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Local and Regional State of Play and Policy Recommendations Concerning Sustainable Heating and Cooling: Focusing on EU Level Policy

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Table of Contents

List of Tables

List of Figures

1 Introduction

This report is the deliverable of the study on the Local and Regional State of Play and Policy Recommendations Concerning Sustainable Heating and Cooling: Focusing on EU Level Policy, and presents the results of Parts 1 to 4 of this study.

It contains the following chapters:

- Chapter 2: An overview of current EU policies with respect to energy, especially heating and cooling, and combined heat and power (CHP).
- Chapter 3: The most relevant provisions in these policies for local and regional authorities.
- Chapter 4: An overview of EU supported projects that focus on energy, especially heating and cooling, and combined heat and power (CHP).
- Chapter 5: The most relevant projects for local and regional authorities.
- Chapter 6: Conclusions.
- Chapter 7: Key highlights and conclusions of good practice examples (the four case studies).
- Chapter 8: Strategies and problems in financing and funding.
- Chapter 9: Policy recommendations for future initiatives focused on innovative heating and cooling projects as well as CHP.

2 Overview of current EU policies with respect to energy and especially heating and cooling and CHP

The EU and its member states are responding to global climate and energy challenges with ambitious energy policy. Central to the current policy is a commitment to the EU '20-20-20' targets: a 20% cut in greenhouse gas emissions, a 20% reduction in energy use through energy efficiency improvements and a 20% share of renewable energy deployment in 2020.

High efficiency cogeneration or Combined-Heat-and-Power (CHP) and district heating and cooling (DHC) have significant potential on all three above mentioned objectives. Various EU instruments have relevance for heating and cooling and cogeneration as they provide for specific measures regulating or influencing energy consumption or production. The main relevant energy policy measures are currently the Renewable Energy Directive[1] (RED), Energy Efficiency Directive[2] (EED) and Energy Performance of Building Directive[3] (EPBD). Also other instruments such as the EU Ecodesign and Energy labelling framework addresses the efficiency of products covering also heating and cooling appliances and equipment. Furthermore, the EU-ETS covers also district heating installations and related CO_2 emissions (with a rated thermal input exceeding 20 MW), and indirectly also CO_2 emissions from electric heating and cooling. Small installations block heating and collective boilers down to household-size boilers/stoves are not included in the EU-ETS. In addition, smaller installations have been opted-in by e.g. Finland and Sweden. The Effort Sharing Decision sets binding Member State targets for GHG emissions in sectors not covered by the ETS for 2020 and will continue to do so for 2030. The remaining majority of heating emissions, in particular from individual heating systems in buildings, are covered by this legislation.

In this chapter the RED, EED and the EPBD will be discussed in detail due to their relevance for local and regional authorities.

2.1 Renewable Energy Directive (RED)

Renewable energy can be produced from a wide variety of sources including wind, solar, hydro, tidal, geothermal, and biomass. By using more renewable energy sources (RES) to meet its energy needs, the EU lowers its dependence on imported fossil fuels and makes its energy production more sustainable. The renewable energy industry also drives technological innovation and employment across Europe.

[1] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

[2] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.

[3] Directive 2010/31 of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings and its amendments (the recast Directive entered into force on 9 July 2010, but the repeal of the previous Directive took place on 1 February 2012).

2020 renewable energy targets

The EU's Renewable Energy Directive sets a binding target of 20% final energy consumption from renewable sources by 2020 (Article 3). To achieve this, EU countries have committed to reaching their own national renewables targets ranging from 10% in Malta to 49% in Sweden. They are also each required to have at least 10% of their transport fuels come from renewable sources by 2020 (Article 3).

All EU countries have submitted national renewable energy action plans (NREAPs) showing what actions they intend to take to meet their renewable targets. These plans include sectorial targets for electricity, heating and cooling, and transport; planned policy measures; the different mix of renewables technologies they expect to employ; and the planned use of cooperation mechanisms.

A new target for 2030

Renewables will continue to play a key role in helping the EU meet its climate goals and energy needs beyond 2020. EU countries have already agreed on a new renewable energy target of at least 27% of final energy consumption in the EU as a whole by 2030, this target is part of the EU's energy and climate goals for 2030. In the coming years, the European Commission will develop proposals to implement these goals in post-2020 European energy and climate policies and regulations.

Apart from the overall RES target for 2020, the RED has a number of provisions specifically relevant to heating and cooling and CHP. For the exact text of these provisions we refer to the Directives itself, an overview of the main points, with references to the relevant articles and considerations, is provided in the following.

2.1.1 Heating and Cooling

It is appropriate for Member States to consider the promotion of district heating and cooling from energy from renewable sources (Article 5; Article 13; Annex VI) and equipment that achieves a significant reduction of energy consumption. Member States shall use energy or eco-labels or other appropriate certificates or standards developed at national or Community level, where these exist, as the basis for encouraging such systems and equipment (Article 13). Two or more Member States may cooperate on all types of joint projects relating to the production of heating or cooling from RES. That cooperation may involve private operators (Article 7).

Information and training gaps, especially in the heating and cooling sector, should be removed in order to encourage the deployment of energy from RES and shall ensure (Article 14):

- that information on support measures is made available to all relevant actors, such as consumers, builders, installers, architects, and suppliers of heating,
- that information on the net benefits, cost and energy efficiency of equipment and systems for the use of heating and cooling and electricity from renewable energy sources is made available either by the supplier of the equipment or system or by the national competent authorities, and
- that guidance is made available to all relevant actors, notably for planners and architects so that they are able to consider the optimal combination of renewable

energy sources, of high-efficiency technologies and of district heating and cooling when planning, designing, building and renovating industrial or residential areas.

Next to that, each Member State shall adopt a national renewable energy action plan (NREAP) in which Member States' national targets for the share of energy from renewable sources consumed in heating and cooling, electricity and transport in 2020 (Article 4) are set out. Under the NREAP, Member States shall assess the necessity to build new infrastructure for district heating and cooling produced from renewable energy sources in order to achieve the 2020 national target and where relevant, take steps with a view to developing a district heating infrastructure to accommodate the development of heating and cooling production from large biomass, solar and geothermal facilities (Article 16).

Each Member State shall also submit a report to the Commission on progress in the promotion and use of energy from RES with detail on the functioning of the system of guarantees of origin for heating and cooling from RES and the measures taken to ensure the reliability and protection against fraud of the system (Article 22).

2.1.2 CHP

Member States shall introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from RES in the building sector. In establishing such measures or in their regional support schemes, Member States may take into account national measures relating to substantial increases in energy efficiency and relating to cogeneration and to passive, low or zero-energy buildings (Article 13).

2.2 Energy Efficiency Directive (EED)

The 2012 Energy Efficiency Directive establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020 including through efficient cogeneration and district heating and cooling (Article 14). Systems using at least 50% renewable energy, 50% waste heat, 75% cogenerated heat or 50% of a combination of such energy and heat can be qualified as efficient district heating and cooling (Article 2).

Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain from its production to its final consumption. Member States were required to transpose the Directive's provisions into their national laws by 5 June 2014.

2.2.1 Heating and Cooling

Article 14 EED focuses on the promotion of efficiency in heating and cooling. The main premise of this article is that Member States need to carry out a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling for saving primary energy, and report this to the Commission (Article 24). Account shall be taken of the potential for developing local and regional heat markets. Cost-Benefit Analyses should become a dynamic and enabling instrument for facilitating the development of high efficiency cogeneration and district heating and cooling installation and the use from waste heat and renewable energy sources. In terms of the main reporting and monitoring requirements under the EED, all new or to be refurbished thermal generation

installations, industrial installations or district heating/cooling networks over 20 MW shall be subject to a cost-benefit analysis. In general, an integrated approach is necessary 'to tap all the existing energy savings potential' by assessing heat supply, demand in end-use sectors and potential. In Annex VIII of the Directive the requirements of the comprehensive assessment are described in detail.

The specific structure of the cogeneration and district heating and cooling sectors, which include many small and medium-sized producers, should be taken into account, especially when reviewing the administrative procedures for obtaining permission to construct cogeneration capacity or associated networks, in application of the 'Think Small First' principle.

The EED also introduces new requirements on the metering and billing of heating, cooling and hot water services provided via district and communal heat networks (Articles 9, 10 and 11). Final customers are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use for existing, new and refurbished buildings when connected to district heating (Article 9). Articles 10 and 11 are concerned with requirements for billing and billing information of heating, cooling and hot water provided to consumers connected to district and communal networks. Billing information for energy consumption is free of charge.

Member States shall submit to the Commission before 30 April each year statistics on national electricity and heat production from high and low efficiency cogeneration, in accordance with the methodology shown in Annex I, in relation to total heat and electricity production. They shall also submit annual statistics on cogeneration heat and electricity capacities and fuels for cogeneration, and on district heating and cooling production and capacities, in relation to total heat and electricity production and capacities. Member States shall submit statistics on primary energy savings achieved by application of cogeneration in accordance with the methodology shown in Annex II (Article 24).

2.2.2 CHP

The EED includes the following provisions for the promotion of CHP:

- By the end of 2015 Member States are required to carry out comprehensive assessments of CHP potential, a territory-level cost-benefit analysis and installation-level cost-benefit analysis, with requirements to take action for promoting CHP based on the results of these assessments (Article 14; Annex IV),
- Regarding small and micro-CHP, the EED includes recommendations to set up an "inform and install" simplified procedure for connecting micro-CHP units to the grid (Article 15) and encourages the introduction of measures and procedures to promote cogeneration installations with a total rated thermal input of less than 20 MW in order to encourage distributed energy generation,
- Opportunities at national level for supply-side energy efficiency measures to count toward the achievement of the energy savings obligations in Article 7,
- High efficiency CHP gets guaranteed transmission and distribution, priority or guaranteed access to the grid and priority of dispatch, within the limits of a secure operation of the national power system (Article 15),
- High-efficiency CHP operators can offer balancing services and other operational services at the level of transmission system operators or distribution system operators.

Where appropriate, Member States may require transmission system operators and distribution system operators to encourage high-efficiency cogeneration to be sited close to areas of demand by reducing the connection and use-of-system charges. Member States may allow producers of electricity from high-efficiency cogeneration wishing to be connected to the grid to issue a call for tender for the connection work (Article 15), and

- To increase transparency for the final customer to enable them to choose between electricity from cogeneration and electricity produced by other techniques, the origin of high-efficiency cogeneration should be guaranteed on the basis of harmonised efficiency reference values (Annex II (f)).

Like district heating and cooling, the specific structure of the cogeneration sector should be taken into account in administrative procedures and yearly reporting to the Commission about statistics on national electricity and heat production from on high and low efficiency cogeneration, statistics on cogeneration heat and electricity capacities, fuels for cogeneration and energy savings achieved through cogeneration (Article 24).

2.3 Energy Performance of Buildings Directive (EPBD)

The EPBD contains a range of provisions to improve the energy performance of new and existing buildings.

Under the Energy Performance of Buildings Directive:

- EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings (Article 10),
- Member States must set minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.) (Article 4; Article 5),
- Member States must implement a methodology for the calculation of the energy performance of buildings, taking account of all factors that influence energy use (Article 3),
- energy performance certificates are to be included in all advertisements for the sale or rental of buildings (Article 11; Article 12; Article 13),
- Member States must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect (Article 14; Article15), and
- all new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018) (Article 9).

2.3.1 Heating and Cooling

Buildings have an impact on long-term energy consumption. Given the long renovation cycle for existing buildings, new, and existing buildings that are subject to major renovation, should therefore meet minimum energy performance requirements (Article 4; Article 7) adapted to the local climate. As the application of alternative energy supply systems is not generally explored to its full potential, alternative energy supply systems should be considered for new buildings, regardless of their size, pursuant to the principle of first ensuring that energy needs

for heating and cooling are reduced to cost-optimal levels. For new buildings, Member States shall ensure that, before construction starts, the technical, environmental and economic feasibility of high-efficiency alternative systems such as those listed below, if available, is considered and taken into account (Article 6):

- decentralised energy supply systems based on energy from renewable sources,
- cogeneration,
- district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources, and
- heat pumps.

The prospective buyer and tenant of a building or building unit should, in the energy performance certificate, be given correct information about the energy performance of the building and practical advice on improving such performance. Information campaigns may serve to further encourage owners and tenants to improve the energy performance of their building or building unit. Owners and tenants of commercial buildings should also be encouraged to exchange information regarding actual energy consumption. The energy performance certificate should also provide information about the actual impact of heating and cooling on the energy needs of the building, on its primary energy consumption and on its carbon dioxide emissions.

Recent years have seen a rise in the number of air-conditioning systems in European countries. This creates considerable problems at peak load times, increasing the cost of electricity and disrupting the energy balance according the EPBD. Priority should be given to strategies which enhance the thermal performance of buildings during the summer period. To that end, there should be focus on measures which avoid overheating, such as shading and sufficient thermal capacity in the building construction, and further development and application of passive cooling techniques, primarily those that improve indoor climatic conditions and the micro-climate around buildings. Also, Member States shall lay down the necessary measures to establish a regular inspection of the accessible parts of air-conditioning systems and boilers used for heating buildings. The inspection shall include an assessment of the air-conditioning efficiency and the sizing compared to the cooling requirements of the building (Articles 14 and 15).

Member States shall ensure that guidance and training are made available for those responsible for implementing this Directive. Such guidance and training shall address the importance of improving energy performance, and shall enable consideration of the optimal combination of improvements in energy efficiency, use of energy from renewable sources and use of district heating and cooling when planning, designing, building and renovating industrial or residential areas (Article 20).

