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Workshop on regional heating and cooling priorities and financing in the framework of the Smart Specialisation Platform (S3P-E H&C)

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Contents

Abstract

The workshop on smart specialisation on heating and cooling was organised by the European Commission's Joint Research Centre (JRC), with the support of the European Commission's Directorate-General for Energy (DG ENER) and Directorate-General for Regional and Urban Policy (DG REGIO). It was held in Brussels, in the Conference Centre Albert Borschette, between May 30th and June 1st 2018.

The Workshop was focused on two key topics: (1) regional heating and cooling priorities from technology and energy planning perspectives, and (2) heating and cooling financing.

The aim of the workshop was to understand the current state-of-play and the expected future of the heating and cooling (H&C) sector across EU regions, to discuss the role of regional authorities and their cooperation with national and EU entities on how to uptake the ESIF funds to decarbonise the heating and cooling sector — including barriers, opportunities and challenges.

The workshop was attended by 40 participants, 18 of them from the regional authorities and regional policy making bodies as regional energy agencies. The eight participating regions/countries were Sofia (Bulgaria), Bulgaria (country), Nord-East (Romania), Slovenia (country), Andalucia (Spain), Western Macedonia (Greece), Castilla-Leon (Spain), Lubelskie (Poland).

Foreword

This report was prepared in a joint initiative by DG ENER and JRC within the framework of an Administrative Arrangement between DG ENER and JRC on Heating and Cooling of the Smart Specialization on Energy initiative. (ENER/C2/2016-519/SI2.760213). The objectives of the project are to support regions developing their strategies and innovation capacities for heating and cooling, and to enhance their uptake of European structural funds for implementing energy efficiency and renewable energy measures in the heating and cooling sector.

Acknowledgements

We would like to thank the presenters for providing updates, valuable information and food for thought in their respective area. We are also very grateful to the participants of the workshop for the active discussions, lively conversations and continued interest in the work of the Smart Specialisation Strategies Platform.

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1 Introduction

The Smart Specialisation Strategies Platform (S3P) assists the European Union Member States and the EU regions to design, develop and implement research and innovation strategies and policy portfolios to enable smart specialisation. The Platform was initiated in 2011 to provide information, methodologies, expertise, peer-reviews and advice to national and regional policymakers, as well as to promote mutual learning, trans-national co-operation and to contribute to academic debates around the concept of smart specialisation.

These strategies set priorities at national and regional levels to build competitive advantage by developing and matching research and innovation (R&I) own strengths with business needs, to address emerging opportunities and market developments in a coherent manner, while avoiding duplication and fragmentation of efforts. The strategies developed can also concern the transition to a low-carbon economy through the implementation of energy efficiency measures and sustainable energy sources.

The EU has set five ambitious EU level objectives for 2020 on employment, innovation, education, social inclusion and climate/energy[1], and Member States have adopted their own national targets in each of these areas, which must be underpinned by implementation strategies and actions at national and sub-national level. The role of the S3P is to link in regional authorities across Europe viand help them to design smart specialisation strategies promoting the entrepreneurial discovery process, using the European Structural Investment Funds (ESIF) efficiently and building synergies between different EU, national and regional policies, as well as public and private investments[2].

In this context, the initiative on Heating and Cooling aims at helping regions to develop their strategies on this specific energy theme. One of the major activities planned is the organisation of a regional workshop.

The Workshop on Smart Specialisation on Heating and Cooling was organised by the European Commission's Joint Research Centre, with the support of DG ENERGY and DG REGIO, and held in Brussels in the Conference Centre Albert Borschette, between May 30th and June 1st 2018. The Workshop was focused on two key topics:

- Regional heating and cooling priorities from technology and energy planning perspectives;
- Heating and cooling financing.

The aim of the workshop was:

- To understand the current state-of-play and the expected future of the heating and cooling (H&C) sector across EU regions;
- To discuss the role of regional authorities and their cooperation with national and EU entities on how to uptake the ESIF funds to decarbonise the heating and cooling sector — including barriers, opportunities and challenges.
- To support the efficient uptake of the cohesion funds by sharing knowledge and experience from regions and experts in H&C topics;
- To disseminate information about useful tools and methodologies for planning, implementation and monitoring;
- To foster the cooperation among regions; creating long—term partnerships (i.e. Vanguard initiative / Partnerships in the S3P-E)

(1) Europe 2020 strategy https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/european-semester/framework/europe-2020-strategy_en

(2) Factsheet on Cohesion Policy 2014-2020. National/Regional Research and Innovation Strategies for Smart Specialisation (RIS3). Available at: http://s3platform.jrc.ec.europa.eu/documents/20182/84453/Fact_Sheet_smart_specialisation_en.pdf

- To provide information and evidence to improve next funding period post 2020.

The Workshop was attended by 40 participants, 18 of them from the regional authorities and regional policy making bodies as regional energy agencies. The eight participating regions were:

- Sofia, Bulgaria
- Bulgaria (country)
- Nord-est, Romania
- Slovenia (country)
- Andalucia, Spain
- Western Macedonia, Greece
- Castilla-Leon, Spain
- Lubelskie, Poland

The list of experts that provided insights on technology and financial aspects related to the heating and cooling sector are presented **Table 1**.

Table 1: List of experts

Expert	**Organisation**
Lukas Kranzl	TU Wien
Sibylle Braungardt	Öko-Institut
Cyril Roger-Lacan	Tilia
Andreas Hermelink	Ecofys
Brian Vad Mathiesen	Aalborg University
Manuel Torrent	Agència d'Energia de Barcelona
Eva Hoos	DG Energy
Greg Gebrail	EBRD
Reinhard Six	EIB
Gergana Miladinova	DG REGIO
Simone Alessandri	EU.ESCO
Rüdiger Lohse	Klimatschutz- und Energieagentur Baden Württemberg
Timothee Noel	DG Energy
Agnė Kazlauskaitė	Ministry of Finance of the Republic of Lithuania
Nicholas Stancioff	LABEEF, Latvia
Piero Pelizzaro	Municipality of Milan

The aim of this report is to collect and summarise the content presented and discussed during the workshop as well as major conclusions derived from the discussions.

The report is organised as follows: Section 2 summarizes the issues presented and discussed at the Workshop, with Section 2.1 focusing on strategies, priorities, and technology solutions, and Section 2.2 directed at financing challenges and solutions in relation to heating and cooling at the regional level. Section 4 reviews key messages, conclusions and a future perspective. Annex in section 5 provides a brief overview of each presentation.

2 Regional heating and cooling present and future

The Workshop on Smart Specialisation on Heating and Cooling looked at policy, technical, business and financing aspects of regional heating and cooling strategies/planning and implementation.

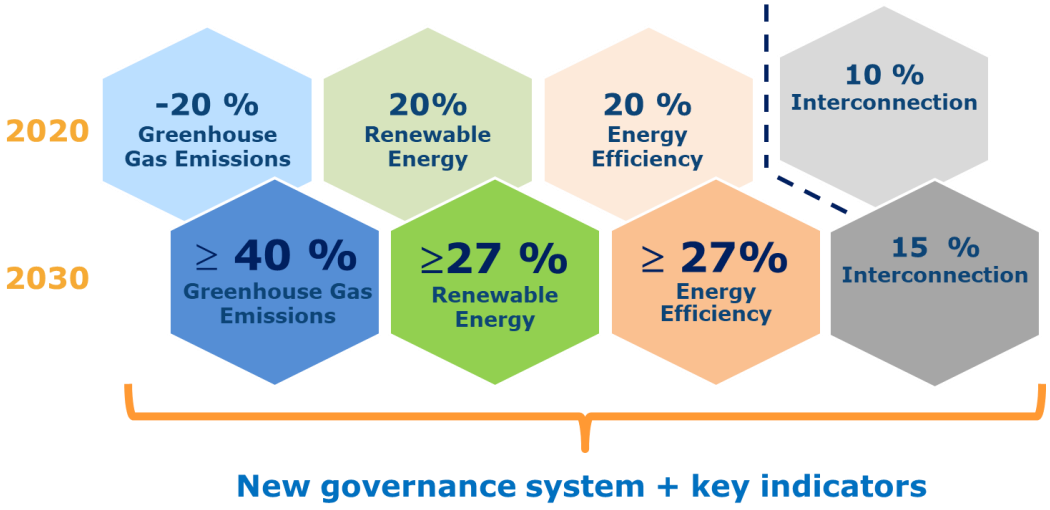
The participants stated their interest in the S3PE, as well as in the Workshop. They listed a large number of topics of interest, such as to understand implementation practices at the local level, to implement monitoring of programmes, to design local H&C strategies, how to integrate energy strategies with decarbonisation aims, how to utilize the RES potential for H&C, how to integrate biomass usage, how to integrate with sustainable construction concepts, what smart technology/smart buildings means for H&C, to find business models to develop H&C and other energy projects, and especially through combining energy efficiency and RES, how to combine different funding mechanisms, etc.

The following section gives a review of the most important issues that were raised by the presentations and the following discussions.

2.1 Strategies, priorities, and technology solutions in the EU regions

The EU has a comprehensive energy legislation to achieve energy efficiency and renewable energy legislation goals. The EU energy efficiency, renewables, climate, as well as employment and housing policies are fitted into the framework of the Headline Targets of the European Council (**Figure 1**).

Figure 1. European Council Headline Targets



Source: Eva Hoos presentation

The EU energy and climate headline targets are the means to achieve overall policy goals set at the EU or at International level, namely the European Energy Union and the Clean Energy Package, as well as the 2015 Paris Agreement. (Eva Hoos)

The 2020 targets are still challenging for some countries, although time is getting short to comply with them. The average energy efficiency target for the EU is on track, although there are also Member States that need improvement (e.g. Romania, Slovenia, Poland, Italy, Hungary, Spain, Greece). Energy consumption has been growing in most of the sectors and most of the countries (Juan Pablo Jimenez Navarro).

Figure 2. Trends in energy consumption in 2014-15

MS	Total	BE	BG	CZ	DK	DE	EE	IE	EL	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK
Primary Energy		↗	↗	↗	→	→	↘	↗	→	↗	↗	↗	↗	→	↘	↗	↘	↗	↘	↗	↗	→	↗	↗	→	→	↘	↘	→
Final Energy	Total	↗	↗	↗	↗	↗	→	↗	↗	↗	↗	↗	↗	↗	↘	→	→	↗	↗	↗	↗	↗	↗	→	↗	↗	↘	↗	↗
	Industry	→	↗	↗	→	→	↘	↗	→	↘	↗	→	→	↘	→	↘	→	↗	↗	→	→	→	→	→	→	→	→	↗	↘
	Transport	↗	↗	↗	→	→	→	↗	↗	↗	↗	↗	↘	↗	↗	↗	↘	↗	↗	↗	↗	↗	↗	↗	↘	→	→	↗	↗
	Residential	↗	↗	↗	↗	↗	↘	↗	↗	↗	↗	↗	↗	↗	↘	↘	↗	↗	↗	↗	↗	→	↘	→	↗	↗	↘	↗	↗
	Services	↗	↗	↗	↗	↗	↗	→	↗	↗	↗	↗	↗	↗	↘	↘	↗	↗	↗	↗	↘	→	↗	→	↗	↗	↘	→	↗

↗ Increase → Stable ↘ Decrease

Source: Analysis of the annual reports 2017 under the EED. JRC, 2017[3] cited in Juan Pablo Jimenez Navarro presentation. See Abbreviation section (page 60) for the Member State codes.

