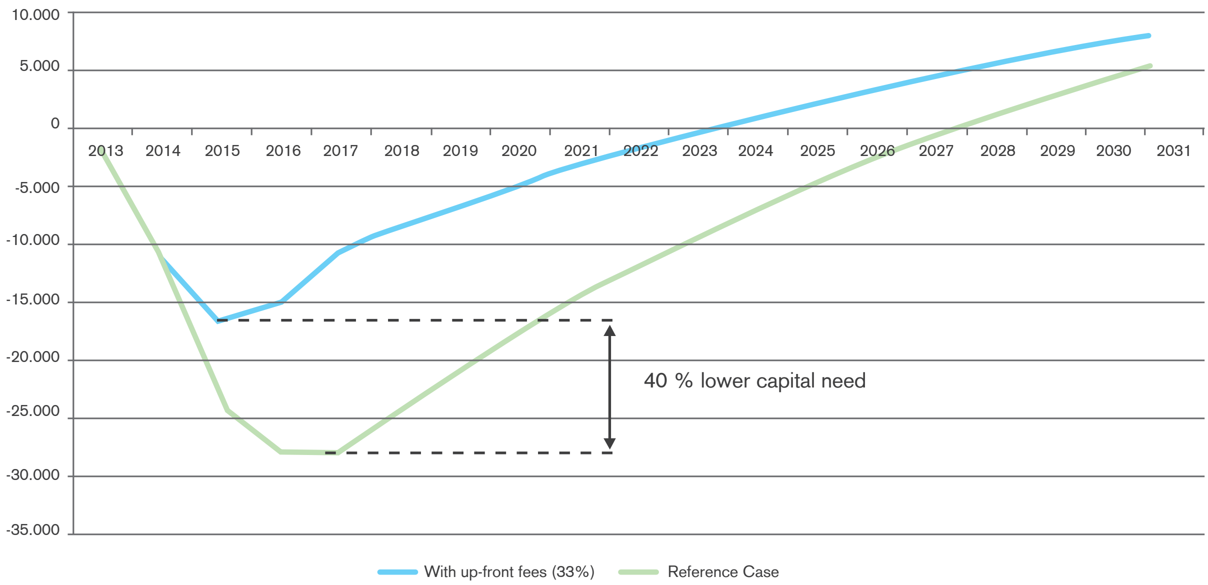


Figure 14. Cash flow for a 60 MW DC scheme with and without high up-front fees. Source: (Capital Cooling)

With high up-front fees that are in the same range, an on-site chiller solution at the customers' building, the capital need can be reduced by around 40%. The discounted payback time is also reduced by around 4-5 years.

Risks from the financial point of view

The risks have been discussed with their effects as follows:

- Investments
- Costs
- Revenue
- Delays

If the reference, District Cooling scheme gets 10 % higher investments, thus the cash flow behaves as shown in Figure 15. Higher investments can have many reasons but much is related to poor purchase process, increased material and labor costs and insufficient completion on key components and in local markets.