2.3.2 CHP

In the EPBD there is no specific provision for CHP except that Member States shall take the necessary measures to ensure that new buildings meet the minimum energy performance requirements and ensure that, before construction starts, the technical, environmental and economic feasibility of high-efficiency cogeneration, if available, is considered and taken into account (Article 6).

3 Role for local and regional authorities

Local and regional authorities, together with other stakeholders, have vital roles to play in achieving the EU '20-20-20' targets. Local and regional authorities are crucial actors in the preparation and implementation of several common European policies. In particular, they can contribute by promoting the use of renewable energy and the improvement of energy efficiency at the local and regional level, for example by setting ambitious targets, by streamlining administrative procedures and regulations, or by providing financial support (e.g. grants or guarantees).

In this chapter we will explore the role for local and regional authorities as described in the main EU-directives on Renewable Energy (RED), Energy Efficiency (EED) and Energy Performance in Buildings (EPBD). In general, the European Commission calls on Member states to actively encourage strategic cooperation between local and regional governments when defining and implementing their energy strategies.

3.1 Promoting renewable energy (RED)

The RED sets targets and regulations on a national level, and does not as such address local or regional level authorities directly. Nevertheless, the involvement and role of local and regional authorities in achieving the national targets is recognized in various provisions and in the preamble. In order to comply with the RED member states have submitted their National Renewable Energy Action Plan (NREAP), which should include adequate measures to achieve the national targets, including cooperation between local, regional and national authorities. Member States may encourage local and regional authorities (Articles 4, 13 and 14):

- to set targets in excess of national targets,
- in drawing up national renewable energy action plans,
- in raising awareness of the benefits of energy from renewable sources,
- to ensure equipment and systems are installed for the use heating and cooling from renewable energy sources and for district heating and cooling when planning, designing, building and renovating industrial or residential areas, and
- to use minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation.

The lack of transparent rules and coordination between the different authorisation bodies has been shown to hinder the deployment of energy from renewable sources according to the RED. Therefore the RED includes a number of provisions which address this issue in Article 13. The specific structure of the renewable energy sector should be taken into account when national, regional and local authorities review their administrative procedures for giving permission to construct and operate plants and associated transmission and distribution network infrastructures for the production of electricity, heating and cooling or transport fuels from renewable energy sources. Administrative approval procedures should be streamlined with transparent timetables for installations using energy from renewable sources. Planning rules and guidelines should be adapted to take into consideration cost-effective and environmentally beneficial renewable heating and cooling and electricity equipment. In addition, Member States may allow that obligation to be fulfilled by complying with

standards for zero energy housing, or by providing that the roofs of public or mixed private-public buildings are used by third parties for installations that produce energy from renewable sources.

3.2 Promoting energy efficiency (EED)

The EED includes many elements to improve energy efficiency and achieve energy savings. Public bodies at national, regional and local level are important drivers as regards energy efficiency, and the EED includes a number of provisions that encourages Member States to involve the local and regional government levels in their efforts.

Member states shall encourage public authorities to adopt an energy efficiency plan (Article 5(7)), freestanding or as part of a broader climate or environmental plan, containing specific energy savings and efficiency objectives and actions. For example, to purchase only products, services and buildings with high energy-efficiency performance (Article 6) and using efficient cogeneration and heating and cooling systems (Article 14). Member States may require competent local, regional and national authorities or operators of individual installations to carry out the cost-benefit analyses in relation to measures for promoting efficiency in heating and cooling (Article 14; Annex IX).

Secondly, Member states shall encourage public authorities to put in place an energy management system, including energy audits (Article 5(7); Article 8; Annex VI). In the EED, energy audits are defined as systematic procedures used to identify, quantify and report existing energy consumption profiles and energy savings opportunities in buildings, industrial or commercial operations or installations, and in private or public services. Energy management systems are defined as sets of elements of plans establishing energy efficiency objectives and strategies to achieve these objectives. Energy audits are an integral part of energy management systems.

Thirdly, Member states shall encourage public authorities to use, where appropriate, energy service companies, and energy performance contracting (when tendering service contracts) to finance renovations and implement plans to maintain or improve energy efficiency in the long term (Article 5(7)).

And lastly, Member states shall encourage public authorities in raising awareness of the benefits of taking energy efficiency improvement measures (Article 17).

3.3 Promoting energy efficiency in buildings (EPBD)

Measures are needed to increase the number of buildings which not only fulfill current minimum energy performance requirements, but are also more energy efficient, thereby reducing both energy consumption and carbon dioxide emissions. For this purpose Member States should draw up national plans for increasing the number of nearly zero-energy buildings and regularly report such plans to the Commission (Article 9).

Since local and regional authorities are critical for the successful implementation of this Directive, they should be consulted and involved (Article 20; Article 21), as and when appropriate in accordance with applicable national legislation, on

- planning issues,
- the development of programs to provide information on energy performance,
- training and awareness-raising, and
- the implementation of this Directive at national or regional level

Such consultations may also serve to promote the provision of adequate guidance to local planners and building inspectors to carry out the necessary tasks.

4 Overview of main types of EU supported projects with respect to heating and cooling and CHP focusing on LRAs

As already mentioned above high efficiency cogeneration (CHP) and district heating and cooling, especially when fired with RES, have significant potential to contribute to the achievement of all three EU '20-20-20' targets. The technologies are mature, however, progress in deployment is still slow. Public funding seems to be necessary to fill possible financial gaps that cannot be filled by market parties because of the risks[4]. The scale of investment needed to meet the EU's 2020 energy efficiency target is estimated at around EUR 100 billion per year. The EU has increased the amount of public funds available for energy efficiency, but there is a need to boost private energy efficiency investments through a targeted use of public funds, the development of robust investment solutions and support activities for project developers.

EU support for projects in the field of heating and cooling as well as CHP focusing on LRAs originates mainly from the Intelligent Energy Europe (IEE) Programme with its successor, the Horizon 2020 programme, the European Structural and Investment Fund (ESIF) with its coordinated funds, the European Regional Development Fund (ERDF) and the Cohesion Fund, and to a smaller part the FP7 programme Smart Cities and Communities. Besides these, the European Energy Efficiency Fund (EEEF) exists, being a public-private partnership open to investments from institutional investors, professional private investors, international financial institutions and donor agencies. Under the EU's LIFE programme the Private Finance for Energy Efficiency (PF4EE) instrument co-funds energy efficiency programmes in several EU countries. This new financial instrument is based on a joint agreement between the EIB and the European Commission which aims to address the limited access to adequate and affordable commercial financing for energy efficiency investments. The instrument targets projects which support the implementation of National Energy Efficiency Action Plans or other energy efficiency programmes of EU Member States.

In this chapter the main types of EU supported projects with respect to heating and cooling and CHP will be discussed, followed by an overview of the most relevant projects for LRAs and conclusions.

4.1 Intelligent Energy Europe and Horizon 2020 programmes

Under the IEE Programme a total budget of EUR 730 million was available to fund projects from 2003 to 2013. Projects in the heating and cooling sector and for CHP were possible under the funding areas Energy efficiency and the rational use of energy (SAVE) or New and renewable resources (ALTENER). In particular, under the IEE II programme from 2007 to 2013 a total sum of circa EUR 32 million has been granted for projects supporting the market uptake of heating and cooling with energy efficient and renewable energy sources (RES).

[4] E.g. banks don't trust energy savings as revenues.

Besides this a range of European portals, facilities and initiatives (such as the Covenant of Mayors initiative, the EU Sustainable Energy Week and the BUILD UP Skills initiative) were established.

From 2014 onwards these types of activities are funded under the European Union's Research & Innovation Programme Horizon 2020. A total sum of EUR 198 million was spent for the Energy Efficiency Calls for 2014 and 2015 and a budget of approximately EUR 194 million is foreseen for the Energy Efficiency Calls for 2016 and 2017.[5]

The IEE Programme offered, inter alia, funds to support energy-efficient buildings and industry, heating and cooling, SMEs and energy-related products and services, as well as for improving the attractiveness of energy-efficiency investments. It was launched in 2003 by the EU Commission and ran until 2013. A number of projects funded under the programme are continuing. The EU's Horizon 2020 programme now supports the research, demonstration and market up-take of energy-efficient technologies.

The main objectives for the whole duration of the IEE programme were:

- in the field of energy efficiency and CHP
  - to improve energy efficiency as far as economically possible and to reduce energy intensity by 1% a year in order to achieve two thirds of the energy-saving potential, which is estimated at 18% of total consumption, by 2010, and thus
  - to achieve a reduction in CO_2 emissions estimated at 40% of the EU's Kyoto commitment, and
  - to make a significant increase in the quantity of electricity generated from CHP by 2010.

- in the field of RES
  - to commence activities aimed at the development of RES and to promote legislative measures so that the share of RES in gross domestic energy consumption is increased from 6% to 12% by 2010 (electricity, heat, biofuel),
  - to increase the share of electricity generated from RES to 22.1% by 2010, and
  - to create the best possible conditions to speed up investment so that the capacity installed for the generation of energy from RES is increased.

Heating and Cooling

Examples of the supported types of projects include development and implementation of standards for the quality of products and installations, market analyses, streamlining of administrative and authorisation procedures, capacity building activities at regional and local levels, regional heating and cooling planning and resource assessments.

Besides this, the EU Commission set up a series of Project Development Assistance (PDA) facilities to support ambitious public authorities from the regional and local level and public bodies in developing bankable sustainable energy projects. These PDA facilities[6] are meant to bridge the gap between sustainable energy plans and real investment through supporting the

[5] For more details see: http://ec.europa.eu/easme/en/horizon-2020-energy-efficiency.
[6] For an overview on PDA facilities supported by the EU Commission see http://ec.europa.eu/energy/intelligent/getting-funds/project-development-assistance/index_en.htm

activities that are necessary to prepare and mobilise investment into sustainable energy projects. The activities include for example feasibility studies, stakeholder and community mobilisation, financial engineering, business plans, technical specifications and procurement procedures. The Mobilising Local Energy Investments (MLEI) PDA is relevant here as it has supported public authorities and public bodies in developing inter alia large scale heating and cooling infrastructure projects using RES. Under the Horizon 2020 programme this type of funding has been extended to cover both public and private organizations.

The Horizon 2020 energy programme is designed to support the transition to a secure, clean and efficient energy system for Europe and is split into three focus areas: Energy-efficiency; Low carbon technologies; and Smart Cities & Communities.

The already running projects (STORM and FLEXYNETS) in the field of district heating and cooling focus on the development of intelligent district heating and cooling networks. Under the STORM project a DHC network controller will be developed and then be implemented in two pilot sites, where the resulting energetic, economic and environmental gains will be assessed. Through replication, dissemination and education efforts, the project outcomes will be transferred to several stakeholders across the EU, and shall thus contribute to a wider deployment of DHC networks at the EU level.

The calls for the period of 2016-2017 partly contribute to the implementation of the relevant legislation in the energy sector:

- EED: The engagement and capacity building of public authorities is pursued through two calls[7] and the development of tools for public authorities to carry out heating and cooling mapping and planning in one call[8].
- Ecodesign & Labelling Directive: The support for market surveillance authorities for enforcement of the EU's energy-related products legislation is pursued through one call[9] and increasing consumer interest for energy efficient products in another call[10].

Besides this the following calls deal with (district) heating and cooling:

- EE-03-2016: Standardised installation packages integrating renewable and energy efficiency solutions for heating, cooling and/or hot water preparation;
- EE-04-2016-2017: New heating and cooling solutions using low grade sources of thermal energy;
- EE-05-2016: Models and tools for heating and cooling mapping and planning; and
- EE-17-2016-2017: Valorisation of waste heat in industrial systems (SPIRE PPP).

CHP

Examples of supported types of projects (CHPGOESGREEN) include awareness raising of key stakeholders and the public especially for pairing of CHP and RES, feasibility studies for

[7] EE-9-2016-2017 – Engaging, activating public authorities and EE-19-2017 – Public Procurement of innovation in energy efficiency.
[8] EE-5-2016 – Models and tools for heating and cooling planning.
[9] EE-16-2016-2017.
[10] EE-6-2016-2017.

CHP projects running on RES, the development of marketing material, websites and international seminars for the dissemination of project results.

Under the Cogeneration Observatory and Dissemination Europe projects (CODE and CODE2) the project partners and the COGEN Europe members encouraged the rapid and effective implementation of the CHP Directive and independently reviewed the Member States' progress and the success of implementation. CODE highlighted best practise where it occurred and drew attention to areas of poor performance or practical difficulties in implementation. CODE2 disseminated the lessons learned from the CODE project and structured and supported the development of national and European CHP roadmaps. Besides this "How-to" guides focused on understanding the CHP legislation and business case to simplify first steps for new users interested in expanding CHP deployment in specific sectors (food, paper, hospitals and commercial premises) were developed. Based on the lessons learned through developing roadmaps with the pilot Member States a concrete and realisable European Roadmap to 2030 as well as national cogeneration roadmaps for all 27 Member States was developed.

4.2 ESIFs: European Regional Development Fund and Cohesion Fund

With a budget of EUR 454 billion for 2014-20, the European structural and investment funds (ESIFs) are the European Union's main investment policy tool. Partnership agreements between the European Commission and individual EU countries set out the national authorities' plans on how to use funding from the European Structural and Investment Funds between 2014 and 2020. They outline each country's strategic goals and investment priorities, linking them to the overall aims of the Europe 2020 strategy for smart, sustainable and inclusive growth. Once the partnership agreements have been adopted, the EU Commission and the national authorities agree on programmes setting out the priorities for each country, region or policy area concerned.

The European Regional Development Fund (ERDF) aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. For the 2014-2020 funding period the rules of the ERDF required Member States for the first time to allocate a mandatory minimum proportion of the available funding to the low-carbon economy (20% of national ERDF resources in more developed regions; 15% in transition regions; 12% in less developed regions).