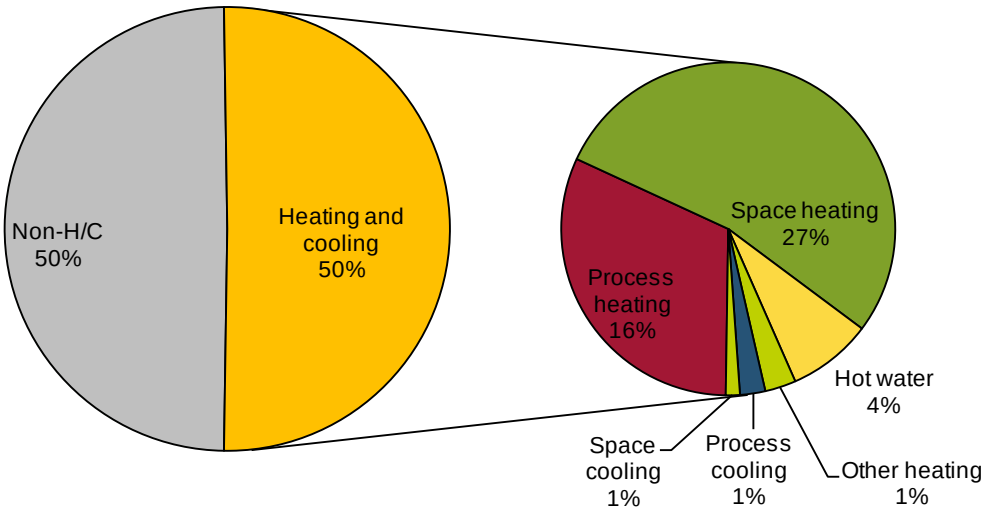
2.1.1 Status of Heating and Cooling

Heating and cooling makes up half of the total final energy consumption in the EU or ca. 6 500 TWh, with space heating responsible for 27 %, process heating 16 %, space cooling 1 %, and hot water 4 % of total final energy consumption % (Eva Hoos and Juan Pablo Jimenez Navarro) (see **Figure 3**). Around 75 % of heating and cooling demand is supplied from fossil fuels[4], making an important source of CO_2 emissions and air pollution this sector a.

The residential sector is the most prominent user of H&C, and accounted for 54 % of final energy heating and cooling consumption in 2015, followed by services' share of 21 % and industry's of 24 %. (Juan Pablo Jimenez Navarro).

In general, the heating and cooling sector is characterised by low efficiencies, and large amounts of waste heat.

Figure 3. Total final energy consumption in 2015 by the EU28



Source: Fleiter et al, 2015, www.heatroadmap.eu cited in Eva Hoos and Lukas Kranzl presentations

[3] Analysis of the annual reports 2017 under the Energy Efficiency Directive. JRC, 2017.
[4] 66 % in 2015 according to Lukas Kranzl

The H&C sector features large saving potentials due to the inefficiencies in the systems (Eva Hoos):

— 75 % of EU buildings are inefficient and obsolete, and large part will need energy renovation;

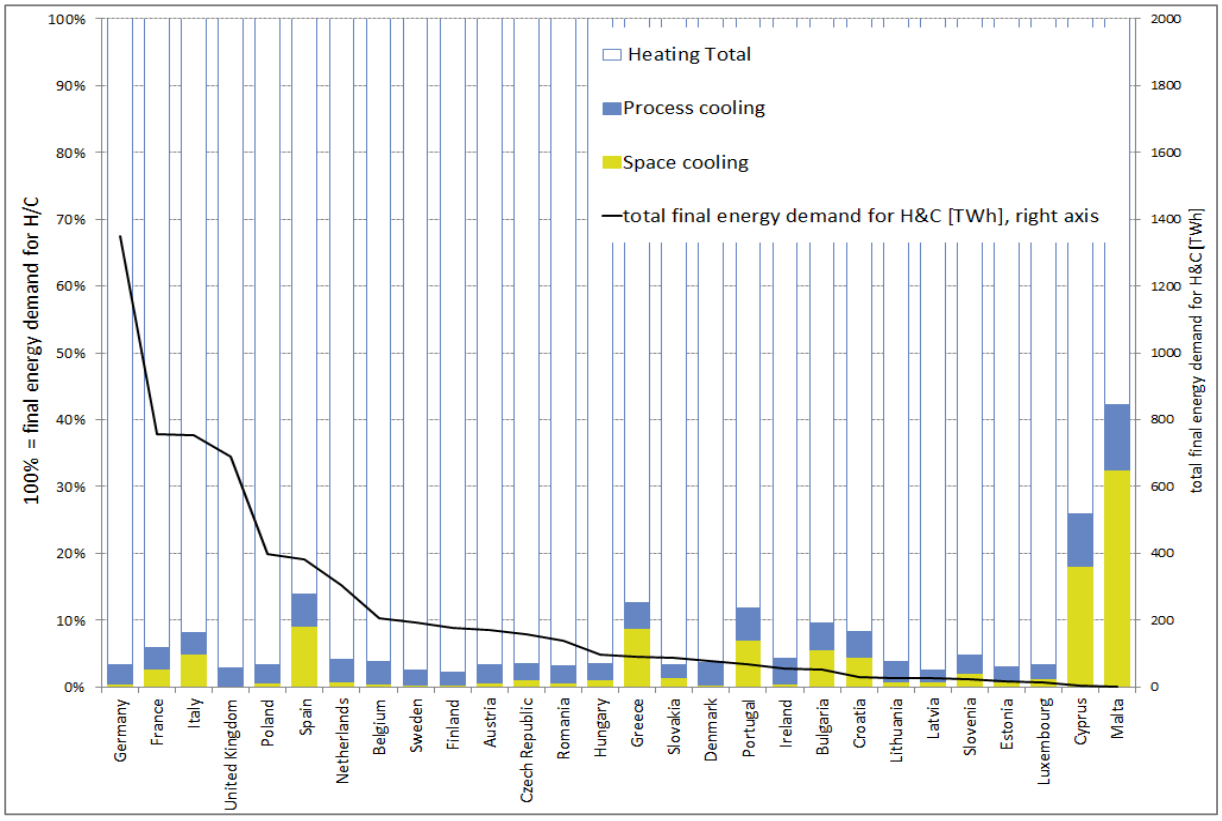
— Around 50 % of the heating equipment is beyond its technical lifetime and will need to be replaced in the next 5-10 years;

— The share of district heating varies widely across countries from cs. 65 % in Latvia to practically 0% in Malta, Cyprus, Ireland and Spain. (2013 data);

— District heating has a high potential to incorporate renewable energy sources, nevertheless in 2012 the main fuels were natural gas (40 %), coal (29%), while renewable source other than %), and biomass (16 %) are marginal (below 1 %).

The share of cooling demand within the H&C energy demand is quite low at the moment across Member States, but naturally varies widely, reflecting the climate conditions (**Figure 4**). (Sibylle Braungardt)

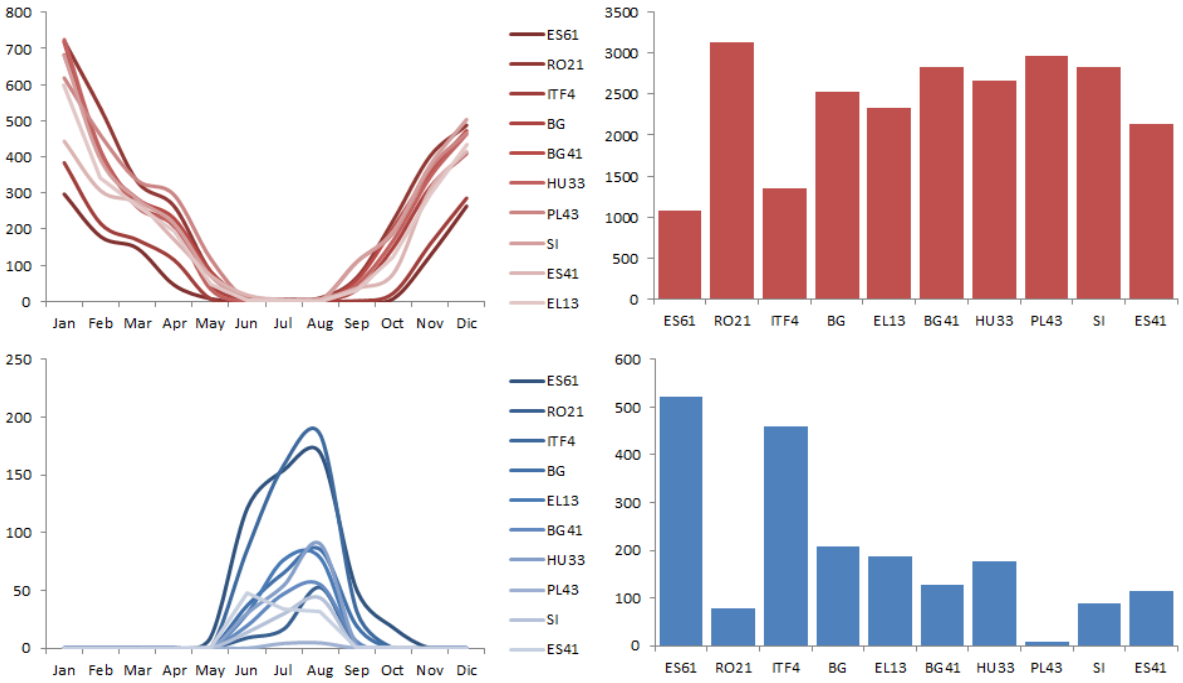
Figure 4. Final energy demand for heating and cooling in EU Member States



Source: Sibylle Braungardt presentation

The participating regions have different heating and cooling degree day profiles due to different climates, nevertheless heating constitutes around 50 % of the total final energy demand in all regions.

Figure 5. Heating Degree Days (HDD) and Cooling Degree Days (CDD) on the left for the S3P partners. Total final energy demand on the right.



Source: Juan Pablo Jimenez Navarro presentation

2.1.2 Policy foresight

Energy efficiency is the most cost-effective way of achieving Energy Union objectives. Policy conclusions for 2030 are (Timothée Noël):

1. Building renovation has to do more.
2. Financing has a more important role to play.
3. Digital/ICT has a big potential to contribute.

The key EU directives are under revision, to strengthen the efforts in Member States.