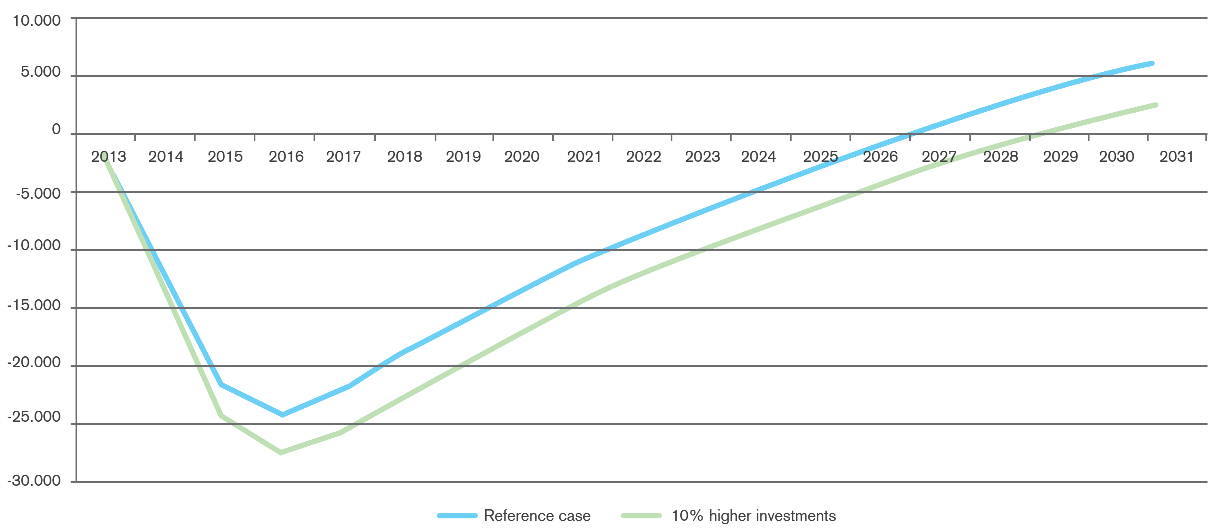


Figure 15. Cash flow for a 60 MW DC scheme with 10 % higher investments. Source: (Capital Cooling)

Costs

The negative effect of the costs increased by 10% is shown in the Figure 16.

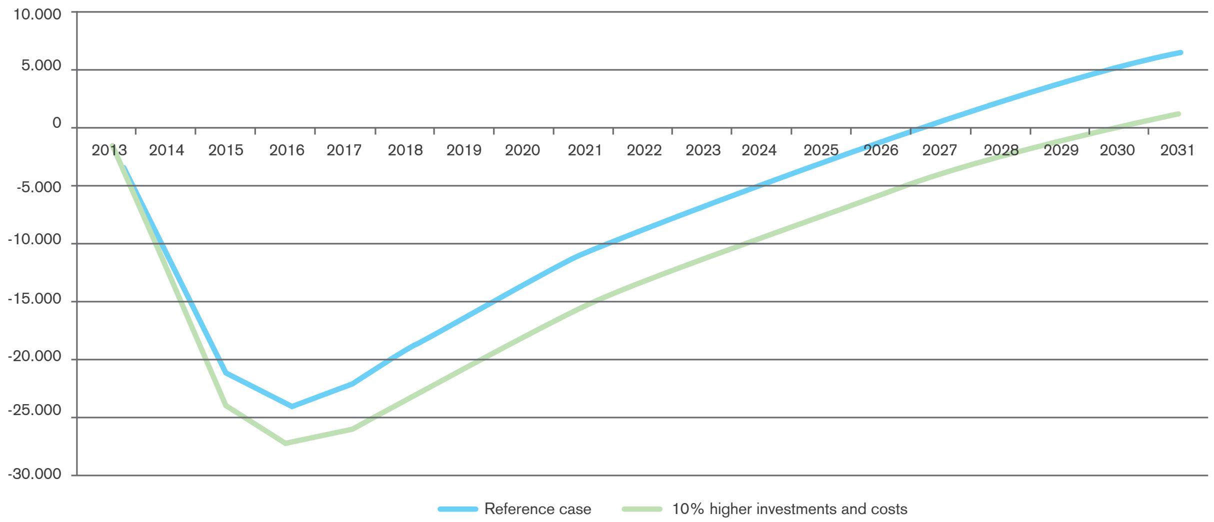


Figure 16. Cash flow for a 60 MW DC scheme with 10 % higher investments and costs. Source: (Capital Cooling)

The cost itself does not affect the cash flow substantially due to low costs of sources (one of DC benefits).

Revenue

Figure 17 shows the cash flow with 10% higher investments costs and 10% lower revenues compared to the reference case. In the realization period, personnel and resources have to be kept with a higher cost as a result, as shown in Figure 18. If all these risks take place at once, the discounted payback period increases from 14 to 25 years.