Article 5 of the ERDF Regulation[11] sets the investment priorities as follows:

- 4) Supporting the shift towards a low-carbon economy in all sectors by:
- 4(b) "promoting energy efficiency and renewable energy use in enterprises";
- 4 (c) "supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings, and in the housing sector";

11 Regulation (EU) No 1301/2013 of the European Parliament and of the Council of 17 December 2013 on the European Regional Development Fund and on specific provisions concerning the Investment for growth and jobs goal and repealing Regulation (EC) No 1080/2006.

- 4 (e) "promoting low-carbon strategies for all types of territories, in particular for urban areas, including the promotion of sustainable multimodal urban mobility and mitigation-relevant adaptation measures";
- 4 (f) "promoting research in, innovation in and adoption of low-carbon technologies";
- **4 (g) "promoting the use of high-efficiency co-generation of heat and power based on useful heat demand".**

ESI Funding programmes focus heavily on energy efficiency investments, particularly on the energy efficiency of buildings and Small and Medium-sized Enterprises (SMEs).
There are no exact data on how much funding is allocated to heating, cooling and CHP, but the following overview of funding allocation illustrates the significance of this programme to these sectors.

- EUR 13.3 billion from the ERDF and the Cohesion Fund will be invested in energy efficiency in public and residential buildings, leading to 875,000 families living in homes that have been renovated to reduce energy use and to public buildings using 5.2 TWh/year less energy than they do now;
- EUR 3.4 billion from the ERDF and the Cohesion Fund will support energy efficiency measures in over 57,000 companies, mainly SMEs;
- EUR 13.3 billion from the ERDF and the Cohesion Fund will be invested in energy efficiency in public and residential buildings, leading to almost 1 million households with renovated dwellings and reduced energy bills for public buildings;
- EUR 870 million and EUR 113 million respectively from the EAFRD and the EMFF for energy efficiency measures in rural development and for fisheries, leading to 24, 000 farms with improved energy efficiency, and a significantly higher number of energy-efficient fishing boats.
- EUR 1.7 million of ERDF and Cohesion Fund are to be invested in the support for high-efficiency cogeneration.

Besides this ESI Funds improve conditions for achieving the Energy Union by providing administrative capacity building and technical assistance. The Commission is undertaking a number of initiatives to help Member States implement energy investments:

- The Energy and Managing Authorities (EMA) network brings together national energy and Cohesion Policy Managing Authorities, and acts as an informal platform for exchanging information and sharing good practices, experiences and latest developments to ensure the best possible use of the funding.
- The Smart Specialisation Platform on Energy is supporting regional energy innovation and the broad adoption of Cohesion Policy energy projects, including policy advice and analysis as well as matchmaking and dissemination. However, this activity just started and no project have been realised so far.

4.3 European Energy Efficiency Fund

The European Energy Efficiency Fund (EEEF) targets investments in the EU Member States. The final beneficiaries of EEEF are municipal, local and regional authorities as well as public and private entities acting on behalf of those authorities such as utilities, public transportation providers, social housing associations, energy service companies etc. With a total sum of EUR 265 million this fund provides tailor-made debt and equity instruments.

Eligible energy saving and energy efficiency investments include:

- Public and private buildings incorporating RES and/or energy efficiency solutions including those based on the usage of Information and Communication Technologies (ICT),
- Investments in high energy efficient CHP, including micro-cogeneration, and district heating and cooling networks, in particular from RES,
- Local infrastructure, including efficient lighting of outdoor public infrastructure such as street and traffic lighting, electricity storage solutions, smart metering, and smart grids, that make full usage of ICT, and
- Energy efficiency and renewable energy technologies with innovation and economic potential using the best available procedures.

5 Most relevant projects for LRAs

In the following the most relevant projects for LRAs are described by focusing on the role and the involvement of the LRAs within the selected projects. A non-exhaustive list of projects is given in the overview table in Annex I.

5.1 Heating and cooling

One of the currently most relevant projects for LRAs for heating and cooling is the project STRATEGO, funded under the Intelligent Energy Europe Programme. The project aims at supporting local authorities of 23 cities/regions in mapping their local heating and cooling demand and supply. Furthermore, areas of priority for intervention are defined. To ensure a cross-border cooperation and exchange of best practices a coaching scheme between 23 learning regions/cities and 8 experienced regions/cities is applied.

A further important project in this area is the RES H/C SPREAD project, also funded under the Intelligent Energy Europe Programme. The project focuses on six regional pilot plans in the field of heating and cooling with renewable energies, representing the EU main climatic zones. The plan implementation is supported by Country Governance Committees. These Committees, constituted in each of the six regions, aim at supporting the Regional Authorities, key stakeholders and citizens representatives in finding a consensus on the proposed policies.

A project with a broader focus, but nevertheless aiming at an active participation of local administration is the Horizon 2020 project call "removing market barriers to the uptake of efficient heating and cooling solutions". To take advantage of the unexploited potential of heating and cooling solutions, the project focuses on an integrated planning and integration of heating and cooling into the territorial context, involving as well the local administration.

The RegEnergy project funded under the ERDF brought together national, regional and municipal players in a Europe-wide network. RegEnergy worked on improving the energy sector through local policy making and financial incentives to boost the efficient use of energy and helped European regions and communities to meet the rising demand for heating and cooling systems. By sharing experience gained on previous projects, these regions and communities were able to exploit innovative uses of renewable energy sources.

5.2 District heating

The project GEO-DH aims at supporting regions and local authorities in removing administrative and financial barriers regarding district heating by sharing best practices of geothermal district heating through workshops within 14 target countries.

Similarly, the project ECOHEAT4CITIES aims at removing "non-technological" barriers of district heating, fostering the acceptance of municipalities and the public of DHC systems by establishing a voluntary green energy (heating and cooling) labelling scheme.

SMARTREFLEX is a project focusing on European cities and including regional authorities in their mixed project consortium. The project focuses on the implementation of legislative and organisational measures for promoting high-RES DHC. Furthermore, a know-how transfer by Denmark takes place.

The project RESCUE aims at enabling local communities to recognize the benefits of district cooling by giving practical guidance and assist municipalities and local utilities.

All four projects are funded under the Intelligent Energy Europe Programme.

The Horizon 2020 Call "Improving the performance of inefficient district heating networks" aims at increasing the efficiency of existing heating networks by retrofitting inefficient networks and supporting city-wide networks or networks at the district/neighbourhood level to take actions.
The projects funded under the ERDF mainly included rehabilitation of district heating system in a number of municipalities in order to bring them in line with EU requirements. Another focus of the projects was the construction or expansion of local heat networks powered by biomass.

5.3 CHP

While the project CODE assessed the progress of the CHP Directive across Europe, CODE2 will disseminate the lessons learned from the previous project and will develop a simplified guide explaining the CHP legislation and business case for new users interested in CHP deployment. Furthermore, individual National Cogeneration Roadmaps for all Member States will be developed.

The project CHP GOES GREEN carried out promotional activities for the use of RES in cogeneration in eight model cities and regions across Europe. Good practice examples were promoted through the website, workshops and conferences. Furthermore, the know-how acquired was transferred to other European cities and regions through international workshops and personal meetings.

SOLROD on the other hand is a project of the municipality of Solrød in the Zealand region of Denmark. Within the MLEI PDA project a CHP biogas plant is constructed, benefitting local stakeholders and the wider community.

6 Conclusions current EU policies and supported projects

6.1 Current EU policies

Various EU Directives have relevance for heating and cooling as they provide for specific measures regulating or influencing heat consumption or production, even though they often have a more general focus on energy demand and supply, and only indirectly target heat. Cooling is even less the object of EU regulations. The main instrument is the Energy Efficiency Directive (EED), which requires Member States to carry out a comprehensive assessment and cost-benefit analyses of potentials for high-efficiency cogeneration and efficient district heating and cooling. The Energy Performance of Building Directive (EPBD) mandates setting requirements for the energy efficiency of buildings, including the reduction in buildings' thermal energy demand. The Renewable Energy Directive (RED) includes the heat sector in the 2020 renewable energy target and promotes direct renewable energy use in buildings or use of renewable energy through district heating and cooling as an instrument towards that target.

Local and regional authorities are pivotal in achieving the EU ‘20-20-20’ targets and can play an important role, together with central governments, in defining and implementing national energy strategies and developing plans for specific areas. Local and regional authorities are, however, not regulated directly in the RED, EED and EPBD. In the RED, Member States may encourage local and regional authorities to set requirements (e.g. minimum levels of renewables and use of district heating and cooling systems) in existing and new buildings in all stages of construction. The role for local and regional authorities is more pronounced in the EED, where local and regional authorities are involved in adopting an energy efficiency plan containing efficiency objectives and actions and implementation of this plan through an energy management system. Cost-benefit analyses are to be carried out to make well informed decisions for the purpose of heat planning. They should also fulfill an exemplary role in purchasing only products, services and buildings with high energy-efficiency performance and stimulate other parties through service contracting in doing the same. In the EPBD local and regional authorities should be consulted in the effective implementation of this Directive at national or regional level and also ensure that buildings owned by these authorities are nearly zero-energy by 2020.

In general, local and regional authorities have furthermore a relevant role to play to inform citizens of the opportunities and implications of the development of energy from renewable sources and energy reduction as these public bodies are closest to citizens as underlined in the Directives.

6.2 EU supported projects

When looking at the multiannual financial framework (MFF) 2014-2020 it can be noted that energy efficiency projects and activities receive two times more money than within the former MFF. Specific indications of the level of support for heating and cooling, district heating and CHP respectively, are not available (and could not be estimated due to time limits). The level

of support in the past, however, seems to be quite low when compared to the budgets foreseen for energy efficiency measures in general, and the renovation of buildings in particular. Under the ESIFs it seems that there are no specific budgets allocated to heating and cooling, district heating and CHP.

The number of EU supported projects is quite small (compared to for example projects dealing with RES generation), however, under the Horizon 2020 programme an increase especially of projects in the heating and cooling sector is noticeable.

While in the past LRAs were in many cases only involved via pilot projects and invited to join awareness raising campaigns this seems to have changed significantly in recent years: LRAs are given assistance in fulfilling their tasks, are offered comprehensive exchange possibilities with other LRAs and are actively involved in the processes of implementation of organisational and legislative measures. The necessity of an integrated planning and integration of heating and cooling into the regional and local context seems to have been detected.

This momentum is at least partially created by the implementation of the energy efficiency relevant EU legislation and in particular by the obligation of the EU Member States to carry out and submit comprehensive assessments of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling for saving primary energy, and report this to the Commission (Articles 14 and 24 EED, as laid down above).

7 Key highlights and conclusions of good practice examples

7.1 Methodology

The four city case studies on district heating and cooling – Purmerend (The Netherlands), Milan (Italy), Miskolc (Hungary) and Vienna (Austria) – were selected to ensure that several criteria are met and represented, namely, among others: geographical location within Europe, size of population, climate zone, energy policy and targets of the city as well as system and special type of district heating and cooling, stakeholder involvement and replication potential.

The case analysis followed the established and proven template of ICLEI's case studies, but was adapted to the needs and focus of this study through the following overarching questions:

- Which European and national policy was helpful and/or counterproductive?
- What is new and/or different about the approach at local, regional and/or national level?
- What future activities are planned in reflection of expected framework conditions?
- What would be the ideal framework to replicate DHC?
- How could the EU / MS better support the respective project at regional and local level?

The comprehensive case studies can be found in Annexes II-V.

7.2 Case analysis of Stadsverwarming Purmerend: the most sustainable district heating company of the Netherlands

Local Government Full Name	*Purmerend*
Official Name (in original language)	*Stadsverwarming Purmerend*
Country	*The Netherlands*
State/Province	*Noord-Holland*
Web address	*www.stadsverwarmingpurmerend.nl*
Municipal Budget	*142 million Euro (2015)*
Total Geographical Area	*24.56 km² (2014)*
Geography	*Coastal*
Climate	*Marine west coast*
Population	*79,576 (2014)*
Community's total annual GHG emissions in t CO_2e	*385,000 t CO_2e (2012)*
Climate commitments and pacts signed	*Covenant of Mayors (N)*
System type of district heating/project	*Heating, low temperature grid (outgoing temperature <95 °C)*
Spatial type of district heating/project	*Centralised system, local*
System's type of fuel	*Two gas auxiliary boilers (cover 20% of heat demand) and one 100% biomass plant of 44 MW_{th} (contributes 80% of total heat demand) with local biomass from the state forestry agency of the Netherlands.*

Table 1: City and DHC profile Purmerend

Stadsverwarming Purmerend (SVP) is a district heating company formed in 2007 by taking over the municipal heating company of Purmerend (existing since 1981) and is currently the largest sustainable district heating company in the Netherlands. 80% of total heat production is sustainable, biomass sources are local and come from the state forestry agency of the Netherlands. SVP provides heat for 25,000 households and 1,000 businesses and thus connecting 75% of the total municipal area.

7.2.1 Economic and financial aspects

Forecast Profit & Loss account Amount x € 1,000	**2016**	**2019**	**2020**	**2024**
Revenues	28,355	31,272	32,272	36,494
Cost of goods sold (COGS)	9,551	10,655	11,201	12,152
Gross margin	18,804	20,617	21,071	24,342
Operating expenses (SG&A)	17,821	14,922	14,241	15,960
Financial income & expenses	3,144	3,074	2,536	2,302
Net profit/ EBT (before taxes)	-2,162	2,621	4,294	6,079

Gross profit for 2016 is estimated at € 18.8 million and Net profit is -€ 2.2 million.