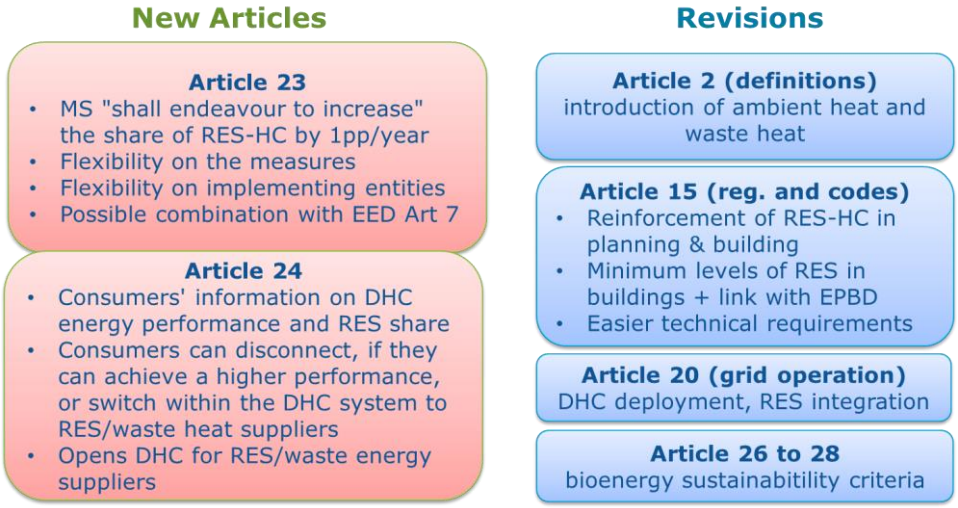
The **EPBD** revision includes stronger long term renovation strategies for Member States, aiming at decarbonisation by 2050 and with a solid financial component. A "Smart Readiness Indicator" is introduced, to be implemented through a combination of delegated and implementing acts. Requirements for ducting to allow cables for charging points for electric vehicles in new and refurbished buildings are introduced with (a few) electric vehicle charging points in all non-residential buildings. Member States will have to express their energy performance requirements in ways that allow cross-national comparisons. New provisions are foreseen to promote building automation, room temperature controls, heating systems that are effective at part load conditions, and the inspection of ventilation systems. Furthermore, a greater role for automation is provided for under Articles 14 and 15, and on self-regulating devices in Article 8(1). (Timothée Noël)

The review of the **Energy Efficiency Directive (EED)**, Article 7 will extend the energy saving obligations post 2020 (1.5 % per year), based on simplified and streamlined rules with strengthened social dimension and in coherence with the EPBD. The overall aim is to attract private investment and to boost the renovation rate of buildings, and thus to contribute to all climate and energy targets for 2030. (Timothée Noël)

The European Commission has proposed a **Renewable Energy Directive** recast to set us on track to achieve the proposed at least 27% RES target for 2030 , as compared to the currently foreseen 24.7 % business-as-usual scenario. The proposal builds on the

current directive (2009/28/EC), by strengthening and complementing the current provisions (see **Figure 6**). In particular the proposed heating and cooling Articles (23 & 24) aim to ensure that the largest energy using sector is addressed within the post-2020 renewable framework and contribute to the EU renewable target. (Eva Hoos)

Figure 6. New provisions and revisions in the recast Renewable Energy Directive



Source: Eva Hoos presentation

The RES directive covers both heating and cooling, however a methodology to account for RES used for cooling is not yet developed, as was explained by Sibylle Braungardt. In her presentation a technical solution was recommended to make up for this lack of methodology.

According to Ms. Hoos, the aim of the proposed Renewable Energy Directive is to ensure that in the future energy system, the consumer will play a central and more decisive role. The European Commission proposal foresees more prosumers, i.e. users to be empowered to produce their own energy. But the consumers, as private investors are the means to mobilise private investments, too. These will ensure that citizens can take critical role in the energy transition.

The European Commission proposed a new **Action plan on sustainable finance** in March 2018 to reorient capital flows towards sustainable investment, in order to achieve sustainable and inclusive growth, manage financial risks stemming from climate change, environmental degradation and social issues, and to foster transparency and long-termism in financial and economic activity (Timothee Noel).

2.1.3 Past and present: barriers and enablers

The **EU Strategy on Heating and Cooling** (COM(2016) 51 Final) places particular emphasis on efficiency improvement, deployment, as well as incorporation of more renewable energy sources in the heating and cooling sector as a priority for the EU. It also underlines the possible benefits of linking heating and cooling with the electricity sector as this could enable realising synergies in terms of energy and cost savings in buildings and industry.

The **Smart Specialisation Strategies Framework** is a fact-based, dynamic entrepreneurial discovery process, involving all forms of innovation (social, business, etc.), and has an ecosystem approach. The specialization aspect is seen in differentiation, concentration, synergies, and place-based economic transformation. (Juan Pablo Jimenez Navarro) This can for example consist of collaboration between two or more regions on

developing new technologies, which should improve skills and eventually create job opportunities.

The S3P-E regions have implemented H&C projects in different domains, and have experience with almost all types of relevant projects: building retrofits, thermal works, decentralized energy production, campaigns and trainings, and demonstration projects. They have participated in a number of international/interregional projects related to the heating and cooling topic: see **Figure 7**.

Figure 7. Flagship projects

Source: Juan Pablo Jimenez Navarro presentation

There are many challenges as well as opportunities associated with the H&C sector, which were reviewed by the JRC (Juan Pablo Jimenez Navarro).

1) The progress on energy efficiency and renewable energy deployment in many Member States still shows a gap towards the 2020 targets.
2) A significant increase of demand is expected especially in cooling needs.
3) Technological challenges are faced by the Regions. Some of the technologies may need large investments, significant infrastructural changes/modifications and the adaptation of user behaviour especially for energy district level solutions. Thus for example the implementation of a district heating network requires: i. a high upfront investment mainly related to the thermal network, ii. the replacement of conventional end user heating systems (i.e. individual boilers) by the heat exchange station per building or user.
4) Energy poverty was mentioned by a number of presenters, because this is closely linked to the status of the H&C sector. When it comes to the design of regional energy planning, regional authorities have to ensure the inclusiveness of the future energy solutions. A few indicators are shown in **Figure 16**.

   A sustainable project should take into consideration the human dimension (e.g. health), the social dimension (e.g. increased value of the property), and the environmental dimension (including embodied energy). (Andreas Hermelink). Heating and cooling, as well as the building system as an end-use place is challenged by the Human dimension. The number of unhealthy buildings in 2014 was shown by Andreas Hermelink (**Figure 8**). Almost twice as many Europeans report poor health when living in a damp home. 1½ times as many Europeans report poor health when living in a dark home.
5) The economic value of a renovated house can significantly increase as opposed to a building that has not been renovated making the energy investment more attractive not only in terms of energy performance but also from real estate market perspective.

6) Significant difficulties were reported by the Regions to the JRC in a survey in relation to funds and funding schemes (most of which are in line with other similar reviews), including:
    a. Too complicated procedures, rules are unclear;
    b. Too many documentary obligations;
    c. Need for a clearer and more complete classification of actions;
    d. Lack of pre-finance: need for finance and technical support at the design and feasibility study stages;
    e. Lack of coordination among administrations, in particular lack of clarity in division of tasks between national and regional authorities, or changing roles;
    f. Lack of competences and dedicated staff;
    g. Capitalisation of the projects results: e.g. dissemination of monitoring visits and audits as a source of knowledge-sharing
    h. Need to explore new financial mechanisms

    The survey was filled in by participating regions in the workshop (8 regions) as a preparatory activity to facilitate further discussions during the workshop.

Figure 8. Number of unhealthy people due to low quality indoor comfort

Issues related to indoor comfort (EUROSTAT, EU-SILC database)	Affected number of Europeans (2014)
Leaky roof, dampness, rot	80 million
Unable to keep dwelling warm in winter	50 million
Unable to keep dwelling cool in summer	100 million
Environmental pollution in neighbourhood	70 million
Daylight	30 million

Source: Andreas Hermelink

Suggestions to overcome some of the above barriers were discussed repeatedly. A collection of them as follows:

1) Local/regional level:
    a. Mainstream H&C strategies in local planning and strategies;
    b. Participate in networking, develop partnerships;
    c. Collaborate internally and with the national administration;
    d. Identify local problems and communicate them to higher levels (national, EU);
    e. Set targets at achievable yet ambitious levels;
    f. Local targets and achievements will encourage others;
    g. Select the appropriate sequence of actions, e.g. energy efficiency first, or decentralized systems first, and size DH systems to the lower demand.
2) EU level:
    a. Set realistic, but ambitious targets;
    b. Simplify funding procedures and documentation burden;

c. Help partnerships;

d. Promote dissemination of experiences, demonstration projects;

e. Reflect on shared local problems, e.g. on technical or financial issues.

2.1.4 Future scenarios: heating and cooling forecast

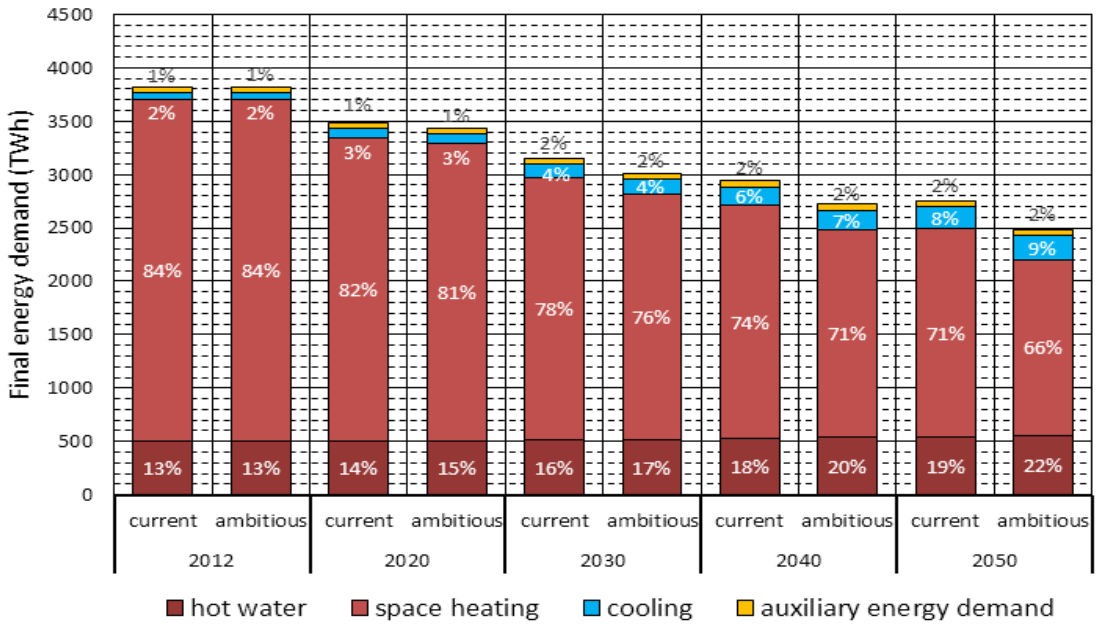
Scenarios about the future of energy demand, including the H&C demand have been developed by many models, e.g. at the Technical University of Vienna (TUW).

Based on the results of the Invert/EE-Lab model in Hartner et al. (2018)[5], a 28 % decrease in final energy demand for heating and cooling can be expected from current policy, and 38 % in ambitious policy scenario is possible by 2050, with a parallel 3-fold increase in final energy demand for space cooling (**Figure 9**). The total demand change for heating vs. cooling was also forecast by Fraunhofer ISI for 2030, and the strong growth of space cooling can be seen in **Figure 10**. (Lukas Kranzl, Sibylle Braungardt)

These scenarios are realisable with technological advancements, including an increase in the penetration of heat pumps, solar thermal and biomass, and an increased market share of district heating (**Figure 11**). (Lukas Kranzl)

However, even the ambitious scenario, resulting in a 73 % reduction of carbon emissions from the H&C sector in 2050, is not enough to reach the Paris target.