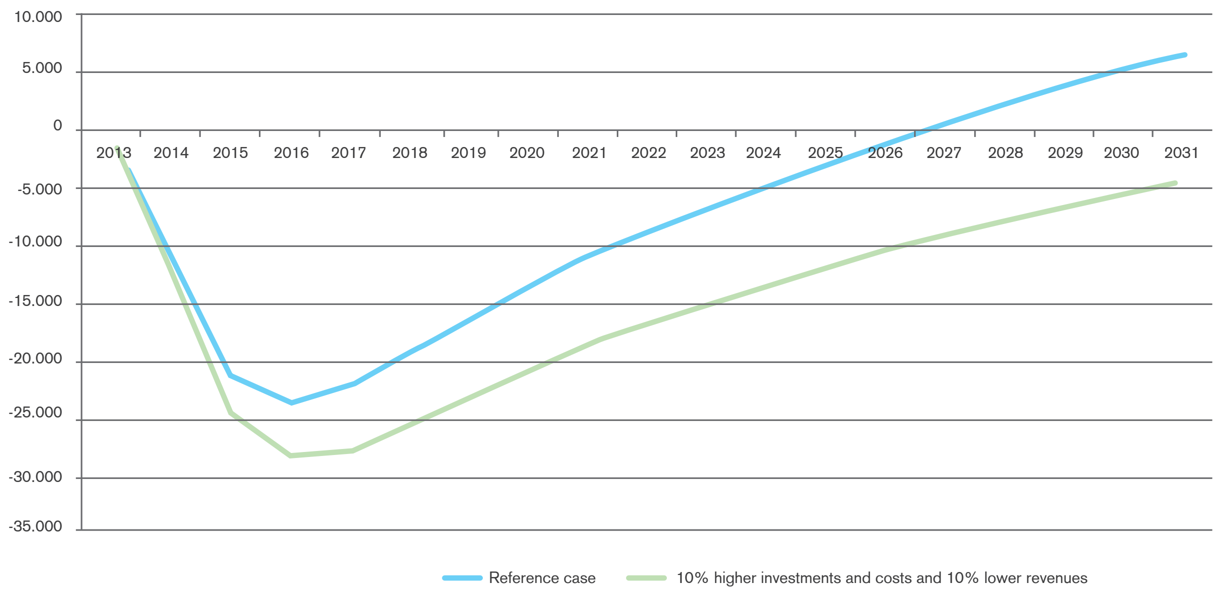


Figure 17. Cash flow for a 60 MW DC scheme with 10 % higher investments and costs. Source: (Capital Cooling)