Table 2: Profit & Loss account Stadsverwarming Purmerend (SVP)

According to the profit & loss account, SVP is not profitable yet. It is projected that from 2019 on SVP will be profitable. It is expected that dividends can be paid from 2020 onwards, given a then structurally profitable situation, to the municipality of Purmerend which is the 100% shareholder of SVP. Dividends will also be paid retrospectively for the period 2013-2018 and are € 4.2 million.

The municipality Purmerend is 100% shareholder of SVP. In the past, the municipality took huge losses. As a shareholder, the municipality has also provided guaranteed loans to SVP. The outstanding loans are currently € 13 million (31.12.2015). For this, it receives a commission risk of € 0.7 million annually. Part of the municipality debt by the participation in SVP by € 38.3 million, or about 17% of total debt.

However, at the same time SVP also contributes to the local economy, namely through social contribution (employment, CSR, training for installers/housing associations) and the positive image of sustainable district heating. Two new residential areas will be connected to the district heating network.

The most important parameters for profitability:

- Legislation and regulation (the selling price of heat is regulated through the Dutch Heat Act. It came into force on January 2014 and sets a maximum price for supplying heat).
- The gas price (under the current legislation this has a major influence on the selling price of heat. Heat cannot cost more than what customers pay for a gas).
- The weather (affects sales of heat). The uncertainty of weather conditions is an important risk factor for the return and profitability, the sales volume is lower in warmer months/years. In warmer years it is corrected for the temperature and this is a risk for budgetary outlooks since it is not known beforehand whether the year will be cold or not.

In 2007 for instance this was the case, the heating season, between November and February, was relatively warm in the Netherlands and led to lower sales.
- The condition of the district heating network (affects heat loss, disruption of heat transportation and water).
- Residential builds and maintaining existing connections (affects sales of heat).

The DHC system is financed through various actors, models and funds, mainly:

- PUBLIC/ LOCAL: Municipality/shareholder: € 38.3 million.
- EU: ELENA-subsidy (European Local ENergy Assistance) of European Investment bank: € 1.8 million.
- MARKET: A consortium of banks (BNG Bank and Triodos Bank) lent € 46.7 million under municipal guarantees.
- PUBLIC/NATIONAL: Dutch government subsidy SDE+ (Netherlands Enterprise Agency carries out SDE+ for the Dutch Ministry of Economic Affairs). SDE+ compensates producers for the unprofitable component of renewable energy production for a fixed number of years, depending on the technology used.
- PUBLIC/NATIONAL Government tax benefits: *Energie-Investeringsaftrek* (EIA) which provides deduction of the customary depreciation charges. Also, deduction of 41.5% of the investment cost of energy conservation equipment from taxable profit. Consequently, this results in less corporation tax.
- PUBLIC/NATIONAL: Subsidy from government programme (*Programma industriële warmtebenutting - PIWB*) to better use of waste heat and renewable heat in industry.
- Green Deal with the government and the municipality Purmerend, Province of Noord-Holland and *Staatsbosbeheer* (manages a sizeable amount of the nature reserves in the Netherlands) for knowledge development, networking, removing legislative barriers, and for the needed exposure. SVP is, with the green deal, taken more seriously. The Green Deal does not give subsidy per se but rather informs participants about subsidy.

7.2.2 Achievements and results

One of the main achievements is surely that SVP is the most sustainable heating company of the Netherlands. From 2014 onwards, 80% of the annual heat demand of SVP comes from biomass and SVP is climate neutral. The source is local biomass from the state forestry agency of the Netherlands (*Staatsbosbeheer*). Through the use of RES SVP reduces 50,000 tons CO_2-emissions annually. 75% of total households in Purmerend (25,000 customers) are connected to district heating as well as 1,000 business customers. The cooperation with 25 other parties for the realisation of a regional district heating network with other cities like Amsterdam (Metropole region) is established.

In 2015, SVP has put the final steps of the improvement programme drawn up in 2009:

- Completion of project 'SlimNet': in 5 years time, the connections of nearly 4,000 households are renovated with plastic pipelines instead of steel. This renovation and innovation of the district heating reduces the heat loss with 36% and delivers 10% in energy savings. In addition, the number of failures in the system decreases by 50%.
- Completion of project 'Charon': 8 underground substations have been replaced by ground-level substations.
- Sole responsibility for the heat production over 2015 (no third parties anymore who deliver the heat).

- Revision of the in 2014 acquired gas auxiliary (*HulpWarmteCentrale1*) from NUON.
- Operationalisation of 100% biomass plant (*BioWarmteCentrale De Purmer*).

7.2.3 Replication potential

According to the interviewee an integrated approach is crucial. Also the operation should be kept in own hands as this leads to an optimal (technical) situation with fewer losses. The customer will benefit from this. The contact at SVP was not in favour of an 'open district heating network' with multiple suppliers, like gas and electricity networks, because it leads to different/conflicting interests, which will eventually have a negative impact on the DHC company and the customer.

Under certain conditions the DHC can become and remain sustainable, namely when a higher efficiency in system is reached by reducing the losses at costumer level. SVP is already very sustainable since 80% of total heat demand is produced with local biomass (woodchips). The remaining 20% is peak load and the innovations now on the market focus on base load. An option would be to use biogas for peak load instead of natural gas but this is looked at in the long term.

Moreover, according to the interviewee, the most important factor that made SVP successful was the human component. The ability to persuade, convince and push through was very important since SVP was coping with significant technical and financial issues and was perceived as a risk.

7.2.4 Conclusions

A key driver for success was the collaboration with the state forestry agency of the Netherlands (*Staatsbosbeheer*) for local biomass source (woodchips) since 2011. This cooperation was important, because it guaranteed supply, sustainability and the future profitability of the *BioWarmteCentrale De Purmer* (biomass plant) which was then in construction. Another important driver was that the municipality of Purmerend was 100% shareholder and it was also in their interest that SVP succeeded in their activities. This resulted in positive outcomes in financing (loans) and permit procedures. The managerial practices and organisational structure of SVP as a small company were favourable for implementing innovations without having to pass a comprehensive hierarchy structure (decision-making is fast). Other positive factors include:

- Sole responsibility for the heat production over 2015 (no third parties anymore who deliver heat);
- Membership of Euroheat & Power;
- Local & supra-local partnerships: Green deal with the Dutch Government & other parties. Also, cooperation with 25 other parties for the realisation of a regional district heating network with other cities like Amsterdam (Metropole region); and
- The ELENA subsidy worked very well, because it enabled the hiring of necessary experts for a technical support to prepare, implement and finance investment programmes.

In general, the Netherlands should stimulate more heat projects (financially) and make the alternative (gas) more expensive through taxes or other means. Denmark is an example of the latter, the alternative is always more expensive and this is would make DHC more favourable.

In this context a strategic framework for district heating and cooling should be created through EU Directives and national legislation.

7.3 Case analysis of Milan: Enhancing and integrating district heating grids and developing district cooling through a successful public-private partnership mode

Local Government Full Name	*City of Milan*
Official Name (in original language)	*Comune di Milano*
Country	*Italy*
Web address	*www.comune.milano.it*
Municipal Budget	*4.706,4 million Euro (2014)*
Total Geographical Area	*181.76 km² (2015)*
Geography	*Lowland*
Climate	*Humid subtropical with continental influences*
Population	*City 1,343,163, Metropolitan area 3,204,601 (2015)*
Community's total annual GHG emissions in tCO2e	*3.729 ktCO_2e (2013)*
Climate commitments and pacts signed	*Covenant of Mayors (18 Dec 2008), Compact of Mayors (2015)*
System type of district heating	*Heating, cooling, combined heating and cooling, CHP*
Spatial type of district heating	*Decentralised system, serves the city and part of the metropolitan area*
System's type of fuel	*Methane, waste, waste heat, groundwater (through heat pump)*

Table 3: City and DHC profile Milan

Milan forms the centre of the largest Italian metropolitan area, with more than 3.5 million inhabitants. It is situated in the most important production and strategic areas of Italy, with high-tech innovation companies, business enterprises and financial institutions, as well as an administrative centre. In order to address the issue of climate change, Milan has joined multiple international climate initiatives, including ICLEI's Cities for Climate Protection (CCP) Campaign, the ICLEI Local Renewables Initiative, the Covenant of Mayors in 2008 and the Sustainable Energy Europe Campaign (SEEC). In February 2009 Milan set the goal to achieve a 20% reduction of CO_2 emissions based on 2005 levels by 2020.

7.3.1 Economic and financial aspects

Faced with a high number of polluting diesel fuelled boilers used for heating purposes (domestic, commercial and industrial), Milan and the local electricity and gas utility company A2A have invested in CHP for district heating and partly for cooling, as well as into recovering the heat of the Silla 2 incineration plant and that of an aquifer using it for district heating. After a period of great expansion, the city is now looking at connecting its major DH networks to increase their flexibility in heat provision and at increasing its 11km district cooling network. All these objectives are part of Milan's emissions reduction plan and are

integrated into the city's Sustainable Energy Action plan and in its general urban planning development.
Such an impressive development has been made possible through cooperation between the Municipality and A2A. A2A has carried the infrastructural costs and pays yearly fees to the Municipality for land use.

In its turn, the Municipality has supported the district heating network development with enabling legislation and urban planning instruments. As an example, the city has created a shared database to integrate the various public works involving the removal of the urban road surface so that different infrastructure providers can work simultaneously and inconveniences for urban traffic and citizens are kept to a minimum.

Furthermore, the Plan for Underground Services, PUGSS, which defines the use of the city underground network sets the future vision for the district heating network and prescribes that the already happening integration of different networks in the city will continue to create a larger network ring around the city center.

To support its DHC development, Milan has also participated in the EU-financed STRATEGO project, aiming at helping national and local authorities develop enhanced Heating & Cooling plans.

The infrastructural costs for the installation of the DH plants and network were carried by A2A. The total investment during the years 2008-2013 amounts to ca. 200 million €, with a constant grow over time. Notwithstanding this considerable investment, the cost of DHC for customers was kept competitive in comparison to alternative technologies. The customers pay a connection fee to join the district heating network in addition to the fee linked to the energy consumed. This varies according to the location and the size of the household. As such, DHC does not represent a cost for the Municipality. Milan grants concessions to A2A every year for the underground use, creating an income for the city.

7.3.2 Achievements and results

The 2014 building code has mainstreamed energy efficiency, and thus also the uptake of DHC into the general urban development. Specifically, the code prescribes precise energy efficiency standards for new and retrofitted buildings and the possibility to increase the cubic volume of new buildings in case stricter energy efficiency parameters than the minimum requirements are set, thus incentivising higher energy efficiency standards in the city.

Other main achievements of the past energy and DH strategy include the following:

- Diesel boilers in Milan have been reduced drastically, contributing to improved air quality and emissions' reduction and dramatically reducing heating costs for residents.
- Highly efficient heating service for citizens has been made accessible, affordable and easy. Maintenance costs have been reduced as condominiums no longer have in-house boilers that they need to operate and maintain and this is rather centralised and done by A2A.
- Emissions have been reduced and waste heat is being used. In 2014, DH in Milan avoided the emissions of 84,000 tons of CO_2, 4.3 tons of particulate, 108.8 tons of NO_x, 39.5 tons of SO_2 and the consumption of 29,000 tonnes of oil equivalent. The total thermal energy

delivered amounted to 713,819 MWh and the total cooling energy delivered to 3,542 MWh.
- CHP contributes to tackling the high electricity demand in the highly industrialised Lombardy region.
- High acceptance and satisfaction of citizens is guaranteed through continuous quality controls, information sharing and public consultations. During a public consultation in 2011, 90% of the citizens recognised the further development of the district heating as a priority for the future of the city.
- Citizens are guaranteed a service that is safer and more convenient. The district heating has the advantage of eliminating boilers, tanks and flues in buildings, diminishing the risk of fires and cutting maintenance costs.

7.3.3 Replication potential

DHC can be replicated very easily in densely populated areas and especially if renewable energy sources (e.g. geothermal) or waste heat (e.g. industrial production, waste incineration) are available. Especially through CHP costs are contained as energy efficiency is increased and the power produced is sold to the grid.

Including district cooling into the picture can dramatically increase efficiency, reduce electricity peaks on the grid in summer and further reduce GHG emissions. This is particularly applicable to new building stock and office buildings while it is hardly applicable to the existing domestic building stock.

Replication potential	*Medium – building density and/or existing heat sources should be present*
Finance requirements	*Low – by replicating the financing model through a local utility there is virtually no cost for the municipality*
Expertise requirements	*Medium – an interface between urban planning and the local energy provision is necessary*
Staff intensity	*Medium – the utility that is in charge of the public works can include the DH network development in its BAU operations*
Technology requirements	*Medium – the technologies used are mature and available on the market*
Preparation time	*Medium – memoranda of understanding and coordination is necessary between different bodies*
Area requirements	*Cold winters, high electricity demand, underground aquifer available*

Table 4: Replicability assessment Milan

7.3.4 Conclusions

Cooperation with the local energy and heat provider represent a successful business model. The provider can sell electricity and heat to the market and pay the investment back by taking a part of the energy savings created for citizens. Integrating different infrastructural underground public works (ICT, electricity, DHC, etc.) sensibly reduces economic costs and inconveniences for citizens and eases implementation.

Creating a business case that is profitable for everyone, the city, the local utility company and citizens, facilitates the uptake of the measure. Integrating DHC into the strategic climate

objectives of the city is crucial to keep momentum on its development and to progressively integrate it into urban planning. Creating a helpdesk raising awareness and explaining advantages of DHC for citizens is crucial to creating a market demand and fostering acceptance.