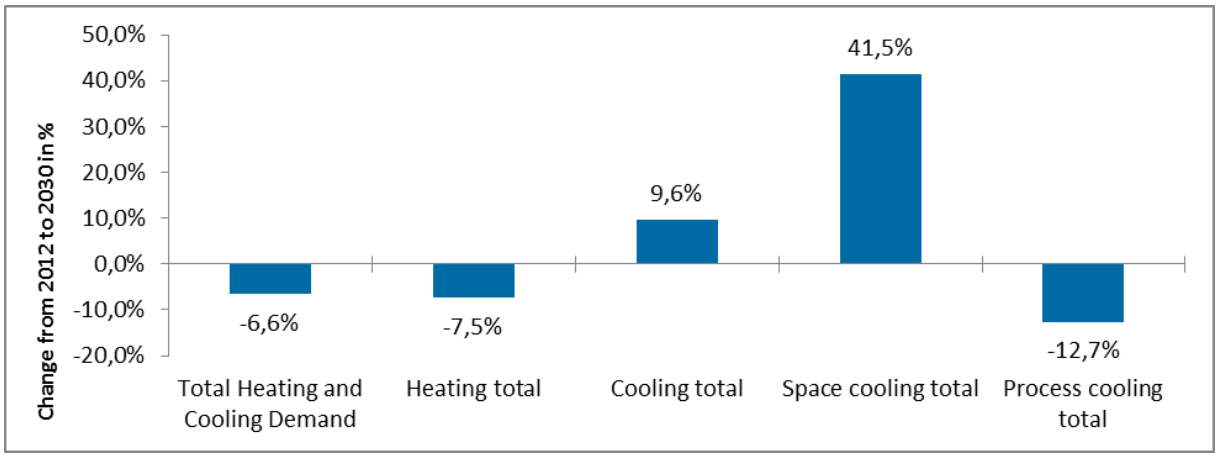
Figure 9. Heating, hot water and cooling (HVAC) demand in the EU28 scenarios of the Invert/EE-Lab model



Source: Lukas Kranzl presentation

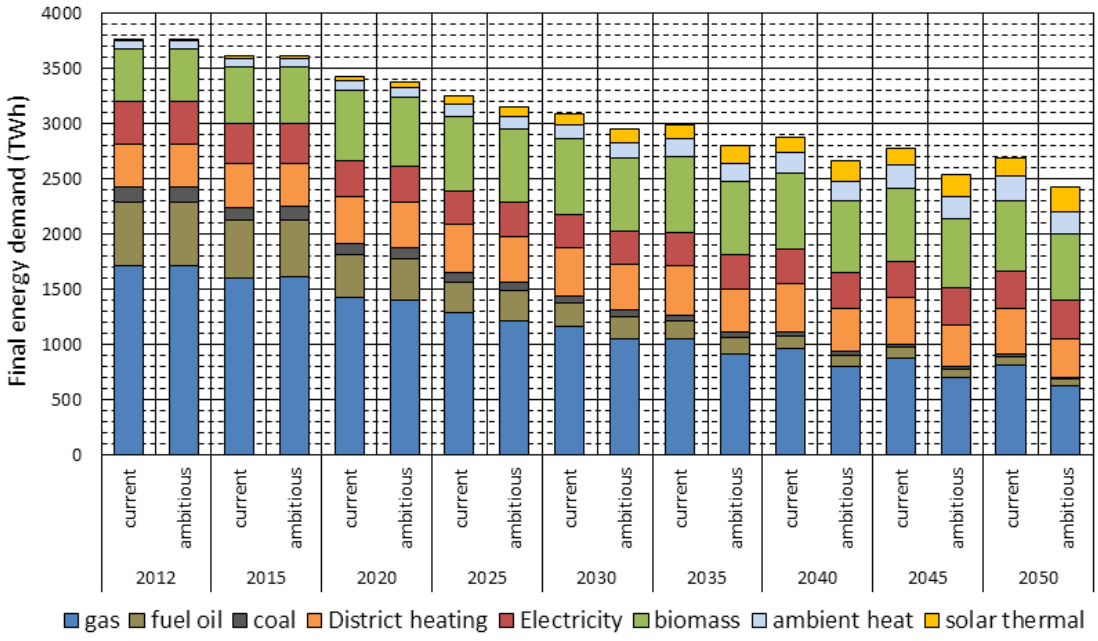
[5] http://set-nav.eu/

Figure 10. Projected development of heating and cooling demand until 2030 in the EU



Source: Sibylle Braungardt presentation

Figure 11. Technological transition in the BaU and the ambitious policy scenario of the Invert/EE-Lab model in the EU28



Source: Lukas Kranzl presentation

In order to achieve decarbonisation of the H&C sector, the TUW found that there is a need to:

- Increase building refurbishment and efficiency improvements (~40 % to >50 % reduction of heat demand 2015-2050, EU-28);
- Increase the share of decentralised renewables: biomass, heat pumps, solar should make up 40 %-60 % of H&C demand in 2050, EU-28;
- District heating needs to expand and achieve high connection rates (~15 %-40 % of H&C demand, EU-28);
- Share of renewables in DH should be up to ~80 %-95 % in 2050, EU-28;
- DH needs to use excess heat integration;

- Transition to 4th generation district heating that allows the utilisation of additional energy sources and improves efficiency by reducing the temperatures of operation in the network;
- Decarbonisation of electricity generation (~14 %-20 % of H&C sector to be covered by electricity);
- Smart solutions, sector integration and making use of the heating sector as a flexibility option to balance increasingly volatile RES-E generation;
- Local, regional, national heat planning and mapping

2.1.5 Examples of technology solutions

The whole energy system is foreseen to be changed as the H&C systems and technologies change. According to Eva Hoos, the new technical systems are underlined by:

- new fuel mix for H&C;
- new types of appliances that meet the new standards;
- this can bring about changes to the supply chain, and a changed infrastructure, e.g. heat networks and electricity network;
- while the solutions have to be adapted and brought closer to the consumers, making the reliable, affordable, and understandable;
- buildings as a whole can become more flexible and adaptable both at construction and planning phase (integrating EE and RES) and at the use phase. Participants at the workshop emphasized the difficulty to realize the integration of RE and EE in real life projects, because investments are often led by cost minimization.
- focus on building retrofits has to be increased across Europe.

To achieve these technical and policy goals, appropriate policies at local level and coordination with the actors is necessary. Investments require both public and private funding (see more in Section 2.2). The national and local priorities have to be brought in line.

The future energy system will not be one-directional as today, but more flexible and more diverse, with a lot of possibilities for combinations.

2.1.5.1 Heating technologies

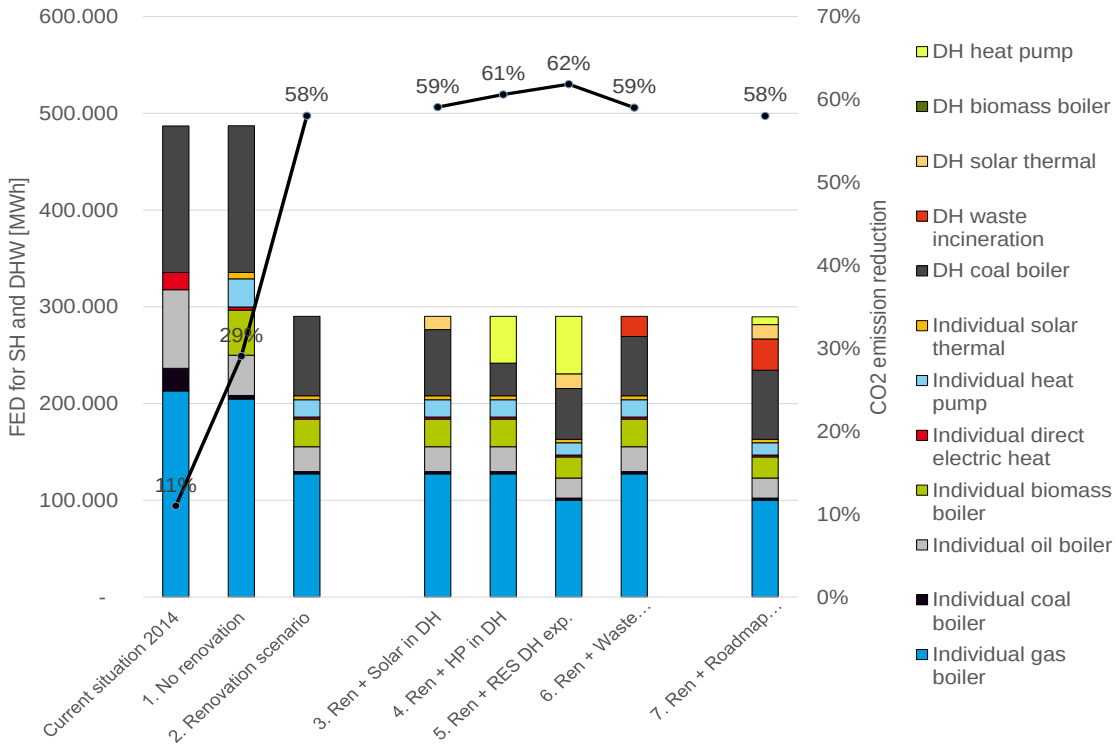
Several presentations and the following discussions compared and contrasted various technological solutions available for the regions for heating. These can be small or large scale.

Lukas Kranzl showed forecasts about the potential impact of various technologies on local energy demand volumes.

Building renovation, district heating, RES, heat pumps

The TUW looked at alternative energy system development scenarios in the case of the city of Herten (Austria) by 2030. Depending on the type of investments, such as renovations only, decentralized or centralized (district heating) investments can bring about around 60 % final energy demand savings compared to BaU, but the technology mix will be very different depending on the choices (**Figure 12**).

Figure 12. Forecast of the final energy demand and the technology mix in Herten in 2030



Source: Lukas Kranzl presentation

Solar district heating and heat pumps

The combination of a large solar plant and heat pumps has been considered for the city of Graz (Austria). Heat costs for heat pump based solutions were projected to be in the range of those solutions with natural gas. Combining with heat pumps had the advantage to lower the final energy demand that had to be supplied by solar sources. (Lukas Kranzl)

District heating

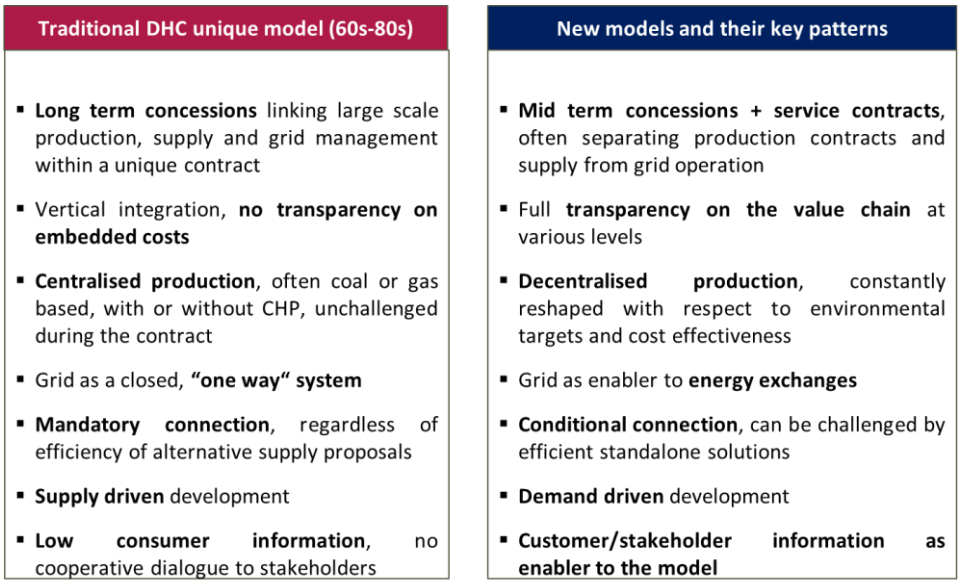
Using the TUW scenarios, it can be determined that the distribution costs of DH can be reduced by renovation, especially by achieving high connection rates, e.g. from 45 % to 90 % could mean a reduction of costs in the range of 2-4 times. (Lukas Kranzl)

Paradoxically, countries with the highest buildings efficiency are also those where DH grids are most developed: this is the case for Sweden, Denmark, Finland, and to a lesser extent Germany and Austria. (Cyril Roger-Lacan)

In other cases, such as social housing in Eastern and Central Europe, jointly upgrading district heating and buildings could provide better business cases than "only" building refurbishment. (Cyril Roger-Lacan)

Cyril Roger-Lacan and other participants emphasized that the modernization of DH models is necessary (**Figure 13**).