Delays

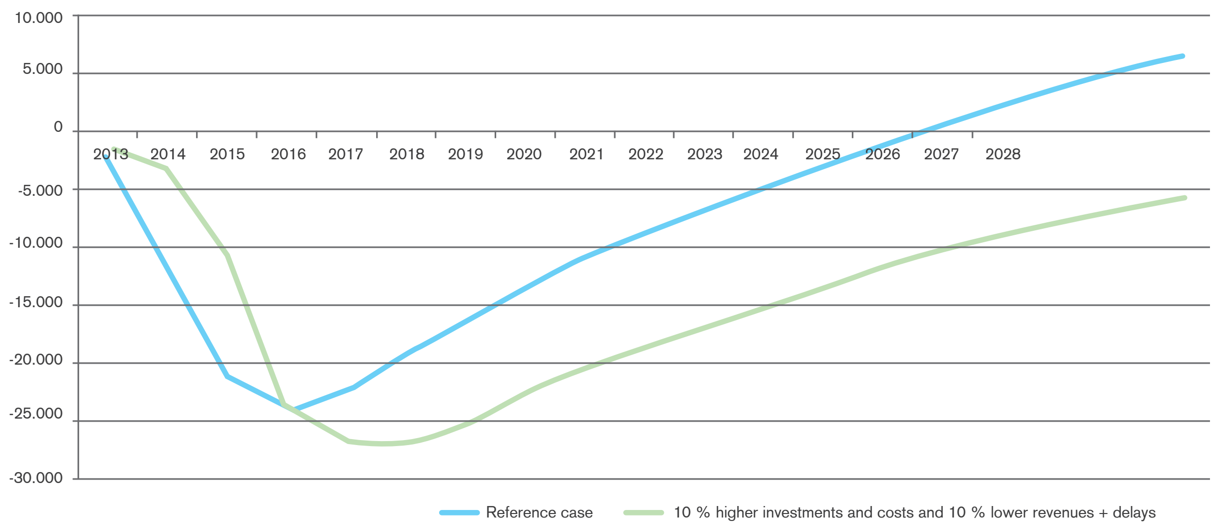


Figure 18. Cash flow for a 60 MW DC scheme with 10 % higher investments and costs, 10 % lower revenues with delays. Source: (Capital Cooling)

Summary Risk

Figure 19 and Figure 20 show a summary of IRR and NPV reduction.

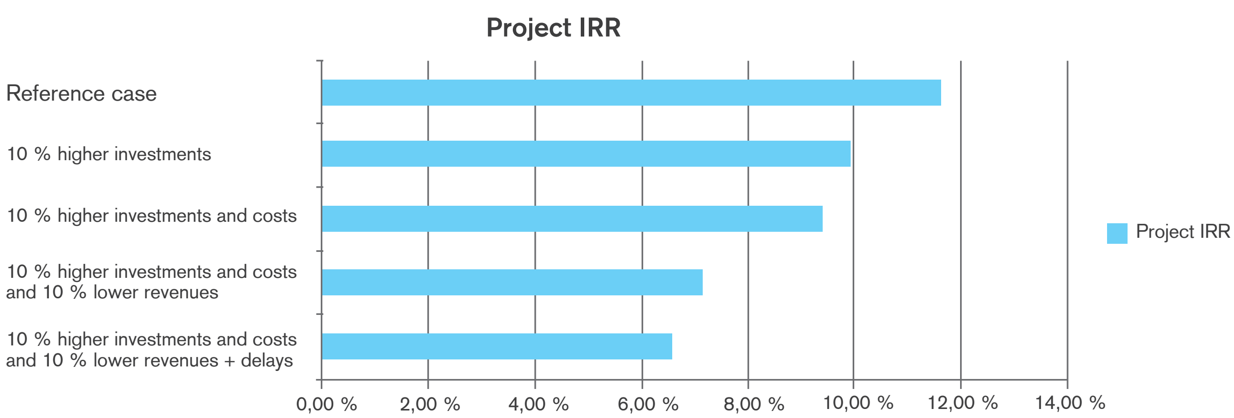


Figure 19. IRR reduction. Source: Capital Cooling.