The Milan case shows that municipalities do not necessarily incur into high costs to develop DHC and CHP technological and infrastructural solutions. The EU should develop management guidelines on feasible business models for cities so as to raise awareness on these already existing possibilities and how to kick-start and coordinate them. The EU should incentivise the uptake of District Heating and Cooling especially in local contexts in which domestic heating is still mainly provided through highly polluting fuels (such as diesel) as this facilitates a streamlined and fast replacement of the older technology.

7.4 Case analysis of Miskolc: Utilising local renewable potential to sustain district heating and create regional value chains

Miskolc is a city in north-eastern Hungary, mainly with heavy industrial background. With a population close to 160,000 Miskolc is the fourth largest city of Hungary.

Local Government Full Name	*Municipality of Miskolc City of County Rank*
Country	*Hungary*
County	*Borsod-Abaúj-Zemplén*
Web address	*http://miskolc.hu/*
Municipal Budget	*144 million EUR (44.7 billion HUF- 2016)*
Total Geographical Area	*236.7 km²*
Geography	*Lowland*
Climate	*Humid continental*
Population	*159,554 (2015)*
Community's total annual GHG emissions	*503,457 t CO_2e (2008)*
Covenant of Mayors	*Signatory (12 March 2015)*
System type of district heating	*Heating, sanitary hot water, CHP, thermal smart grid to be developed*
Spatial type of district heating	*Mix of centralised and decentralised system*
System's type of fuel	*Geothermal, wood chips, landfill gas, natural gas*

Table 5: City and DHC profile Miskolc

The goal of the City of Miskolc is to provide competitive energy and district heating service to the consumers. Local renewables as well as waste energy are understood by Miskolc to be available free of charge or at a significantly cheaper and predictable price than (imported) conventional energy sources. However, these energies can only be utilised with new and/or more expensive technological equipment. District heating offers itself as an optimal field for using renewable due to its size and the economics. Currently, Miskolc was able to integrate landfill gas, biomass and geothermal energy sources into the local district heating system. In 2015 55.99% of the consumers – about 32,000 households and 1000 other consumers – have been supplied with renewable energy for heating in Miskolc. This results in the substitution of natural gas of 25,719,200 m^3 and a reduction of CO_2 emissions by 48,812 tons in 2015. Moreover, savings of up to 323,000 EUR can be achieved by a centralised energy

procurement of Miskolc. At the moment there are no district cooling services offered in Miskolc, as its finance is not feasible with the current electricity price structure.

7.4.1 Economic and financial aspects

Miskolc Holding, which manages the local utility MIHŐ, is one of the most capital-intensive companies in Miskolc. The organisation is fully owned by the City of Miskolc together with the County Rank. MIHÖ supplies heating and sanitary hot water to around 32,000 homes and almost 1,000 companies and public institutions. The utility's annual turnover is 20.6 million EUR and generates profits of about 1.06 million EUR. 189 persons are employed and engaged in the supply of thermal energy with the volume of 1.23 million GJ. Besides the jobs created, Miskolc benefits from the local tax revenues of MIHÖ.

All current renewable energy projects related to district heating built on the same financing scheme in Miskolc:

- 30-50 % of the budget from EU funding;
- 30-50% of the budget from bank loan;
- 10-20% of the budget from own resources.

The total implantation costs of the landfill project were 1.61 million EUR. The subsidy received from the national KEOP programme reached 39 %. The plant provides hot water and heating for 319 apartments and co-generates electricity. Since Miskolc owns the local utility and operator of the landfill project MIHŐ, financial revenues flow back to the city if not used for further investments or tasks like the recultivation of the landfill after its complete closure in about 7 years time, which is demanded by the Environmental Protection Directorate.

The biomass heating plant in the *Kilian* district is managed by Bioenergy-Miskolc Ltd., a company with is owned 75% by WIS Zrt. and 25% by MIHŐ. The total investment cost of 2.53 million EUR was financially supported by 1.04 million EUR from the KEOP funds of the Hungarian government. Further development opportunities for the heat supply of *Diósgyőr* and *Bulgárföld* districts worth 3.2 million EUR are explored.

The geothermal project is managed through a public private partnership between Miskolc Geotermia Plc. and KUALA Ltd.. Both are owned 90% by the private company Pannergy Nyrt and 10% by the public utility MIHŐ. Due to the initial high investment costs associated to the exploitation of geothermal energy, a long-term contract for the next 25 years was established between the heat supplier (Miskolc Geotermia Plc. and KUALA) and heat purchaser (MIHŐ). The total investment cost from May 2013 until end of 2015 is about 28 million EUR. A grant of 4.2 million EUR came from the KEOP funds.

The City of Miskolc and Miskolc Holding are deliberately seeking the participation in European projects to receive funding to learn and explore new, complementary and innovative concepts and measures to develop the city's district heating system further. Currently, this is most prominently and intensively done through the Smart City Lighthouse project REMOURBAN which implements large scale interventions to demonstrate the potential of the urban regeneration model and proposes integrated solutions for the energy, mobility and ICT sectors. The main objective of Miskolc in REMOURBAN is to develop a replication plan in order to implement a smart urban district through a set of targeted interventions. These include both technical measures (in the field of energy, mobility and ICT) and non-technical

actions (such as urban plans, regulations, innovative financial schemes and effective citizen engagement).

7.4.2 Achievements and results

Miskolc's achievements and results in regards to the district heating are diverse and numerous. The main highlights are:

- Systematic analysis of local RES to maximize their utilisation for district heating system;
- By using a mix of landfill gas, biomass and most of all geothermal energy Miskolc substitutes by now more than 50% of fossil fuels (20,810,681 m^3 natural gas);
- Landfill gas since 2008 - total cost to implement was of 1.61 million EUR, which were recovered within approximately 3 years time – CO_2 savings 3,900 tons/year;
- Biomass since 2011 - Biomass heating plant with an output of 3 MW/41,000 GJ and an efficiency of 85 % - CO_2 savings 50,077 tons/year;
- Geothermal energy since 2013 – 15% of the total investment cost of 28 million EUR financed by KEOP grant – CO_2 savings 166 million tons (in 20 years);
- Savings of up to 323,000 EUR per year are achieved by centralised energy procurement and long-term agreements;
- National tenders and European Regional Development Fund are used to gradually increase the renewable share and finance the (high) up-front investment of new or more expensive technological equipment. Moreover, Miskolc has strategically used these funds to follow its own local energy strategy.

7.4.3 Replication potential

The review of Miskolc's experiences and perspectives is necessary in order to properly assess the replication opportunities for local RES and their use for district heating in Hungary and beyond. Miskolc identified the following aspects as relevant for their decision-making process:

1. Utilisation of RES has favourable environmental effects and therefore receives support from the Hungarian government including climate programmes. The utilisation of RES, in particular biomass, is a labour-intensive activity and creates local jobs.
2. It is to be expected that in the long run, the price of renewable energies will increase at a slower pace than that of natural gas.
3. Experience shows that within the current energy price system, renewable energies are unequivocally more competitive than heating oil and are mostly more competitive than liquefied gas. However, due to direct and indirect state subsidies to balance the effect of the natural gas price changes, currently renewable energies are only more competitive if their price of supply is low and/or support for the network development and installation costs is available. Therefore subsidies to fossil fuels should be stopped and fuel poverty, if necessary, differently alleviated.
4. The profitability of both RES and energy from waste in district heating improves with the scale of utilisation. Therefore a replication and expansion is more likely, if larger districts and public or industrial heat consumers can be (strategically) engaged. LRAs should have the possibility to connect public buildings and give preference to those district heating systems that are utilising local renewable energy.

5. In many cases, local RES or energy to waste requires the cooperation of many players (e.g. agriculture or forestry, district heating provider, public agencies, industrial companies, investor-entrepreneur, banks etc.). Local and regional authorities are in a good position to facilitate, assist and even directly take part in respective partnerships and market processes for their and their citizens' benefit. However, to fulfill this role effectively, awareness and capacity (building) is needed and LRAs need to be allowed to provide energy related public services.
6. Renewable projects in district heating with high investment cost become economical more feasible if the number of productive hours can be increased. Therefore new opportunities for heat demand should also be explored for the summer period. In general, the district heating should be combined with power production as well as cooling to becoming economically more stable.
7. Different technology and engineering knowledge is required for the utilisation of RES and waste to energy, which are available on the (Hungarian) market. Therefore local and regional authorities or utilities may choose from multiple entrepreneurs during both the preparatory, implementation and operation phases. The replication potential is higher, if an adequate procurement process is applied which includes for instance pre-procurement market dialogues.
8. A programmatically performed series of energy audits in public (and private) buildings have proven to be an effective tool to reveal the opportunities of intervention where RES could be used and where their appliance would be economically feasible within the district heating system of Miskolc.

7.4.4 Conclusions

There are a number of conclusions that can be drawn from the approach and practical experience that the City of Miskolc and its local utility and other involved actors have taken to establish and maintain an economically feasible district heating as well as to continuously increase the supply of local RES in the energy system.

- Local RES as well as waste energy are understood by Miskolc to be available free of charge or at a significantly cheaper and predictable price than (imported) conventional energy sources. Therefore they are able to sustain the district heating service better due to competitive energy prices and consumer loyalty based on support of the local economy.
- Deliberate focus on local RES is a political and environmental choice, as it fosters the creation of regional added value chains and contributes to the achievements of climate and energy targets under the Covenant of Mayors as well as Hungary's obligations towards the EU.
- District heating presents an excellent potential to integrate RES by scale and save CO_2 by substituting fossil fuels. Therefore national and European funds should be set up to enable local and regional authorities to exploit local RES for district heating purposes.
- Local RES can best be organised locally. To ensure the sustainability of the use of RES, especially biomass, for heating purposes, and the optimal balance between environmental, social and economic effects, central governments and EU directives should provide local and regional authorities with the ability (capacity) and mandate to explore this potential.
- More than half of residential buildings have poor thermal insulation. State and local refurbishment programmes seek improvement, which impacts on the heat demands and make their business case viable in time and district. Therefore a local, national and European DHC strategy need to be closely analysed, planned and implemented with an energy efficiency and/or refurbishment strategy to be sustainable, fast and affordable.

- It is a common characteristic of the listed energy types that their economical utilisation is possible only locally. It is definitely not worth transporting low-potential (i.e. having low temperature or yield) or waste energies over larger distances. The listed renewable or waste energies are usually available free of charge or at a significantly cheaper price than conventional energy sources. These energies can however be utilised with more expensive technological equipment. Due to the fact that utilisation is local, renewable energies may be of special significance in terms of energy management at local or regional authority level.

7.5 Case analysis of Vienna: Sustainable District Heating and Cooling in Vienna – a big challenge

Local Government Full Name	*Vienna*
Official Name (in original language)	*Wien*
Country	*Austria*
State/Province	*Vienna*
Web address	*www.wien.gv.at/english*
Municipal Budget	*12,471.103 million Euro (2013)*
Total Geographical Area	*414.6 km² (2013)*
Geography	*Lowland*
Climate	*Humid continental*
Population	*1.754 million (2013)*
Community's total annual GHG emissions in t CO_2e	*8.355 t CO_2e (2013)*
Climate commitments and pacts signed	*Covenant of Mayors (Y, 4 Oct 2012): Climate Alliance Austria (4 Oct 2012) Initiative "Climate Protection and Education" (2015)*
System type of district heating	*Heating, cooling, CHP, high efficient – high temperature grid*
Spatial type of district heating	*Centralised system within the administrative area of Vienna*
System's type of fuel	*Municipal waste, natural gas and oil, biomass, waste heat from industry*

Table 6: City and DHC profile Vienna

A lot of facilities all over the city including environmental and climate friendly innovations build a big thermal network in Vienna. This network is bounded to CHP plants, waste incinerations and the upcoming use of RES. District cooling is implemented at several locations with a higher cooling demand. Sustainability is supported by high efficiency of facilities and modern energy management, but is limited by physical and organisational reasons (like the high temperature and high pressure primary net or the energy service price structure with a big part related to connected performance and a smaller part on energy demand of customers). Existing infrastructure investments and contracts for heat supply and the net characteristics are hindering in many cases the efficient integration of RES for heating and cooling as well as innovative and decentralised heat management.

7.5.1 Economic and financial aspects

In Vienna about 290,000 private households - one third of all private households – and 5,600 other customers (some with high demand) are using district heating for space heating and hot water preparation. So the low-temperature heat market is covered with 35% by district heating. The sold heat by district heating (including district cooling) was 5,238 GWh in 2014 (6,167 GWh in 2013).
The turnover (2014) in the energy sector of the *Wiener Stadtwerke Holding AG* has been 2,240 million EUR. The share between heat, gas and electricity is 21.3%, 18.2% and 60.6%. This shows that the main economic interest is led by the sale of electric power.

The equity-to-assets ratio of the *Wiener Stadtwerke Holding* was 35.2 % in 2014 (34.4 % in 2013). The number of employees of the holding is 16,100 with a turn-over of about 3 billion EUR and the balance sheet total is 13.6 billion EUR 2014 (plus 180 million EUR compared with 2013).

The capital expenditure (CAPEX) ratio for investments and depreciation allowances of the holding was 28.2 % in 2014 (27.4 % in 2013). The Earnings Before Interest and Tax (EBIT) marge of the holding was 7.5 % in 2014 (7.0 % in 2013). The Return of Average Capital Employment (ROCE) of the holding was 5.2 % in 2014 (5.5 % in 2013).

The profit on ordinary activities of the holding was 20.1 million EUR in 2014 (25.6 million EUR in 2013).

The operational costs regarding the district heating are managed and covered by the municipal infrastructure service provider *Stadtwerke Holding AG* which is owned by the City of Vienna. Investments are manly financed by the turnover of the holding and borrowing. National and European grants are used so far they are available and only with a very small share.