Figure 13. The main differences between traditional and modern DH systems



Source: Cyril Roger-Lacan

Heat pumps

As the energy demand for heating decreases due to building renovation and high efficiency buildings, the cooling demand is expected to rise significantly, and thus the required electricity demand, too. By 2050, TUW forecasts a 200 % increase of cooling electricity demand.

The electricity grid in this case has to cope with the load from the heat pumps. This is possible as long as the building refurbishment has gained momentum reducing energy demand and indoor temperature levels, therefore heat pumps are applied in suitable buildings (i.e. buildings requiring moderate inlet temperature levels of the heating system) to allow efficient operation with acceptable COP.

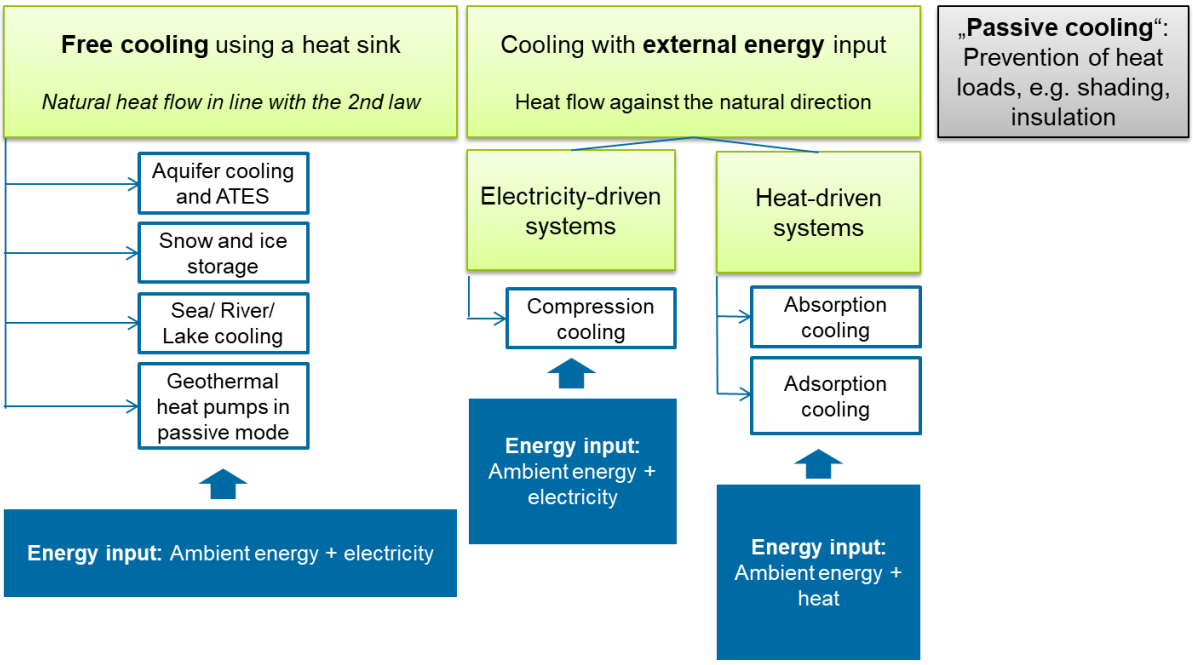
Heat pumps, due to their flexible operation, reduce systems costs by around -0.5% compared to the 2015 base case scenario due to the lower heat generation costs of heat pumps is about EUR 6/MWh.

2.1.5.2 Cooling

Currently space cooling demand is mainly provided by electricity-driven vapour compression systems, however several low-carbon cooling technologies based on renewable sources are available.

The basic concepts of supplying space cooling were presented by Sibylle Braungardt (see **Figure 14**). Some of the technologies were explained in details.

Figure 14. Overview of cooling technologies



Source: Sibylle Braungardt presentation

For electricity-driven vapour compression cooling systems as well as cooling systems driven by heat, the main strategies towards low-carbon cooling are to increase the efficiency of the cooling system and maximizing the share of renewable electricity. (Sibylle Braungardt)

Free cooling systems using natural heat sinks can reduce CO_2 emissions for space cooling. (Sibylle Braungardt)

Interestingly there is not much known about passive cooling and shading. The envelope has been shown to reduce heating demand, but not enough similar data are available for cooling demand. TUW includes shading in models, and has shown that these can have large impact. Furthermore, the European Solar Shading Association has done some studies. (discussion)

2.1.5.3 Local technology portfolio

The workshop included a lot of discussions on which technology fits best in the regions, and depending on the local circumstances, how to select among them. This is a critical issue when local plans have to be designed. Clearly, there is no silver bullet. The examples presented have shown the benefits and challenges underlying different options.

Decarbonisation of the H&C system is an opportunity and a challenge, and to achieve it all ingredients (technologies and planning) will be required. The examples of combining technologies show that the benefits of several technologies can be reaped at the same time. (Lukas Kranzl)

2.1.6 Exemplary development projects

A rather large number of examples of technological solutions – from district heating, through heat pumps, geothermal cooling systems and comprehensive building refurbishments – were presented with the presentations and during discussions. These are summarized below.

2.1.6.1 Refurbishment of a multi-family building using passive house elements in Dunaújváros (Hungary)

The EU-supported SOLANOVA project was the first renovation of a multi-apartment building with passive house components in Eastern Europe (Hungary). The project has won a number of awards.

The local stakeholders and the developers decided together how "deep" to go. A 30 kWh/(m^2a) threshold of target heat demand was set as a tipping point between renovation and demolition. Furthermore, embodied energy was taken into consideration, not only direct energy efficiency. The social dimension was also treated in the project, e.g. through surveys before and after the renovation. Concerns were with summer overheating, therefore the project had to install passive shading to overcome these. (Andreas Hermelink)

Type of project: Renovation of a multi-apartment building (42 apartments)

Energy savings: winter heating demand reduced from 120-180 kWh/m^2 to 15-50 kWh/m^2

Investment cost: 225,200 EUR – European Union, 238,000 EUR – Hungarian Ministry for Environment, 120,000 EUR – Local Government of Dunaújváros, 160,000 EUR – Water, Sewage and Heat Supplier of Dunaújváros, 50,000 - owners

Financing sources: EU FP5 (for the research and demonstration part), national, local and supplier sources combined with a very low rate of owners' contribution. The external funds had to be prefinanced from bank loans because the 2002 upfront costs were only reimbursed in 2005.

More information at: http://www.solanova.org, http://www.energotrade.hu/solanova_projekt

2.1.6.2 District heating and cooling networks in Barcelona (Spain)

Barcelona aims to improve into a self-sufficient city. In recent years, two neighbourhoods were revived based on the implementation of locally designed DH and DC networks. DISTRICLIMA is the revitalization of the East Neighbourhood of Barcelona, which used to be an old industrial area, building on "the Knowledge Economy". Discussions started in 1998, and the project was implemented by 2010, and extended in 2015. The implementation is a complex urban development plan, including mobility plan, public space renewal, new energy networks, etc. Waste is used to produce steam (DH and DC) and electricity.

In the West Neighbourhood, the ECOENERGIES project was implemented in a similar manner, in an industrial area called "La Marina" before. The heart of the area became the natural gas processing plant in the Harbour of Barcelona, where biomass from parks and gardens of Barcelona are fed into taking advantage from the waste to be a self-sufficient city.

Barcelona also depends a lot – in the energy system development – on solar and wind energy, and plans to multiply its local energy production and reduce external energy dependency. They have advocated less regulation; therefore joining the network is voluntary, but successful as proven by the increase in the network length (more than 18 km) and number of building connected (100). The business model is always locally adapted, therefore can be PPP, Special Purpose Vehicle, Energy Service Company (ESCO), or Customer-owned Cooperative. (Manuel Torrent)

Type of project: Implementation of District Heating and District Cooling Networks

Energy savings: Key benefits of the district heating and cooling systems is the reduction of CO2 emissions (more efficient system), and the improvement of the local living and working conditions (noise, dust, heat island effect reduction)

Investment cost:

Financing sources: Public-private partnership (PPP), Special Purpose Vehicle (SPV), Energy Service Company (ESCO), Customer-owned Cooperative.

More information at: http://www.districlima.com/en

2.1.6.3 District heating and cooling in Querfurt (Sachsen-Anhalt, Germany)

An example of reviving an ageing, partly obsolete DH infrastructure through a comprehensive holistic concept. (Cyril Roger-Lacan)

At start the DH grid was an ageing, gas fuelled, inherited DH grid, with gradual disconnection of large customers moving to standalone solutions. With much of the demand leaving, the common costs were left on fewer and fewer users, above all they were social housing customers. This made a system upgrade impossible, too.

A holistic project was designed. Conception and construction took place between 2011-2015, and the grid started operation in 2015. Building on the city's fundamental scenarios (demographics, city development, economic development), a large variety of options and potential projects were considered.

A key design element was the close connection with local stakeholders. Benchmarking of potential alternatives considered economic/environmental/social welfare criteria established with the municipality.

As the **project outcome** was a complete reengineering of the DHC concept. A new methanisation plant from local agricultural waste + cogeneration provides most of the heat. As a result 40 % CO_2 reduction in the DH system, and 30 % heating bill average reduction compared to BAU scenario was achieved. A 25 % return on equity for city investment was also achieved.

Type of project: Revival of a District Heating Network

Energy savings: 40 % CO2 reduction in DH system, 30 % heating bill average reduction compared to BAU scenario, 25 % return on equity for city investment

Investment cost: n/a

Financing sources: n/a

More information at: https://www.tilia.info/en/re-engineering-and-upgrading-the-district-heating-and-overall-energy-supply-scheme-of-querfurt/

2.1.6.4 Smart Heating and Cooling network of Paris Saclay

Paris Saclay is a major scientific, economic and academic cluster, and urban development project at the outskirts of Paris. (Cyril Roger-Lacan)

The development: 1 740 000 m² to be built between 2015 and 2028 with associated infrastructure. The total costs of investment are foreseen to be EUR 1.5 billion for real estate projects, and EUR 1 billion for laboratories, scientific facilities and collaborative

institutes. The development of a DH and DC systems is involved with the size of investment around EUR million50 million for 10 km district heating and cooling network. The grid is built on the two geothermal drills and 1 200 000 m² space connected to the network by 2021.