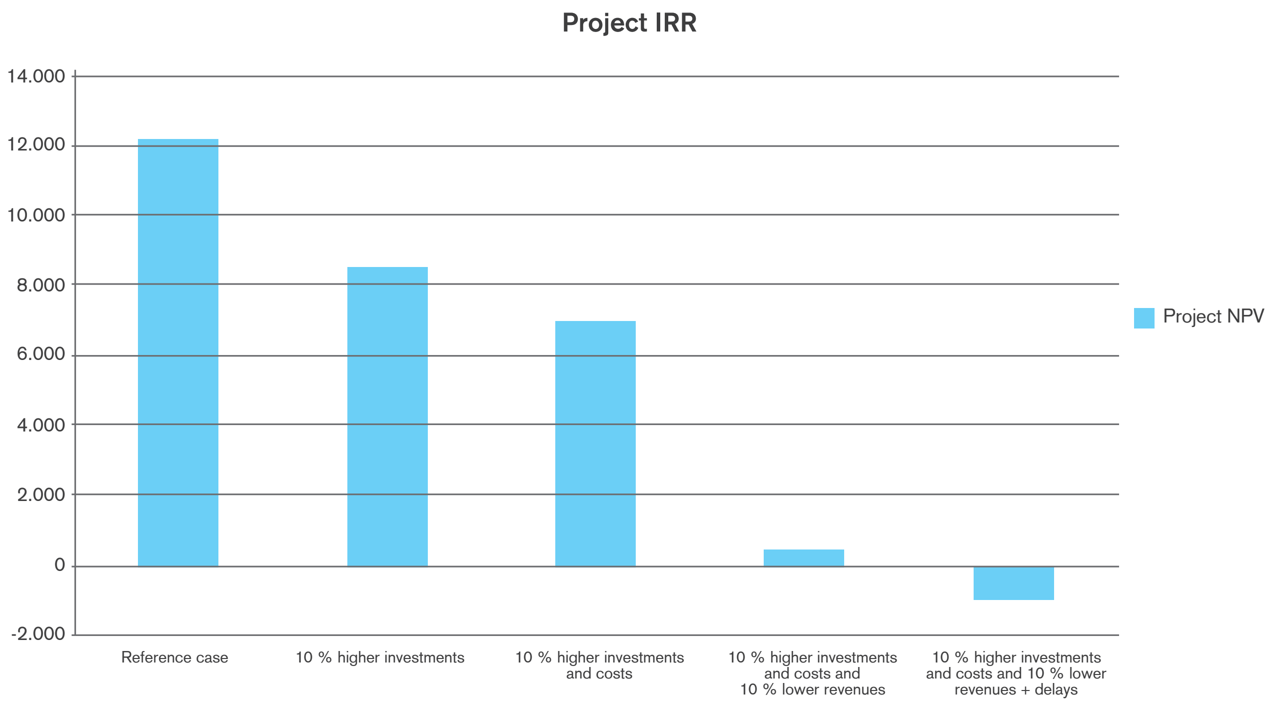


Figure 20. NPV reduction. Source (Capital Cooling)

10.5. BUILDING REGULATION/ BUILDING CODE

A major barrier that has come up in the last years in the Nordic countries is the new building code that regulates how much energy a building is allowed to use. Purchased energy is consequently reduced instead of cutting down on primary energy. When building owners want to refurbish or build a new building, they have to follow these rules and the easiest way to achieve the cut on energy use per square meter is to install a heat pump within the building. Then, they can cut down the purchased energy part and reduce district energy in form of District Heating and Cooling. They have, to the contrary, higher exergy usage and the usage of primary energy is also higher. Using more heat pumpes reduces not only the DH production but also CHP electricity production. This can of course be discussed and depends on the allocation method, see Rescue report WP2.2 (Swedblom, 2014).

11.6. EXPERIENCE IN DISTRICT ENERGY

Countries that have had a long tradition in District Heating and that have a relatively high market share of District Heating have also started to develop District Cooling. One reason is that in countries, regions or cities that have District Heating, there is at least one utility or an energy company that has experience in a district energy business. District Cooling is not that much different from District Heating and here are some examples of experience that these regions or cities already have (Tvärne, 2015).

CITY	COUNTRY	POPULATION CITY CENTER	DC CAPACITY PRESENT / POTENTIAL (MW / WM)	TECHNICAL SOLUTION
Barcelona[1]	Spain	1.600.000	(69/XX)[3]	Absorption, electrical chillers, sea water, CWS
Copenhagen	Denmark	537.000	(22/150)	Absorption, electrical chillers, sea water
Gothenburg	Sweden	510.000	(60/100)	Absorption, electrical chillers, river water.
Halmstad	Sweden	58.000	(7/30)	Absorption, electrical chillers, sea water, CWS
Helsinki	Finland	738.000	(130/250)	Absorption, electrical chillers, sea water, CWS
Paris[2]	France	2.234.000	(290/XX)	Electrical chillers, river water, CWS and ice storage
Solna/ Sundbyberg	Sweden	108.000	(43/60)	Sea water, heat pumps, electrical chillers, CWS
Stockholm	Sweden	868.000	(250/XX)	Sea water, heat pumps, electrical chillers, CWS and aqurfer
Vienna	Austria	1.730.000	(57/200)	Absorption, electrical chillers, river water
Växjö	Sweden	61.000	(13/35)	Absorption, electrical chillers, lake water, CWS

[1] Two separate DC systems exist in Barcelona. Districlima operates one of them.
[2] Two separate DC systems exist in the Paris area. Climespace operates one of them.
[3] Connected GFA is presently 390,000 m². An additional market potential for GFA of 2.640,000 m² for system expansion has been identified.