Two examples of European RTD projects in Vienna, which are relevant for the district heating and cooling system, are

- TRANSFORM dealing with energy planning on city level including district heating, and
- Concerto/Concerto Plus dealing with big demonstration facilities and planning of renewable heat, heat management and district cooling.

There is a strong effect on the regional economy by the activities of the holding. The estimated direct effect of the regional added value is calculated for 2013 to 1,627 million EUR and the indirect effect from increased consumer demand and from suppliers of components and services is estimated to be about 3.2 billion EUR. The total contribution of the holding to the regional added value is about 4.8 billion Euro and 51,000 employees. An additional benefit for business in Vienna is the quality of location by a very high security of supply - the probability of failure is between some minutes and some hours per year for district heating - and low energy prices for a good competitiveness of the business sector.

7.5.2 Achievements and results

All mentioned plans and activities will contribute to the Smart City development, a sustainable urban development, improved energy efficiency, a growing share of renewable energy and a decrease of GHG emissions in Vienna.

- City of Vienna is 100% shareholder for most grid-bounded energy services and infrastructure in Vienna and partly in the bigger surrounding area.
- High degree of heat from municipal waste incineration and some use of waste energy from an oil refinery, but very less use of solar thermal and heat pumps for district heating.
- Some testing on district cooling systems focus mainly on absorption refrigeration and chiller with district heating energy in combination with normal refrigeration by compression.
- High quality in net and heat storage technology and energy management with some additional seasonal potential, because of reduced heat demand in summer.
- Strong physical and economic dependence of heating supply from power market by using a lot of heat from CHP plants with some additional efforts and costs.

7.5.3 Replication potential

Waste treatment is an obligation for all countries all over Europe, especially to reduce the content of carbon before landfill waste deposal. The technology for high efficient emission control at waste incineration of flue gas is state-of-the-art in Vienna. Waste incineration with generation of base load heat for district heating should be an interesting option for many urban regions in Europe. Intelligent heat management from waste incineration and CHP with big heat storages should be an economically advantage in many European district heating locations too. Decentralised and centralised district cooling are able to improve heat management and system costs in summer in general. A high standard of transparent sustainability perspective on infrastructure services of investments and operation would be a benefit for public acceptance and stakeholders trust in all cities in Europe.

Replication potential	*High – because of similar situations and circumstances in many cities*
Finance requirements	*High - because of the needed amount of facilities and infrastructure*
Expertise requirements	*Medium - because technologies are available all over the world, but high in administration in the pre-planning phase*
Staff intensity	*Medium - because private enterprises can partly be used for implementation*
Technology requirements	*High - because of high efficiency and complexity*
Preparation time	*Intensive – due to the extent of the district heating system*
Area requirements (climatic, topographic)	*Central European climate zone*

Table 7: Replicability assessment Vienna

7.5.4 Conclusions

A high operative risk and dependence from CHP, which have to look first on the power market to be profitable, leads to additional capacities and higher costs for heat consumers but offers a very high system efficiency for power and heat. Market regulations for the power market have to be checked on their system efficiency.

From an economical and technical perspective a high efficient and big district heating systems are difficult to combine with low energy demand strategies of buildings and with integration of RES. For a better compatibility to integrate RES in existing district heating systems and for a smarter extension of them, forward looking district heating standards can support integration of and the transition to thermal Smart Grids, to other energy grids and the integration of micro-CHP and waste heat in thermal networks.
Rules of price structure offer a big potential to raise energy efficiency measures at buildings, energy awareness of consumers – which is important to prevent rebound effects – and to increase the share of RES for heating and cooling in cities. For example a maximum of 25% of costs for district heating for each consumer should be defined by the connected performance and more than 75% of costs should depend on the used amount of energy. General market rules depending on the local situation and facilities to set this price structure would be helpful. Furthermore heat from RES and waste heat should be given an additional value depending on temperature level and time of generation to increase the economic interest of district heating providers to use and to manage heat from sustainable sources in an efficient way.

More research and demonstration zones for efficiency technologies and the use of RES for sustainable heating and cooling should be supported by European funding programs mainly for zones with existing buildings. Additional RTD effort should be put on long-term spatial energy planning from life-cycle and system perspective.

8 Strategies and problems in financing and funding

The first two subsections of this chapter introduce a short categorisation of business models for district heating and cooling (DHC), as well as an overview of possible policy interventions to support the uptake of district energy, especially by leveraging finance. This analysis is based on the UNEP report on District Energy in Cities (UNEP 2015). In the following subsections, the problems in financing and funding identified in the four case studies will be analysed, also based on the theoretical foundations introduced before. At the end of this section, general conclusions will be drawn regarding main barriers for DHC and CHP in terms of financing and funding and possible means to overcome these barriers.

8.1 Business models for district energy systems

The following categorisation is taken from the assessment carried out in the UNEP report on District Energy in Cities (UNEP 2015).

The type of business model chosen for the realisation of a district energy project depends on the character of the respective national regulatory framework as well as the degree of risk the local authority is willing to/is able to take and the degree of control it wishes to have over the project. An involvement of private investors usually goes together with higher costs of capital, since they commonly seek a higher return on their investment than a public authority. Thus, the project then needs to be more profitable. Moreover, the more control the local authority has over the project, the easier it is to pursue additional aims with it, such as producing additional social and environmental benefits. Authorities might want to reduce energy dependence, provide affordable heat supply to low-income households, connect customers that would not be connected by a private investor alone or speed up the use of RES in heat supply due to local climate and energy targets. The following table gives an overview of three archetypal business model types: public, hybrid (public/private) and private.

Type of business model	Degree of control and risk involvement of public sector	Financial return on investment	Examples
Public	High	Low/Medium	Department of local authority, publically owned special purpose vehicle (e.g. local utility)
Hybrid (public/private)	Medium	Medium/High	Public/private joint venture, concession contract, community-owned not-for-profit or cooperative
Private (with public facilitation)	Medium/Low	High	Private company, strategic partnership with local authority (joint cooperation agreement)

Table 8: Spectrum of business models for district energy systems
Source: adapted from UNEP 2015.

Wholly public ownership

Wholly public ownership is the most common business model for district energy globally (UNEP 2015). It can be developed and operated either within a certain department of a local authority, being on the authority's balance sheet. Or it can be realised by a subsidiary of the local authority, by a so called special purpose vehicle (SPV), such as a publically owned local utility. In the first case the city takes most of the project risks and is completely financially liable. In the second case, administrative burden can be reduced, financial liability can be limited and flexibility and speed of decision-making can be improved and organised to be more close to a commercial operation. Furthermore, for both cases there is the possibility to outsource certain parts of the project, for example technical design or construction. Nevertheless, project risk remains high in both cases, since also in the second case the project is wholly owned by the authority.

Wholly public district energy projects usually require lower project returns and are often designed to ensure reaching broader social and environmental objectives. Borrowing costs also tend to be lower in comparison to commercial debt due to public backing. However, projects being developed by SPVs might also partly use commercial debt – if the project return allows – reducing risk for the local authority. In demonstration projects commercial viability might even tried to be proven by financing with artificially high interest rates (at commercial level). Further finance sources might be available, such as national or international grants, loans from development banks, national tax incentives etc. (see below).

Under wholly public ownership the local authority has complete control over the project and keeps all the projects' returns. As an exit strategy, a project can be sold off to other public actors, to the commercial sector (in parts or total) or to the local community (e.g. to a local cooperative).

Hybrid ownership (public/private)

Under hybrid ownership, a local authority usually intends to bring in expertise and/or capital from commercial investors to reduce involved risks but keep a certain level of control over the project. However, to attract commercial investors a project needs to generate sufficient return to make it attractive. UNEP (2015) differentiates between three main options to set up a hybrid ownership structure:

Public/private joint venture: Under a pooled asset approach a single company is created using equity from both parties and sharing risks between both parties. The presence of the public sector can improve borrowing conditions of the joint venture and facilitate access to other sources of finance (see below). Under a split asset model, parties finance different and separate assets of the district energy system, such as production vs. transmission and distribution. In this model, each party is responsible for sourcing its own finance.

Concession contract: The public sector is involved in project design and development, while it is financed, realised and operated by a utility in private or hybrid ownership. The utility receives a concession for a certain term after which the local authority will get back full ownership and control over the project. This way, the majority of the risk is carried by the utility; however there remain significant risks with the local authority due to contracting complexities, since ultimately the project is owned by the municipality. A private utility will most likely use own capital sources and commercial debt for financing, while hybrid utilities

might profit from the presence of the public sector improving borrowing conditions and easing access to further sources of finance (see below).

Community owned, not for profit or cooperative: The municipality establishes a community-owned, not-for-profit company or cooperative as owner of the district energy project. However, the local authority usually takes the majority of risks in the beginning of the project, until the new organisation is well established. The public authority also might need to underwrite the project risk so that low-cost finance can be secured. Risks can be further reduced by using private contractors for certain project tasks, such as design or construction.

Private ownership

In case the local authority is reluctant to carry project risks and does not want a high level of control, a wholly private ownership model can be suitable. However, private investors will require higher level of returns (e.g. due to shareholder obligations) which need to be generated by the project. Financing usually comes from the private company in the form of equity and/or commercial debt. Nevertheless, the local authority is nearly always needed to participate in the project as proponent and facilitator, e.g. through supporting urban planning, acquiring grants and other forms of financing, creating awareness and acceptance or providing anchor load for the district energy system. Often, strategic partnership models are used for this purpose, under which a local authority enters a joint cooperation agreement with a private company. In return, the municipality might be able to ensure certain advantages in project realisation, e.g. lower energy tariffs, profit sharing or other social or environmental objectives, such as use of renewable energy carriers or connection of low-income city districts. The city might be included on a local project board, or the board of the SPV carrying out the investment.

8.2 Policy interventions to leverage finance

In addition to European and national support schemes for district energy, e.g. providing grants, low-cost loans or tax incentives, there are also policies that can be introduced at the regional or local level. Local authorities can influence risks and costs associated with district energy in a variety of ways. The following categorisation is taken from the assessment done in the UNEP report on District Energy in Cities (UNEP 2015).

Policy Intervention Area	Description of Policy Activity
Financing and fiscal incentives	Debt provision and bond financing, loan guarantees and underwriting, revolving funds
	Grants, low-cost financing/loans, rebates, subsidies
	Tax credits and exemptions (e.g. sales tax, property taxes, permitting fees, carbon taxes)
Use of city assets	Use of local government land/property/buildings for district energy installations or connections, provide anchor loads
Demonstration projects	Piloting and testing of emerging technologies
	Piloting of new policies for district energy systems

Table 9: Policy activities to leverage finance for district energy
Source: adapted from UNEP 2015

Financing and fiscal incentives

On the European and national level there can be financial and fiscal policies and support schemes for district energy systems. These can include grants, direct subsidies, feed-in tariffs, funds, abolishment of subsidies for fossil competition, environmental taxes or tax reductions. Here, the local authorities can support the project to access these and/or advocate for the introduction of favourable policies on a national and international level.

Furthermore there are various ways in which local authorities can get involved in terms of financing and fiscal incentives. Regarding debt provision, municipalities can raise low-cost recourse capital or issue general obligation bonds. They also can give loan guarantees to reduce the risk of the lender and thus the cost of capital. However, in the case of project default, the city will be liable for the open debt. In addition, loan guarantees influence the borrowing capacities of the local authorities and can potentially create a precedent making lenders always ask for guarantees for this kind of infrastructure projects and not accepting e.g. recourse debt anymore. Therefore, some municipalities are wary of giving loan guarantees.

In addition to helping access national or European grants, the local authority can also set up an own grant scheme, e.g. to support the initial development of a project or direct a project towards social and environmental goals. Another opportunity is the creation of a revolving fund out of which subsidies, grants and low-cost financing can be funded. The fund could for example be filled with revenues from the sale of a city asset, a surcharge on the energy bill or avoided subsidies for other projects. These types of instruments allow for the public support of strategic investments without necessitating direct ownership. Further opportunities could be local feed-in tariffs, net-metering or heat incentives, or tax and fee reductions.

In growing cities in Europe development-based land-value capture strategies can be used to generate funds. The development of new urban zones increases their value. Future and continuing revenues from land sale or leasing and capturing taxes from land owners can provide finance for infrastructure investments.

Use of city assets

Local authorities can allot land and real estate for district energy generation. The use of publicly owned parcels can be organised in-kind or generate rents for the municipality. Furthermore, public facilities can provide the anchor loads for district energy, e.g. through guaranteeing demand from government buildings, public pools, hospitals, schools etc.

Demonstration projects

Municipalities can start demonstration projects to illustrate the feasibility and commercial viability of district energy systems, to showcase their socio-economic and environmental benefits, to pilot new policies for district energy uptake, to build local and institutional capacities and confidence, to facilitate the development of a market, to raise awareness of potential investors or to accelerate private sector engagement.

8.3 Assessment of case studies

Purmerend

Purmerend uses a wholly public business model for the operation of its DH system. Stadsverwarming Purmerend (SVP), formed in 2007, is owned 100% by the municipality of Purmerend.

When SVP took over the DH system in 2007 it faced problems with an outdated piping system, heat losses and pipe ruptures, leading to technical and financial problems. Attempts to sell parts of the DH system failed as no buyers were interested in taking over the high risks involved. Problems started being tackled through the 2009 improvement programme (pipeline renovations, installation of ground-level substations instead of underground ones, etc.), which is nearing finalisation.

Since its foundation in 2007, SVP has not been profitable, incurring losses for the municipality. The earnings before taxes (EBT) for 2016 are estimated to be EUR -2.2 million. However, predictions for the near future show an increase in revenues and lower operating expenses, resulting in positive EBT figures. It is expected that dividends can be paid to the municipality from 2020 onwards.