The **result** of the project is foreseen on several levels. Due to the locally available geothermal, i.e. low carbon source, the system will run with 60 % local RES, and have an impact of less than 100g CO_2 / kWh. Balancing heating and cooling needs is solved between different purpose buildings (residential <-> offices <-> educational facilities). The DH and DC can be provided at a competitive price compared with natural gas price, with long term price stability. Possible electrical and heat demand response and real time optimization.

Type of project: Complex urban development project

Energy savings: saving of 100g CO2/kWh

Investment cost: 50 million EUR

Financing sources: Local government and EU funds

More information at: https://www.tilia.info/en/geothermy-based-smart-district-heating-and-cooling-grid-of-paris-saclay/

2.1.6.5 STACCATO project

The **S**ustainable **T**echnologies **A**nd **C**ombined **C**ommunity **A**pproaches **T**ake **O**ff (STACCATO) project took place in Sofia (Bulgaria), Budapest (Hungary) and Amsterdam (the Netherlands). In Óbuda (part of Budapest), Hungary a block of 800 homes was renovated in just 6 months in 2009. Financial contributions from the European Commission and the National Government enabled an own private contribution of only 27 % of the costs. (Evgeni Atanasov)

On the other hand, in Bulgaria the initially planned 5 panel buildings to be renovated had to be renegotiated. The buildings were in very poor condition and there was lack of agreement between the residents for general renovations, thus other partners and sources of co-financing had to be included. The project was redirected to monolithic old multifamily buildings in the area. Cooperation with the Ministry of Regional Development and Public Works (MRDPW) and the United Nations Development Program (UNDP) was established and a lot of communication took place. Around 150 buildings expressed interest. Technical inspections were made and a sociological survey was conducted on the needs, problems and readiness for financial participation. Conceptual projects for solar collector installations on 3 buildings were prepared. The first stage was completed in August 2011 with 3 renovated buildings. Combination of building refurbishment to improve energy performance and RES (solar thermal) were implemented.

A second stage was added using a national support scheme, and in a third phase a hospital renovation was added.

The challenges of STACCATO:

- For the first time such project was done in Bulgaria;
- There were no high-rise multifamily residential buildings with installed solar collectors in Sofia before;
- The technology was yet to enter on the market and was not widespread and popular;
- Required relatively higher initial investment.

Results:

- The energy savings achieved by STACCATO were about 50-55 % per year;
- Solar installations are paid for 8-10 years, which is 1/3 of their life;
- The project not only improved the living conditions in residential buildings but also showed that the inclusion of RES in renovation of buildings significantly increases their energy efficiency.

Type of project: Renovation of multi-apartment buildings

Energy savings: 50-55 % per year compared to BaU

Investment cost: EUR 20 166 712 (in three cities: Sofia, Budapest, Amsterdam)

Financing sources: Local government and EU funds

More information at:

https://smartcities-infosystem.eu/sites-projects/projects/staccato

-

2.1.6.6 Community owned/shared projects

The solar and seasonal water storage DH system project in Gram (Denmark) includes an innovative and flexible heat supply, enabling to integrate a higher share of renewables and surplus heat, and create synergies with the electricity sector and balancing services to the electricity grid. (Cyril Roger-Lacan)

The components of the heat production and storage/distribution are:

- 44 000 m^2 solar thermal panels (62 %)
- A 10 MW electric boiler (14 %)
- A 5 MW_e/6 MWth CHP gas engine (9 %)
- A 5.5 MW gas boiler (7 %)
- A 900 kW heat pump (5 %)
- 2 MW industrial surplus heat (3 %)

The seasonal storage pit (122 000 m^3) enables to integrate complementary technologies and to optimise the generation in real time through an automatic control unit, based on technical and economic criteria (improved flexibility and cost-efficiency). This way it can also provide balancing services to the Danish and German TSOs.

Above all, the governance is innovative: owned by the customers through a non-profit citizen-owned entity.

2.1.7 Communities

The workshop focused much on community assistance and peer-assistance. It was actually organised in the framework of the Thematic Smart Specialisation Strategies Platform on Energy, or S3P-E.

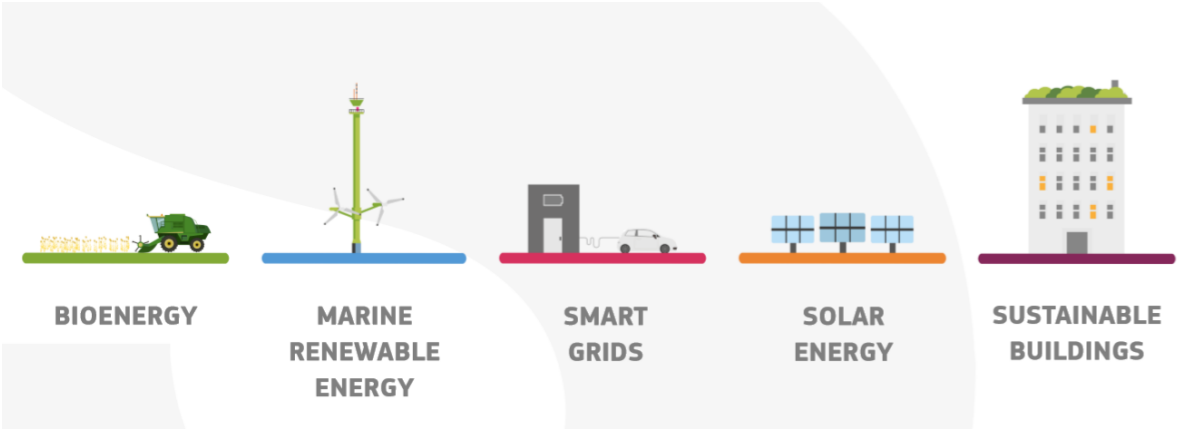
The S3P-E is the space where Member States, regions and energy stakeholders receive support for an optimal and effective uptake of European Structural and Investment Funds for sustainable energy.

The S3P-E promotes activities at national, regional and local levels, for achieving a shared vision on knowledge-based energy policy, with the aim of better alignment of regional and local activities through the identification of the technologies and innovative solutions.

The S3P-E allows its members to share experiences and activities on innovation and energy-related policies and establish partnerships between regions and Member States that have identified renewable energy technologies and innovative energy solutions as priorities in their S3.

The European Commission and the Member States and their Regions are/can become participants of the Platform.

Figure 15. Already existing Energy Partnerships under the S3P



Source: Fernando Merida Martin

The above shown Energy Partnerships have their own structures, members, and are very varied in their methods, sizes, and operational equipment.

There are already a lot of lessons learnt from these partnerships.

- There is a need for critical mass and peer learning at the regional level;
- A joint initiative between European Commission and MS and regions is beneficial to pursue common interests;
- The drivers of S3P implementation are primarily regional administrative capacity and strong leadership by regional actors;
- The S3P fills in a gap by linking regional, energy and innovation policies;
- The S3P is also important because promotes effective communication and collaboration between EU, MS and regional levels, which is otherwise very difficult and not prioritised;
- Until now, it is clear that the functioning of this network is highly dependent on external support
- There is a high participation amongst regions from most developed countries which led/co-led mostly of the activities, whereas less developed/eastern Europe regions are much less represented;
- Partnerships experience difficulties in designing pilot projects, which is a very slow process;
- Leading regions with well-defined projects and mature innovation clusters are unsure about how to engage or cooperate with others.

Two partnerships also described their activities in more details:

- Sustainable Buildings, which is the largest among them with 55 entities. Their chosen priority areas are: 1) Eco construction, bioclimatism and insulation of buildings, 2) Renewable energy integration in buildings, 3) Systems of maximum energy efficiency use in buildings and cities.

They have participated in internal and external events during 2017, elaborated a "Map of capacities" and started to implement the first pilot project: "Smart Campus project"

- The Bioenergy Partnership is led by Lapland (Finland) and Castilla and Leon (Spain). They aim to validate and demonstrate the sustainability of 2nd generation bio-fuels. They have implemented a survey to identify regional capacities. The next step is to identify business demo cases.

2.1.8 Useful resources

A number of various tools and methods were discussed during the three days of the workshop that are relevant either for the project managers, strategy and planning administrations or for acquisition of funding.

2.1.8.1 Heat Roadmap Europe

The Heat Roadmap Europe (HRE) is a complex portal, with the basic function of providing and assessing data. Data are collected on building demand savings potential, the cost of saving energy, DH and DC potential, energy system potential. This is combined with GIS data and a specially available database can be accessed. Based on these, locally relevant energy system analyses are made. Technical reports, guidelines, and webinars are also available.

Besides the data management, HRE actively communicates and disseminates information, aims to remove non-technical barriers to energy efficiency investments, and opens markets up.

Regions can access for example a thermal atlas, which provides information about heat demand, biomass potentials, geothermal heat, and prospective supply areas.

2.1.8.2 Hotmaps

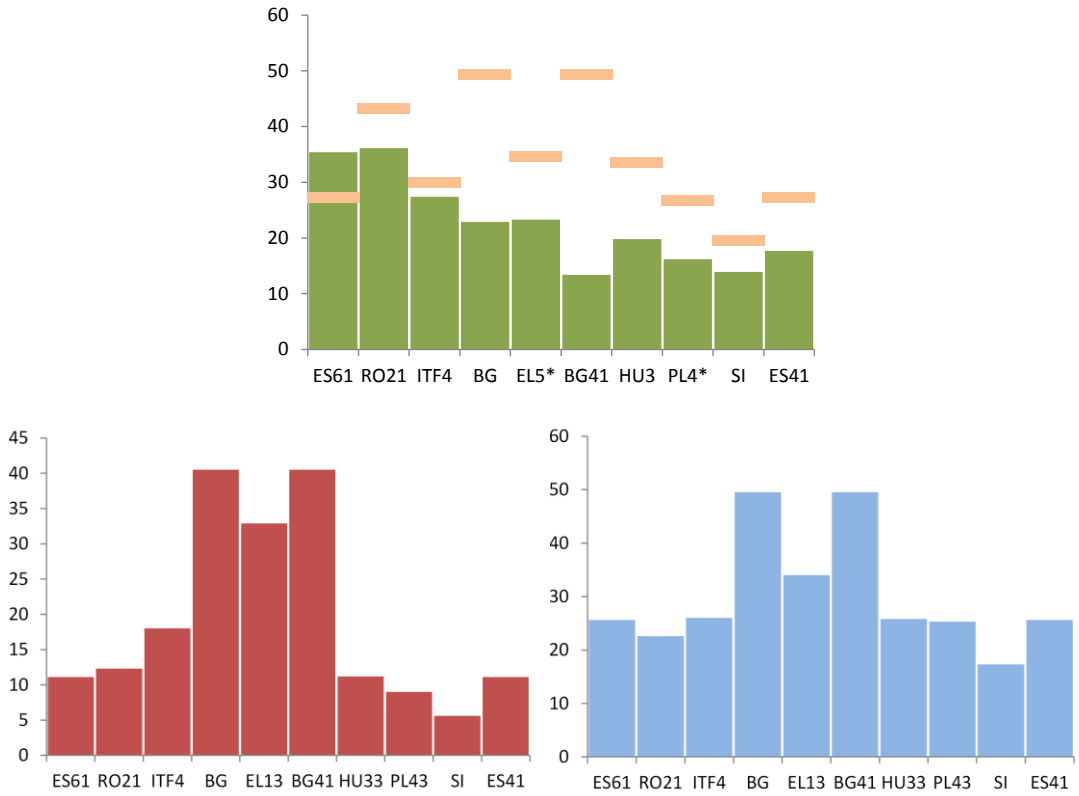
The Hotmaps project develops a toolbox that supports heating and cooling mapping and planning processes. More information is available from www.hotmaps-project.eu

Regions can access an open sources heating / cooling mapping and planning toolbox, which could help regions to analyse, model and map resources and solutions to supply energy within their territory.