MANAGEMENT OF A DISTRICT ENERGY BUSINESS

If there is an existing district heating business in the local market, the energy company already has the basic knowledge that also makes an introduction of district cooling easier.

The main difference between DH and DC business is the following:
Production of DH is much more complicated than district cooling. The production of DH generally includes a mix of a variety of different fuels. DH plants are huge in size, due to the fuel handling and emission cleaning systems. DH also need more staff for its production than DC.

The initial investments for a DC system are larger than a DH system. The main reason for this is the low ΔT (temperature differential between supply and return) for DC. A good DC system can have a ΔT of 10°C when a good DH system can have 50°C. This means that that a DC network needs to have around 4-5 times larger flow (and then larger pipe dimensions) to distribute the same energy capacity. On the other hand a DC system has much lower production costs than a DH system.

Why Paris succeeded with developing a DC system and not London has many reasons but one major reason is that Paris and France has broader experience and tradition of district energy business, which has not been the case in the UK and London.
Without the tradition of district energy it is more difficult to find companies with local presence that feel comfortable to enter a new type of infrastructure business (uncertainty how to get the real estate market interested in a new cooling product).

11 PRACTICAL ADVICE FOR LOCAL AUTHORITIES

Local governments play a key role in the establishment of DC as planners and regulators. The municipality controls the policy and planning framework, which can encourage the development of district energy through mixed-use zoning, compact urban form, community energy plans, and checks and balances incorporated into the approval processes. Previous sections already described the role of LAs as key stakeholders and as agencies responsible for energy master planning and SEAPs.

This chapter aims to provide some more practical examples how local authorities facilitate the investigation, establishment and operation of a DC system or provide a more favorable environment for private parties interested in establishing a DC system.

11.1. URBAN PLANNING

Land use planning or zoning can encourage a greater concentration of cooling loads and by that faciliating the economy of DC system. Particularly for new developments, the implications of land use planning on energy use needs to be considered already at an early stage.

A number of land-use tools can be used to encourage connection and reduce investor risk, such as:
- density bonus or zoning to encourage high density and mixed use;
- development cost charges;
- public and private rights-of-way and easements for DC infrastructure.

Establishing a map of heat and cold users as well as heat and cold sources is an essential planning tool for local governments and for DC systems. Future cooling demands are even of higher relevance than assessment of current demands.

On top of this information, a map for district energy should also contain data on:
- Present and future development density;
- Demand by different user groups;
- Building ownership, building users and key contacts;
- Age of buildings and characteristics (e.g. HVAC equipment, age and replacement cycle)
- Any anchor loads – large cooling consumers with both high energy and capacity demands;
- Barriers and opportunities particular to the location in terms of local energy sources, distribution, transport, land use, development density and character;
- Socio-economic data

11.2. SHAPE LOCAL REGULATIONS

As the part of a sustainable and low-carbon energy plan, a local government, as a regulator, has many means to assist the uptake and the commercial viability of DC systems. Often the same measures also assist other objectives of local government such as providing for a “liveable’ city, a city in which the residents feel comfortable in and enjoy living and working in. This includes maintaining the visual appeal of individual buildings and districts, particularly for heritage buildings, avoiding noise nuisance, as well as avoiding health dangers (legionella disease in this context).

Local government may:

- discourage or limit the use of split unit air conditions
- discourage or limit the use of cooling towers
- discourage or limit the use of refrigerants
- in areas where DC is available, mandate for DC being the only permissible form of cooling
- mandate for all new buildings to be “DC ready”
- facilitate the permitting of unavoidable civil works such as road openings or tunneling work
- facilitate permitting for water use and water discharge rights

11.3 ACT AS COORDINATOR

In a LAs jurisdiction there are usually multiple owners and operators for infrastructure networks such as for electricity, natural gas, telecommunications, water supply, sewage infrastructure, or subway operators, but also waste and recycling companies.