The DHC system is financed through funds of SVP (thus the municipality) and commercial debt under municipal guarantees. In addition, national support schemes such as the SDE+ scheme, government tax benefits leading to lower corporation tax payments and a subsidy from the national support programme PIWB are being used. Moreover, SVP received a project development assistance subsidy from the EU-ELENA programme, financed by the European Investment Bank. ELENA covers shares of the technical support cost needed to prepare, implement and finance an investment programme. It was stated that the membership in the EuroHeat & Power association was essential to access these funds.

The city supports the development of DHC with local energy and environmental objectives, and provides support with spatial planning and local regulations. The Green Deal with the government provides information about subsidies and networking opportunities. The biomass plant, providing about 80% of total heat in the DHC system, collaborates with the state forestry agency and has a guaranteed supply with biomass.

Main parameters for profitability of the DHC were mentioned to be the Dutch Heat Act, which sets a maximum price that can be charged for heat, the development of the gas price, the weather, the network condition (heat losses, disruptions) and naturally the number of connected consumers. Further challenges include split incentives between landlords and tenants in the case of housing-associations. Also the reform of the SDE+ scheme was mentioned to distort the market for woodchips and create unfair competition, as subsidies under the scheme improved significantly in 2014, after SVP was granted support. Furthermore, some national taxation rules were mentioned to be unfavourable, since a DHC system using less than 50% waste heat is subject to a higher energy tax. During the implementation of the biomass plant, this taxation rule meant that the DHC could be potentially be taxed the higher rate.

Milan

The City of Milan pursues a hybrid business model. The district energy project is being carried out by the local electricity and gas utility A2A, which was once publically owned and is now partially private. The city of Milan however is still a controlling shareholder, owning 27.2% of the company's shares (A2A 2014).

The infrastructural costs for the installation of the DHC plants and network are carried by A2A and do not bear costs for the municipality. Through a concession contract the city receives an annual income.

Milan created a secure investment framework by introducing a long-term vision regarding the city's energy supply. It included the DHC system into its wider emissions reduction plan, its Sustainable Energy Action Plan (SEAP) and sustained its political commitments by signing the Covenant of Mayors. Furthermore, the city gave strong support for DHC through enabling legislation, urban planning and building codes (e.g. the MILAN 2014 building code), as well as information and awareness campaigns. Moreover, Milan created a database to coordinate different underground works and reduce inconveniences caused to citizens. This way, the city supported the build up of market demand and acceptance.

Milan participates in the EU-funded project STRATEGO, which provides support in developing National Heating and Cooling Plans, assists local authorities in evaluating their heating and cooling potential and helps to identify concrete projects that should be implemented. Furthermore, the support and information received from the Covenant of Mayors have been deemed useful.

Miskolc

Miskolc currently integrates biomass, landfill gas and geothermal energy into the local DH system and substituted more than 55% of fossil fuels in only eight years. MIHŐ is the public service provider operating the DH network. It is owned by Miskolc Holding Onkományzati Vagyonkezelõ Zrt., which in turn is owned by the City of Miskolc and the Country Rank.

For the realisation of the latest DH projects based on local RES, the municipality partly used a hybrid business model and always applied the same financing scheme of 30-50% EU and/or national funding, 30-50% bank loans and 10-20% of own resources. The biomass project is organised in the form of a public-private partnership (25% owned by MIHŐ). It incurred a total investment of EUR 2.5 million, of which EUR 1 million came from the national Environment and Energy Operational Programme (KEOP), funded by the European Regional Development Funds and the Hungarian government.

The landfill project is fully owned by operated by MIHŐ, thus revenues out of this project flow back to the city. The project's total implementation costs were EUR 1.6 million, with 39% of these funds coming from KEOP funds.

The geothermal project is managed by a public-private partnership with a minority share owned by MIHŐ. Until the end of 2015, total investment costs summed up to EUR 28 million, with EUR 4.2 million coming from KEOP funds. Due to the high upfront investment costs, a long-term heat supply contract over 25 years was established with the municipality.

The city of Miskolc is signatory of Covenant of Mayors and has implemented emission reduction targets. Historically, DH has played a significant role in the city's heat supply, thus a demand base has already been established with currently 45% of flats connected to DH.

The City of Miskolc and Miskolc Holding are continuously seeking participation in EU projects to receive funding, information and support. Currently Miskolc participates in the smart city lighthouse project REMOURBAN, which implements large-scale interventions to demonstrate the potential of the urban regeneration model and proposes integrated solutions for energy, mobility and information and communication sectors.

Mentioned challenges for the local DH project include unpredictable gas prices, reduced heat demand due to building refurbishments and insulation and unusual mild winters, as well as the economic situation of the supplier's customers (debt levels). Furthermore, direct and indirect fossil fuel subsidies reduce the competitiveness of renewables. Funding support for network development and installation costs is crucial to be competitive with fossil fuels, especially gas. At the moment there are no district cooling services offered in Mikolsc, as its financing is not feasible with the current electricity price structure.

Vienna

Vienna's DHC system is operated under a wholly public business model. The Wiener Stadtwerke Holding AG is the local utility and owns Wien Energie GmbH responsible for DHC operation, sale and distribution of final heat and Wiener Netze GmbH, which carries out DHC network planning, construction and maintenance, as well as the operation of the primary heat network. The City of Vienna is a 100% shareholder of Wiener Stadtwerke Holding.

Project funding comes from internal sources of Wiener Stadtwerke or borrowed capital. Also national and EU grants are being used so far available. Furthermore, the city tries to participate in EU RTD projects (e.g. TRANSFORM, Concerto).

In Vienna, a strong policy framework is supporting the reduction of greenhouse gases, the improvement of energy efficiency and the increase of renewable energy generation, thereby providing a long-term urban development perspective. Strategies include the Vienna Sustainable Development Targets, the Smart City Wien Framework Strategy, the Urban Development Plan 2025, the Urban Energy Efficiency Programme and the Vienna Climate Protection Programme. DHC plays a significant role in the envisaged development towards more sustainability. Furthermore, Vienna is merging spatial and energy planning into a single process at the neighbourhood level and developing energy concepts for urban quarters and new urban districts.

Mentioned challenges for the DHC system in Vienna include volatile gas prices, which influence the energy carrier costs of the gas-fired CHP plant, as well as electricity prices, since the CHP plant is primarily dependent on the sales on the power market for its profitability. Furthermore, increases in energy efficiency of buildings were mentioned as challenging, since they influence the overall heat sales volume.

8.4 Conclusions

DHC projects incur significant risks in project development, implementation and operation, which can either be borne by the local authority alone, such as in the case of Purmerend and Vienna, or be shared with private investors, such as in the cases of Miskolc and Milan. The decision for a certain business model depends on the available European, national and/or local public financial resources, the appetite for risk of the local authority and the desired level of influence on a project. Taking in private investors can help to bring in expertise and ease access to finance, on the other hand a higher share of private investors will lead to higher expectations in terms of returns and less decision-making power. Furthermore, also partly private business models can still bear a significant amount of risks for the public sector, depending on the kind of model chosen. The public sector can still be involved as guarantor for credits or ultimate owner of projects in case of concessions. Also, contracts with the private sector involve a lot of complexities. However, the local authority always needs to be involved at a certain level for all business models to act as project proponent and facilitator.

One of the main factors influencing the competitiveness of non-fossil DHC mentioned in the case studies were the prices of fossil fuel alternatives, such as gas. In some Member States, fossil fuels are still subsidised and thus given an artificial cost advantage over non-fossil sources (see also Ecofys et al. 2014). In addition to that, oil and gas prices are currently on a long-time low. For that matter, the assessed projects deemed national and European support funds crucial to bring their DHC projects into realisation. On the European level, the European Regional Development Fund and the ELENA-Programme of the European Investment Bank were mentioned as crucial funding opportunities.

Miskolc and Vienna also mentioned that building refurbishments are challenges for their DHC systems, since they reduce their heat sales. It is therefore crucial that the development of a local DHC project and low energy demand strategies are part of an integrated SEAP and NEEAP that assess heat provision and demand in the short and long term, including improvements in energy efficiency over time.

Another risk for DHC, especially in lower income regions is the creditworthiness of customers, which was expressed by the City of Miskolc. Missing payments of customers can reduce a project's profitability. This issue can be partially addressed by creating a balanced customer group through connecting different income areas, as well as public and industrial consumers that deliver a stable anchor load.

To receive support in project development, capacity building, planning and implementation, most of the case studies participated in a European research or demonstration project. Mentioned were TRANSFORM and Concerto (RTD), REMOURBAN (demonstration) and STRATEGO (supporting the development of National Heating and Cooling Plans and helping identify the local potential). Furthermore, networks seem to be essential to exchange know-how but also to receive information on opportunities for funding and project participation (e.g. Covenant of Mayors, EuroHeat & Power Association).

On the national level, financial incentives, such as subsidies and tax incentives are partly used (e.g. Purmerend). On the local level, all of the case studies stressed the importance of a secure investment framework by introducing a long-term vision regarding the municipality's energy supply through local energy and emission targets and strategies.

Furthermore, LRAs can play a significant role through supportive spatial and energy planning, reducing financing costs by providing debt guarantees and through the implementation of information and public awareness campaigns to help creating acceptance and a market.

9 Policy recommendations for future initiatives focused on innovative heating and cooling as well as CHP projects

In the following strategies and changes in the policy framework will be proposed mainly on the basis of the outcomes of the case study analysis which could ensure a further expansion and improvement of existing and new innovative DHC as well as CHP projects at the regional and local level. In general, such future initiatives can be fostered by:

- Suitable policy and regulatory framework conditions at the EU, national and regional/local level;
- Adapted (local) energy market conditions;
- Focused and integrated (urban) planning;
- Enhanced knowledge and information sharing;
- Supporting technology / specific projects; and
- Enabling and empowering consumer / stakeholder involvement.

Headline recommendations are given as a result of the analysis conducted by the consortium, based on desktop research and the results of the case studies, these are accompanied by elaborations on each recommendation.

9.1 Suitable policy and regulatory framework conditions at the EU level

1. *The benefits of efficient and low-carbon DHC and decentralised CHP have to be highlighted in the relevant strategies and regulations best along with long-term trajectories or targets, common definitions and standards in order to guarantee for a long-term visibility and stability of related energy policies.*

Efficient and low-carbon DHC networks and CHP technologies provide clear environmental benefits due to the enhanced conversion of energy and use of RES as well as waste heat (especially if best-available technology for exhaust gas treatment is used). These technologies thus directly contribute to the EU objectives on GHG reduction, improvement of local air quality and can contribute to the renewable energy objectives.[12]

The long-term stability of a policy strategy has been detected in various research projects and case studies as the most important lever to unlock deployment of DHC and CHP limiting associated investment risk.[13] Striking a balance between providing security for investors and flexibility for policy makers is often difficult. Therefore the inclusion of long-term trajectories (out to 2050) is an appropriate way to provide certainty around the general vision and

[12] It has to be noted, however, that decentralised heating and cooling facilities in low-density settlements offer highly efficient and RES based options but are often in contradiction with air quality target. Furthermore, there currently small scale CHP technology has a lower total efficiency than centralised big CHP installations.
[13] See for example: IEA 2014, p. 8.

objective without limiting opportunities to adapt and evolve policies during that journey. This approach is also in line with the EU principles of subsidiarity and proportionality.

2. *The important role of LRAs for the achievement of secure, affordable and sustainable energy and especially heat supply for EU citizens should be taken up and reflected in the relevant EU policies, strategies and multilevel governance structure.*

All case studies demonstrate that the efforts of LRAs regarding DHC contribute to the EU objectives by increasing the share of RES and the reduction of CO_2 emissions in the heating and cooling sector.

Within the European Energy Union package there is recognition of the import role that heating and cooling, at a system and a building level, has to play in the transition to a resilient Energy Union with ambitious climate targets at its core. It is pointed out that actions by Member States, particularly at the local and regional levels, are needed to exploit the energy efficiency potential of buildings.[14] However, in key areas dealt with by the Energy Union Package, such as renewable energy, innovation and technology as well as security of supply, references to LRAs are missing, or only formulated in general terms.

As part of the European Energy Union governance, Member States should be obliged to integrate the heating and cooling sector in the national energy and climate plans[15] - LRAs have to be actively involved in this process.

3. *Primary and secondary related EU Directives (EED, RED, EPBD, Air Quality Directive, Electricity Market Design, etc.) should support intrinsic interest and tap potential of cities/LRAs.*

The case studies of Purmerend and Miskolc exemplify that DHC is not (necessarily) driven by EU-policy, but rather by local energy and environmental objectives. Therefore primary, but also secondary related EU Directives should support intrinsic interest and tap potentials of cities/LRAs.

Within the EU strategy on Heating and Cooling the Commission presents that it "will look into" issues of renewable-based and efficient heating and cooling as well as the roles of LRAs in the upcoming reviews of the RED, EED, EPBD and the Electricity Market Design initiative[16].

a. *As decisions about the use of local RES are usually made at the local level, LRAs should be given a clear mandate (and support) for including heating and cooling from RES in the urban planning of infrastructure and for linking heating and cooling and electricity. This could be done by an adaptation of Article 13* ***RED*** *or in the 2030 (renewable) energy policy package.*

As has been laid down in Chapter 3 of this report, the RED sets targets and regulations on a national level, and does not as such address local or regional level authorities directly. Nevertheless, the involvement and role of local and regional authorities in achieving the

[14] European Commission 2015, p. 12-13.
[15] European Commission 2016, p. 10.
[16] European Commission 2016, p. 11-12.

national targets is recognised in various provisions and in the preamble. The administrative and planning systems, however, are very diverse across the EU. While some Member States have made good progress with streamlining their procedures, other Member States have done very little so far.[17] Therefore the requirements for the development, implementation and reporting of NREAPs should include the potential and contribution of LRAs with clearer references.