2.1.8.3 European Energy Poverty Observatory

Energy poverty is a critical problem linked to H&C. The European Energy Poverty Observatory was launched in January 2018 to step-up European efforts to fight energy poverty (**Figure 16**), by improving the measuring, monitoring and sharing of knowledge and best practice.

Figure 16. Indicators of energy poverty. Top: Poverty rate in the regions and in their countries. Bottom left: Share of inhabitants unable to keep home adequately warm (%), and bottom right: Share of inhabitants who are leaving in a dwelling not comfortable cool in summer (%)



Source: Juan Pablo Jimenez Navarro presentation

Regions can find information on this website that will promote public engagement to help decision making at local, national and EU-levels. It also enables networking and knowledge sharing.

2.1.8.4 Technical assistance and tools

Tools related to the Cohesion Policy (see **Figure 17**) (Gergana Miladinova):

- Advisory platform for financial instruments: "fi-compass". Provides advisory services on financial instructions under the ESIF. This includes practical know-how and learning tools on financial instruments;
- Administrative capacity support, including TAIEX REGIO PEER 2 PEER and support on public procurement and state aid. It is designed to share expertise between bodes that manage funding under the European Regional Development Fund and the Cohesion Fund;
- Thematic Smart Specialisation Platform on Energy. This website contains information about existing energy partnerships, technology fact sheets etc.;
- Networks, guidance documents, RegioStars Awards and European Week of Regions and Cities ('Open Days'), workshops.
- Data platforms:

  https://cohesiondata.ec.europa.eu,
  http://ec.europa.eu/regional_policy/en/policy/evaluations/data-for-research/.
  Here you can find information about ESIF finance for the period 2014-2020, achievements from implementation of ESIF, data on EU payments etc.

2.1.8.5 Cost-Benefit Analysis in project appraisal

Johan Carlsson led the audiences through a project appraisal based on CBA, using the example of a waste incinerator with heat recovery. The European Commission promotes the use of CBA for Structural Funds because they are objective and verifiable. CBA measures in money term all benefits and costs of a project for society. The basic rules of conducting CBAs are binding for all beneficiaries[6].

The structure proposed can be used for project proposal development. (see the presentation slides of Johan Carlsson).

2.1.8.6 Collection of financing and best practice examples

The European Commission collects and published demonstration and example projects, for example those funded by ESIFs, and they are publicly available at:

- https://ec.europa.eu/budget/euprojects/
- http://ec.europa.eu/regional_policy/EN/projects/
- http://ec.europa.eu/esf/main.jsp?catId=46

The De-risking Energy Efficiency Platform (DEEP) is an open source database containing real performance data of energy efficiency projects (> 10 000 energy efficiency projects). http://deep.eefig.eu . This forms part of the "Smart Finance for smart buildings" (SFSB) initiative (section 2.2.3.4).

The IEA Annex 61 also collected examples of cost-effective measure bundles to reach deep-energy retrofits:

- www.iea-annex61.org

2.2 Financing improved heating and cooling solutions

Once there is an interest or even a decision to invest in energy efficiency improvement, raising the required funds is not easy. According to Paolo Bertoldi, interestingly, funding capacity is abundant, but bridging between financial resources and potential projects is missing.

Financing energy efficiency projects (EEP) is difficult due to the traditions of the financing market. There is a disconnect between traditional asset-based lending to corporations and the necessary cash flow-based project financing to EEPs. The solution is difficult because energy efficiency markets are not developed enough to motivate local banks to invest in setting up an EEP lending infrastructure.

EEPs funding is not attractive for Local Financial Institutions (LFIs) nor for International Financial Institutions (IFIs). For LFIs energy efficiency is perceived too risky and thus would only offer high interest rate and long-term lending, if any. Furthermore, LFIs offer traditional asset-based lending (which is around 70-80 % of the market), and are not open to extend to cash-flow based project financing. On the other hand, EEPs are typically too small for IFIs, and due diligence is too cumbersome.

[6] Useful notes:
- EC, 2014, Guide to Cost-Benefit Analysis of Investment Projects
- EC, 2014, Best practices and informal guidance on how to implement the Comprehensive assessment at Member State level
- EC, 2014, Background report on best practices and informal guidance on installation level CBA installations
- EC, 2018, Cost development of low carbon energy technologies
- EC, 2017, Techno-economic projections until 2050 for smaller heating and cooling technologies in residential and tertiary sectors in the EU
- EC, 2017, Long term (2050) projections of techno-economic performance of large-scale heating and cooling in the EU
- Member States, 2015-2016, National comprehensive assessments on energy efficiency potential in heating and cooling sector

2.2.1 Barriers and possible solutions

Paolo Bertoldi gave an overview of key barriers that limit energy efficiency project financing by LFIs and IFIs:

1) Cash flow-based project financing is considered overly risky by financing institutions, as opposed to the traditional "asset-based" lending.
2) LFIs do not recognize the cash flow generated by EEPs as a new asset to be valued in the financing structure (credit enhancement).
3) LFIs perceive EEPs with high-risks.
4) LFIs do not have the internal and technical capacity to properly evaluate EEPs.
5) LFIs are unwilling to invest the time and resources needed to develop lending infrastructure due to relatively small size of each EEP.
6) Commercially financing to EEPs is offered at high interest rates and short repayment terms.
7) Difficult to measure and prove achievements.

Similar challenges were experienced in Lithuania at the local levels (Agnė Kazlauskaitė):

- Slow start of financial instruments: raising public awareness and changing mentality requires a lot of information provision and time and security. A move from subsidies to loans/revolving funds was very challenging;
- Challenge to "go first" – must be brave and optimistic;
- Assurance of on-going political support is imperative, which requires a thorough work with politicians;
- Lack of legal assurance combined with complicated and detailed EC requirements as well as complicated national procedures result in non-attractive and lengthy way for final recipient to feel the benefit
- Demand outweighing supply (for multi-apartments): a high sudden demand for refurbishment cannot be supplied with the previously available suppliers, and results in a lack of technicians and a threat of under-performance.
- Reluctance of FIs to perform new administrative functions related to ESIF.
- Low number of revenue-generating projects in other sectors – hard to establish FIs in some sectors.
- Need for national reforms – respective strategic changes need to be done before the potential FIs could practically work in other sectors.

Therefore, the following actions and structures could be considered to overcome the barriers:

1) De-risking, i.e. offering a guarantee of the cash-flow;
2) Valuing other values of an energy efficiency project;
3) Insurances;
4) Technical assistance to LFIs;
5) Pooling of small projects into a large and balanced project bundle;
6) Aggregators and facilitators;
7) Preparing the supply side, while continuously raising awareness among the demand side and also the politicians and decision-makers;
8) Standardization;
9) Independent verification and monitoring.

Furthermore, workshop participants emphasized the importance of communicating the multiple benefits of energy savings is imperative in acquiring more funding for EE.

A large variety of EU regulatory developments are reviewed in Section 2.1.2.

2.2.2 Alternative financing options to be considered available for regions

Based on the presentation of Paolo Bertoldi, even cash-starved municipalities can find investment alternatives for building and system retrofits. The following funding sources for Heating and Cooling systems, retrofits of projects have been reviewed:

DEBT FINANCING

- **On-balance sheet financing**
    - The first option to always consider is to finance new or renovated H&C systems from internal sources, because these are typically the cheapest. In case of a large city, saving a small fraction of the **Operating Budget,** can mean saving millions of euros per year. However, this usually does not work for most cities, and thus rarely considered..
    - The **Capital Budget** can be used if "energy efficiency" can become a "line item" in the budget on an on-going basis. This would set in stone that the city/region has to spend on EE or other energy programme on a yearly basis.

      Both of the above have mostly political limits. Using either operating or capital budgeting for energy efficiency leads to a "crowding out" effect of scarce internal capital when it could go to more pressing issues with more obvious political rewards.
    - Local governments can usually obtain long-term debt through the issuance of **General Obligation Bonds** (GOs). GOs represent the "full faith obligation" of the borrower, which can be the municipality, province, or region.
    - **Loans** are an obvious method for which municipalities could draw on available funds from eager financial institutions. Funders would look at the **credit risk of the municipality** and offer a rate of interest reflecting the cost of capital, swap costs to hedge interest risk, and a profit margin which varies depending on the lending institution, the municipal client, and the perceived risk. Loans are far more costly to local governments, and they put the municipal corporation directly at risk.

Box 1. Security behind the loan (Source: Paolo Bertoldi)

— *Collateral* - Assets pledged as security to assure repayment of debt obligations.

— *Loan guarantee* – Partial guarantee facility with the objective of credit enhancement.

— *Bank guarantees* – A guarantee issued by one bank (Issuing Bank) to another bank (Beneficiary) as security for general banking facilities given by the latter to a mutual customer.

— *Sovereign Guarantee* - A governmental guarantee for fulfilment of obligations.

— *Insurance*

— *In cashing rights* - right for reclaiming repayments through access to bank accounts.

- As part of a **third-party financing scheme (TPF)**, municipalities can undertake energy efficiency projects (e.g. building energy retrofits) by allowing someone else to provide the capital and to take the financial risk (or guarantee the technical risk). A higher cost will reflect the fact that the debt resides on someone else's balance sheet.
    - ***Lease*** payments tend to be lower than the loan payments. It is commonly used for industrial equipment.

        - **Capital leases** are instalment purchases of equipment. In a capital lease, the lessee owns and depreciates the equipment and may benefit from associated tax benefits. A capital asset and associated liability appears on the balance sheet.
        - In **operating lease,** the lessor owns the equipment and rents it to the lessee for a fixed monthly fee. It shifts the risk from the lessee to the lessor, but tends to be more expensive to the lessor. Unlike in capital lease, the lessor claims any tax benefits associated with the depreciation of the equipment. The non-appropriation clause means that the financing is not seen as debt.
    - **ESCO** – Energy Service Company takes charge of (i) project identification, (ii) engineering, design, and permitting, (iii) construction, (iv) operation and maintenance, (v) administration of billing, (vi) and organization of financing for the above.
        - Some alternative versions: Energy Performance Contract (EPC) / Chauffage / Energy Savings Agreements (ESA) / Managed Energy Savings Agreements (MESA) / Metered Energy Efficiency Transaction Structure (MEETS) / Lighting as a Service (LaaS) / Paying for Performance (P4P)/
        - **Public Internal Performance Commitments** (PICO) are provided by a department in the public administration who acts as a unit similar to an ESCO in function for another department. The ESCO/PICO department organises, finances and implements energy-efficiency improvements mostly through a fund made up of municipal money, and using existing know-how. This allows larger cost savings and implementation of less profitable projects, which would be ignored by a private ESCO. However, these projects lack the energy savings guarantee, because there are no sanction mechanisms within a single organisation (even though PICO includes saving targets). This model has been mainly implemented in Germany.
    - **Forfeiting** - The supplier forgoes its accounts receivable to the benefit of the bank or financial institute, which in return assumes associated risks, and passes up its right of reclaims. Forfeiting is used for medium and long term outstanding receivables or annuities.
    - **Public Private Partnership**
        - *BOO(T)* - Build, Own, Operate and Transfer of infrastructure projects, promoted and financed by the private sector, whereby the promoter builds, owns and operates the project and transfers the ownership back to the public sector only after a specified number of years.
        - *Concession* - An understanding between a company and the host government that specifies the rules under which the company can provide service locally.
- **Energy cooperatives** play an important role for consumers who want to take action but are not confident or interested in acting alone. Different types of energy cooperatives exist. Some operate their **own generation assets** (such as wind or solar parks), others can act **as aggregators or intermediaries**, ensuring optimal operation and management of their members' generation installations (such as roof-top PVs on houses), others can **act as financial actors**, helping to fund low-carbon renovation/construction works. They contribute to decarbonising electricity generation, they involve citizens who can easily understand and, hence, play a role in the energy market and help the energy transition.