These operators often do not act in close cooperation, and the LA needs to provide a crucial link in ensuring any synergies to be achieved between the different network infrastructures and operators are fully exploited, both in the planning and in the operational phases. Particular synergies can be found for example in using each other’s energy (waste) streams at certain times, sharing of facilities, common planning for required upgrades or avoidance of upgrades (e.g. of the electricity network for summer peaks), as well as the common planning of civil works such as road openings or tunneling work.

11.4. ACCEPTANCE AND AWARENESS MEASURES

The implementation of any technical measures such as DC always needs to be accompanied by awareness and acceptance measures. This is particularly true in the countries where DH and DC are less well-known, and expertise in the technology and the advantages of networked supply of heating and cooling is limited.

LAs can play a key role in raising awareness and acceptance both at the initial feasibility study stages to identify cooling potential, and at the actual implementation stages to facilitate and assist the uptake of DC. LAs are usually seen as a more trusted supplier of information and guidance than a commercial operator would be.

Typical measures taken are the publication of informational material, information evenings, community events and workshops, education campaigns as well as individual conversations with key users and stakeholders. It is essential that all key stakeholders are addressed.

11.5. USE CITY ASSETS AS CORNERSTONE USERS

Where city-owned buildings or facilities such as schools, hospitals etc. are able to be connected to a DC system; the LA should, wherever it is possible, connect these loads. Apart from leading by good example, this can also be vital to improve the commercial proposition for DC by providing a cornerstone user for the system. Buildings like these also often have space available where energy centres could be placed. Also, often, local governments own property and utility assets that have potential to be used in the transmission or distribution of DC systems such as sewage pipes and pump stations, water mains, communication ducts, metro tunnels, parks, and streets. Key sites for DC infrastructure should be kept aside for this purpose or even purchased.

11.6. OWNERSHIP AND FINANCING OPPORTUNITIES

Development and ownership options of a DC system can range from full local authority ownership, through a partnership (PPP) or joint venture between a local authority and a private operator, to a fully third party owner/operator only connected to the local authority through a concession agreement. Since DC networks and cooling plant are major capital investments, long term (20-30 years) concession agreements are usually required by any third party investor/operator in order to have investment certainty

As a local or regional network, district cooling lends itself well to the community ownership. Whereas full control affords the maximum independence for a local government, when starting up a new system a local authority will usually not have the necessary experience and resources to develop a system completely on its own, and a partnership with an experienced developer and operator should be sought.

Financial assistance can be given in different ways:

- Financial support for District Cooling pipes and also for connecting customers to existing District Cooling networks through provision of grants from national and/or local governments or other possible sources.
- Favourable loans: Providing loans at low interest rates to finance the capital cost of establishing, extending or refurbishing District Cooling.
- Tax deduction, DC: Implementing a tax benefit for District Cooling schemes.

Often LAs can access funds for feasibility study work or implementation of measures for District Energy. For example in the United Kingdom the Department of Energy and Climate Change (DECC) through its Heat Network Delivery Unit (HNDU) offers a support programme for the development of district energy. It offers to LAs funding covering heat and cold mapping, pre-feasibility and feasibility studies. LAs should keep themselves informed and up-to-date what national funding lines or support schemes are available that could be used to assist the investigation or implementation of DC systems.

Some more general structural funds for infrastructure investment are also available through European wide funding lines such as IRENA or ELENA.

11.7. USE NETWORKS FOR KNOWLEDGE EXCHANGE

Several networks and information sources can be used for capacity building in LAs. LAs are encouraged to join existing city networks such as the Covenant of Mayors, ICLEI, Climate Alliance, C40, as well as thematic networks such as Euroheat & Power, AGFW or the International District Energy Association for information, assistance and exchange of experiences.