According to recent findings of the CELSIUS project it is important to consider the efficiency of the energy system as a whole and the integration of heat and electricity networks. DHC systems can play an important part in the integration because of their inherent storage capacity. The DHC networks allow greater integration of intermittent RES into the energy system as they can support grid balancing and storage of surplus electricity in the form of heat.[18] Waste heat could also play an important role in this development. In order to contribute to the achievement of these developments it is important to allow Member States some flexibility, while still providing strategic guidance, fostering regional cooperation and having mutually supportive Directives to avoid conflicting approaches and policies.[19]

b. *The **EED** (especially Article 14) should stress the role of LRAs in preparing, implementing and monitoring energy efficiency programmes, reinforce the involvement of LRAs in the national plans and highlight the requirement of action at local and regional level based on the potential of using efficient DHC systems, especially those using high-efficiency cogeneration.*

All case studies show that LRAs are in contact with the general public and all local stakeholders. Thus they are best placed to facilitate a locally diverse or cooperative ownership structure and influence behavioural changes in the way citizens use energy in a new era of micro-generation, smart grid technology and variable pricing. The involvement of regional and local actors should therefore be reinforced for example when drafting national plans, also ensuring that these plans are consistent with local and regional targets and means.

c. *For a better compatibility to integrate local RES in existing district heating systems and for a systematic development of DHC, forward looking district heating standards can support the transition to thermal smart grids and to energy grids or the integration of micro-CHP and waste heat.*

Article 14 EED - under which the potential for DHC, CHP and the potential of recoverable or waste heat are to be identified - is an appropriate starting point for the integration of the energy system. In the Vienna case study it is highlighted that low energy demand strategies of buildings and RES integration currently could be counterproductive to the establishment of a highly efficient and profitable big DHC system. This could be solved by promoting integrated energy systems and setting suitable standards, respectively.

For instance, as shown by the Heat Roadmap Europe, in the area of heating, it is important that synergies are being made between policies that reduce demand and policies that promote the switch to cleaner heat supply with recoverable or renewable heat.[20]

[17] CE Delft et al. 2015, p. 65.
[18] See also IEA 2014, p. 11.
[19] For more details see CELSIUS 2015.
[20] For more details see STRATEGO 2015.

d. *The EU should incentivise the uptake of DHC especially in local contexts in which domestic heating is still mainly provided through highly polluting fuels (such as diesel or coal) as this facilitates a streamlined and fast replacement of the carbon intensive technologies. This could be done for example by appropriate price signals on carbon for smaller boilers.*

Production plants that form part of DH systems fall under the scope of the EU ETS as their installations in most cases have a capacity of over 20 MW, whereas there is no corresponding price signal on carbon for smaller boilers. This is remarkable considering that the large bulk of EU's heating demand is supplied by millions of small boilers burning oil and gas. Only a few countries have introduced a tax on CO_2 that covers non ETS sectors as well. The expansion of these types of instruments should be encouraged.

Furthermore the high social costs related to particulate emissions from small scale combustion plants for heating and hot water preparation in urban and industrial areas have to be tackled by adaptations for example of the Ecodesign Directive and its Regulations, the EPBD and the Air Quality Directive. This would indirectly support efficient and clean DHC networks.

The competitiveness of low-carbon DHC against fossil fuel driven heating and cooling also needs to be improved through a reduction of fossil fuel subsidies. Furthermore, the revised version of the EU energy taxation directive should aim to tax energy products based on energy content and the amount of CO_2 they emit, in order to incentivise the more efficient use of resources and internalise external costs. To ensure a certain level of incentives, the introduction of minimum tax rates on energy and CO_2 content across the EU could be discussed.

e. *European (and national) regulations should ensure that biomass for district heating purposes does not lead to monocultures, extensive agriculture, competition with local food production and a threat to biodiversity. This could be done by introducing EU level sustainability criteria for solid biomass and biogas for energy use.*

According to one interviewee participating in the case study, biomass should be increased to fuel district heating, if its production is done locally and there is not a major land-use change as well as impact on existing local food production. In general, the sustainability of the local biomass supply should determine the scale of utilisation within the district heating system.

9.2 Suitable policy and regulatory framework conditions at the national, regional and local level

As has been shown in some of the case studies the choice and implementation of efficient and low-carbon DHC and CHP is not necessarily driven by national policy, but rather by local energy and environmental objectives. In general, it is important to keep in mind that the further expansion of DHC as well as the development of local RES based CHP technologies can be carried out best at a local and regional level combined with a major role of LRAs. It is therefore important to be aware of factors that influence the development and implementation of sustainable heating and cooling strategies. In the figure below an overview on 15 important local and regional influence factors is given.

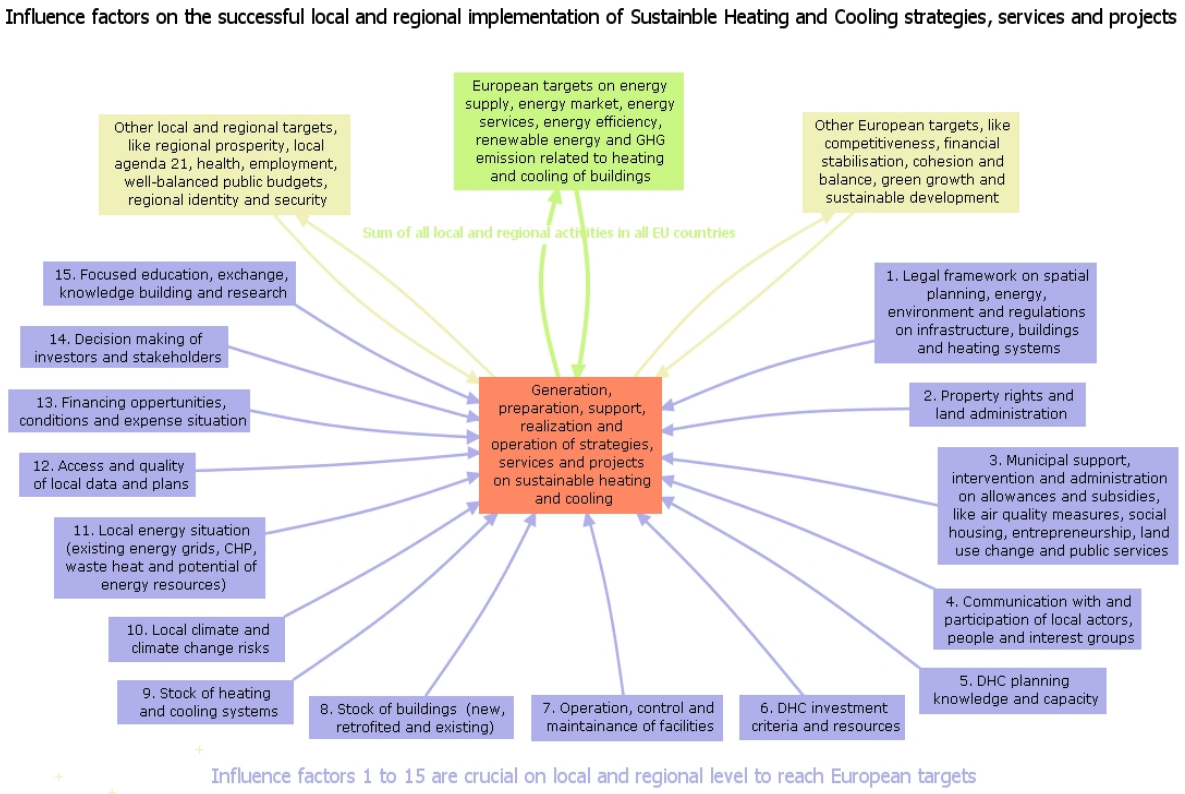

Figure 1: Scheme of influence factors

Source: Own diagram by Alexander Storch, EEA Vienna, 2016.

On the national level this systemic perspective is necessary, too, in order to improve the legal and policy frameworks, standard setting and knowledge transfer in a synergistic way and consistent to other national and European targets. This approach and case study analysis leads to the following recommendations:

4. *MS are advised to foster implementation of an appropriate and enabling multilevel governance framework by establishing coherent mandates, roles and responsibilities across all governmental levels as well as coherent and integrated sectorial policies for LRAs to perform under the NREAPs and NEEAPs.*

5. *NREAPs and NEEAPs should deliberately include local DHC potentials systematically and comprehensively. To this end national governments should actively dialogue with LRAs on how best to exploit potential and empower local DHC projects. Stable funding opportunities should be established.*

6. *MS are recommended to better coordinate with and involve LRAs in policy making and opinion development with regard to EU policies and strategies.*

7. *A supportive and stable national legislation for local DHC and CHP should be created and maintained by national governments.*

8. *Local climate and energy support should be taken up by national governments in relevant communications and documents such as the INDCs - Intended Nationally Determined Contributions (UN commitments on climate).*

9.3 Adapted (local) energy market conditions

As has been stated in the Vienna case study the economic feasibility of CHP and DHC is reduced because of difficulties in securing fair value prices for these types of energy generation at the energy markets. This entails high operative risks and in the consequence higher costs for heat consumers.

Rules for a price structure offer a big potential to raise energy efficiency measures at buildings, energy awareness of consumers – which is important to prevent rebound effects – and to increase the RES share for heating and cooling in cities. For example a maximum of 25% of retail costs for district heating should be related to the connected heat performance and more than 75% of costs should depend on the used amount of heat energy. General market rules for the price structure depending on the local DHC situation and facilities would favour bringing building efficiency measures, RES integration and sustainable DHC together.

In general, market regulation should strive to reconcile long-term investment. The declining wholesale market prices do not reflect the costs that are necessary for the development and modernisation of DHC and CHP infrastructure.

9. *The local energy market conditions should ensure prices that are reflexive of generation costs. In general, market regulations for the energy market have to be checked on their system efficiency and allowance to enhance the uptake of RES.*

10. *Heat generated either by RES and waste heat should be given an additional value depending on temperature level to increase the economic interest of district heating providers to use these sustainable energy sources in an efficient way.*

9.4 Focused and integrated (urban) planning

Local authorities are pivotal, given the relevance of their competences, in the promotion of renewable energy and energy reduction, in addition to be responsible for local regulations, spatial planning and planning applications and being able to influence choices of other actors in designing, building and renovating.

11. *LRAs wish to utilise DHC under local conditions and with local resources. Therefore national governments should allow and enable respective planning mandates and responsibilities as well as provide capacity building opportunities.*

12. *Strategic heating and cooling (infrastructure) planning should be enhanced at the local and regional level as this can help to identify cost-effective opportunities for CHP and DHC networks by identifying, locating, quantifying and characterising thermal sources and thermal end users in specific regions.*

13. *Access and quality of data for spatial energy planning have to be ensured in liberalised markets as a base for efficient strategies and good decisions.*

9.5 Enhanced knowledge and information sharing

The Milan case shows that cities do not necessarily incur into high costs to develop DHC and CHP technological and infrastructural solutions.

14. *Cooperative efforts of knowledge and experience sharing should be supported as these can help to solve technological challenges of innovative and highly integrated DHC systems.*

15. *The EU should develop management guidelines on feasible business models for cities so as to raise awareness on these already existing possibilities and how to kick-start and coordinate them.*

9.6 Support technology / specific projects

The case studies suggest that further research and the promotion of pioneer projects is necessary to overcome technological challenges of innovative and highly integrated DHC systems as well as high efficient and big DHC systems (based on RES).

16. *More research and demonstration zones for efficiency technologies and the use of RES for sustainable heating and cooling should be supported by European funding programmes of e.g. DG ENER/DG Regio/DG Research and the EIB mainly for zones with existing buildings.*

17. *LRAs express interest in the implementation of modern, innovative technologies. Therefore EU projects (e.g. on Smart Cities, etc.) should enable cities further to create testbeds and take the active function of incubators of innovation on DHC.*

18. *National (and European) funds should be set up to enable LRAs to exploit local RES for district heating purposes.*

19. *LRAs express interest on cooperation with national and international enterprises. Therefore national Horizon 2020 contact points should promote DHC opportunities.*

20. *The establishment of a dedicated Project Development Funding Stream, similar to the EIB's ELENA, is recommended that allow cities/LRAs to assemble the specialist support that they need to develop a pipeline of commercially viable projects that they can then seek funding for from public/private investors.*

9.7 Enabling and empowering consumer / stakeholder involvement

Consumers have an important role in the energy and especially (local) heat markets as they can influence the configuration of the markets by the decision to connect to a DHC network and the choice of their supplier on the one hand and on the other hand actively participate in the retail markets as prosumers.

Most of the case study cities are signatories of the Covenant of Mayors – with its objectives to facilitate consumer participation in the energy market and in the effective governance for the Energy Union as well as to promote energy self-generation best practices among consumers.

21. *Raising awareness and outlining advantages of decentralised DHC and CHP for citizens is important to foster acceptance and to create a more diverse and thus higher market demand.*

22. *In order to enable consumers to become prosumers by participating at the energy markets, issues, obstacles and opportunities linked to this participation need to be analysed with a focus on sustainable heating and cooling. LRAs shall be actively involved and supported in these processes.*

23. *LRAs are closest to the citizens/energy consumers and should be (financially) assisted by the EU and the Member States in setting up information campaigns, assistance for local initiatives and community projects as well as support schemes especially for vulnerable consumers in the field of sustainable heating and cooling.*

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