12 CONCLUSIONS

An important aspect of ensuring sustainable cooling solutions for the local real estate market is to develop concepts that provide clear evidence of being resource efficient in the long run and demonstrate good environmental performance and low operational costs.

The main reason that makes a District Cooling scheme successful is that is that there are some dense cooling demand area/ areas in a city or a municipality and that there are some local free cooling or waste energy sources nearby these areas. These two criteria can be found in many areas and cities across Europe.

In order to develop sustainable district cooling solutions attracting investment, creating jobs and a future proof infrastructure for the local community it is essential to have a well-defined methodology that provide a decision making process for developing the District Cooling scheme with acceptable profitability and low risk.

The development should be made in steps in order to understand and evaluate options and make right decisions under the progress of the District Cooling project.

It is also important to have an approach which includes complete business management of District Cooling project. This will enable the project to rapidly assess economic and tactical decisions/options and also have a clear picture of the overall strategic direction of the business project. Clear understanding of the opportunities and risks underpins the development of a successful project.

The Energy Master planning – mapping the energy demand in the area. This will show where the best options are to develop District Cooling and ensuring a resource efficient community. This strategic plan will provide a vision outlining how the district cooling network may be developed and the necessary requirements at the first stage of the development, to ensure future flexibility by identifying areas of existing thermal demand, future growth and density. With this knowledge a plan can be made on how the district cooling energy infrastructure investments can be made at the appropriate time.

To establish district cooling requires genuine knowledge of the local customers, market drivers, business processes, and organization. In order to get this organized it is important to find out the appropriate business model which is the most efficient.

The operator of District Cooling needs to be perceived as a supplier which can secure a long term reliable ability to provide a sustainable solution. To build confidence in relation to the local real estate market is understanding how each business scheme option will operate, and to adapt the design to meet the aspirations of the key stakeholders.

There are many stakeholders in a District Cooling scheme such as the District Cooling owner, operators and their employees, municipal authorities, national policy-makers, DC associations, educational institutions, investors, real-estate owners and their tenants and building owner associations.

To evaluate which business model fits the specific local market needs for District Cooling services the stakeholders in a city/municipality need to consider the most appropriate solution to develop, own and operate the district cooling schemes, as follows:

• financial situation and levels of profitability
• level of control
• willingness for risk-taking.

Public sector organizations or non-profit organizations generally view investment in infrastructure as the means of achieving broader objectives and are willing to accept a longer-term payback.
It is crucial to describe the project mandatory exposure and attitude to risk. This determines the most appropriate business model in respect of the availability of capital (including the assessment of reasonable return) and of the operating risks. This, in turn, will provide the most appropriate method by which affordable energy can be delivered.

Market intelligence is strategically important and should be a high priority for all the work being conducted. It is also essential to determine and compare environmental performance and understand how different choices effect permissions and public perception. Right timing is a key factor in the development of district cooling schemes, existing buildings are typically not viable to connect to a district cooling system until a major replacement in their own equipment is required, and new developments may only come forward in a piecemeal fashion, dependent on inward investment. Therefore it is important that the DC system is developed so it can be extended with the customers' needs and demands.
There are some barriers for development of District Cooling. Lack of interest in development of district cooling due to low revenue or benefits for the supplier.

Another barrier is the lack of visibility of the body in charge of district cooling development, especially in countries without any local energy companies (the UK, Belgium). The profitability is often quite low for District Cooling schemes but when the systems are in operation, they give a rather low but stable revenue, as it has been proven in Helsinki, Stockholm and Vienna, among others.

Ways to handle the barriers for new development of district cooling may be by legislation, for example zoning making building owners in the certain area connect to district cooling. The problem is that this then can create higher society costs if the DC product becomes much more expensive then the alternatives and then undermining development in other fields (taking money from other sectors). Another way might be using subsidies for District Cooling. This also raises the questions how high subsidies are needed and how to manage them. The third way to handle the barriers is by internalizing all the costs in a fair way, in order to ensure transparency. This can be made for example by setting price for pollution, primary energy and CO_2 taxes for all cooling series and then DC should be able to compete successfully.

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