- **Yield-co**'s are companies that are formed to own operating assets that produce a predictable cash flow, primarily through long term contracts. Separating volatile activities (such as development, R&D, construction) from stable activities of operating assets can lower the cost of capital. They pay a major portion of their earnings in dividends.

EQUITY FINANCING

- **Vendor financing** occurs when a financier provides a vendor with capital to enable them to offer "point of sale" financing for their equipment. Under a vendor financing scheme there are two types of arrangements: one between the vendor and the financier; and the other between the vendor and the customer.
- An Energy Efficiency Mortgage is a reduced rate mortgage that credits the energy efficiency of the building in the mortgage itself. There are two types of energy mortgages:
    - **Energy Improvement Mortgage (EIM)** - finances the energy upgrades of an existing home in the mortgage loan using monthly energy savings, and
    - **Energy Efficient Mortgage (EEM)** - uses the energy savings from a new energy efficient home to increase the home buying power of consumers and capitalizes the energy savings in the appraisal. An EIM is used to purchase existing homes that will have an energy efficiency improvement made. In the US both EEMs and EIMs require a home energy rating to provide the lender with the estimated energy savings.
- **On-bill financing** integrates loan payments with energy bills**,** allowing utilities to cut off energy supply to defaulting customers. This has the potential to lower collection costs and enhance credit quality of the financing scheme, thereby lowering financing costs. Payment via utility bill reduces risk of credit default and lowers collection risk.

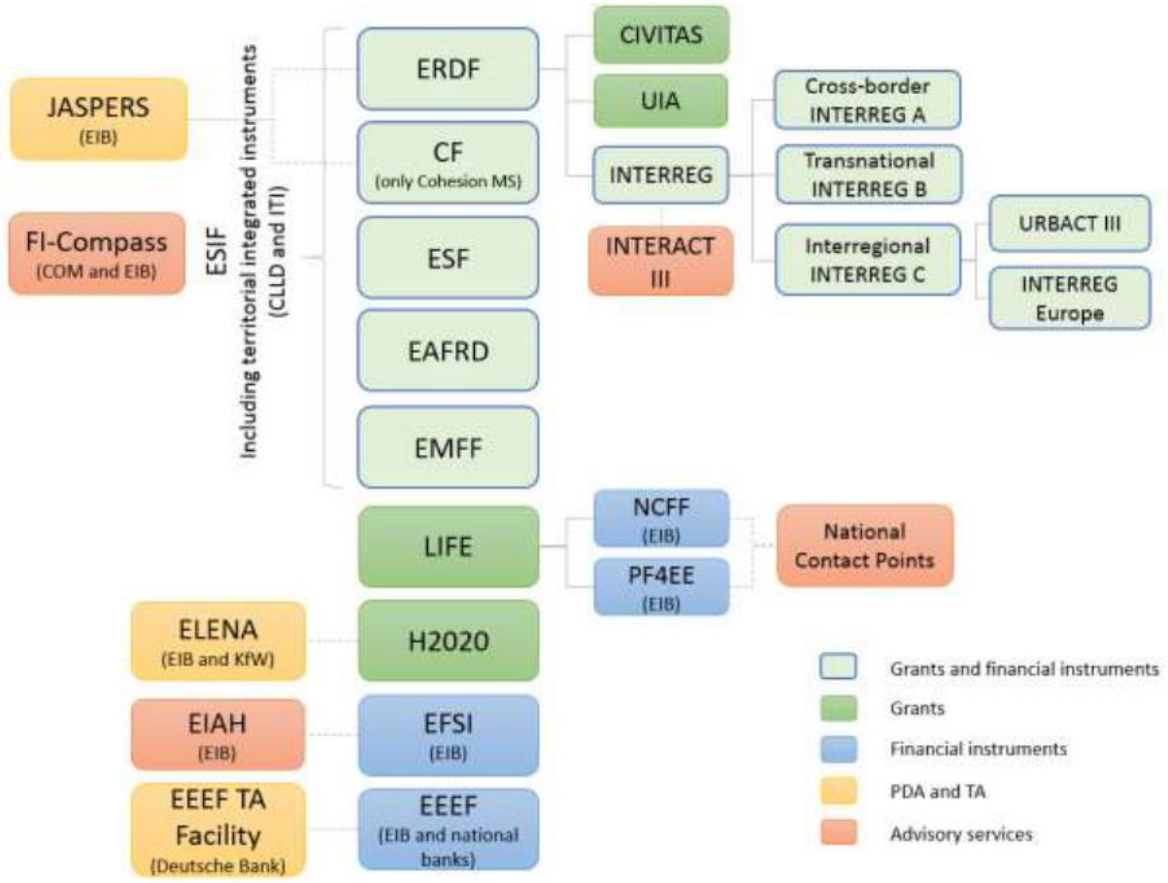
2.2.3 European funds and initiatives

2.2.3.1 European structural and investment funds (ESIF)

Over half of EU funding is channelled through the 5 European structural and investment funds (ESIF)[7] (see **Figure 17**), which are particularly relevant for regions and municipalities. The Cohesion Policy regulates the **European Regional Development Fund** (ERDF), the **European Social Fund** (ESF) and the **Cohesion Fund** (CF) (Gergana Miladinova). The ERDF aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. The ESF invests in people, with a focus on improving employment and education opportunities across the European Union. It also aims to improve the situation of the most vulnerable people at risk of poverty. The Cohesion Fund is aimed at Member States whose Gross National Income (GNI) per inhabitant is less than 90 % of the EU average. It aims to reduce economic and social disparities and to promote sustainable development. Eva Hoos explained that EUR 4.6 billion is available for RES and EE, with a focus moving towards EE. In the future, 25 % of the future funding will be earmarked for energy transition.

[7] Information from the presentations was complemented with information from: https://ec.europa.eu/info/funding-tenders/funding-opportunities/funding-programmes/overview-funding-programmes/european-structural-and-investment-funds_en

Figure 17. System of EU funding alternatives



Source: Paolo Bertoldi presentation

The three Funds spend EUR 352 billion over 2014-2020 concentrated in less developed regions, aiming to reduce disparities between Europe's regions strengthening economic, social and territorial cohesion, and to contribute to the Europe 2020 Strategy for smart, sustainable and inclusive growth. (Gergana Miladinova)

There is no minimum size for projects, which is also important at regional and city level. What counts is the European added value of an investment, their impact on employment, their innovative nature and whether they contribute to the region's economic competitiveness. (Gergana Miladinova)

Synergies can be built up between various funding schemes, e.g. European Fund for Strategic Investments or Juncker Fund (EFSI)[8], H2020, TAs, etc. It is important to know that synergies between policies and funding must be respected. For example, when an EU Directive is not yet transposed, related project cannot be funded from the Cohesion Policy funds in order to concentrate on the added value. Emphasis is on new financial instruments instead of grants (even though grants are still available). (Gergana Miladinova)

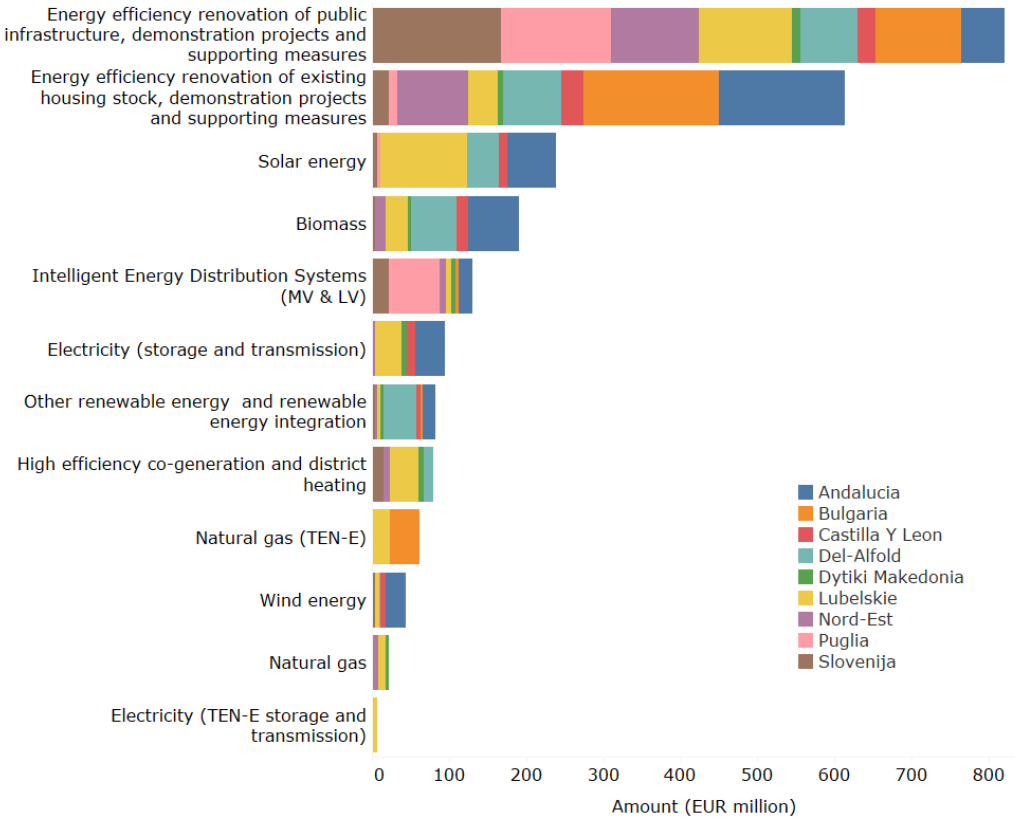
In the new funding period (2021-2027), the total available budget is foreseen to decrease by around 10 %, and the thematic objectives have been revised. Thematic ear-

[8] The EFSI and EFSI 2.0 (Juncker Plan) are the central pillar of the Investment Plan for Europe, managed by the EIB Group to provide a guarantee to cover a first loss protection, in order to establish financing to higher-risk projects than the market would normally take up. It aims to tackle the lack of confidence and investment which resulted from the economic and financial crisis, and to make use of liquidity held by financial institutions, corporations and individuals at a time when public resources are scarce. It also helps small businesses to start up, to grow and to expand by providing risk finance.

marking will increase to 30 %. Further change is a decrease in co-financing (50-85 %) to enlarge the leverage factor. Political agreement is foreseen in spring 2019. (Gergana Miladinova)

Due to its focus on environment, sustainable growth and regional development, the ESIF Funds are available for the improvement or installation of H&C technologies and systems. Based on the survey results by the JRC, presented by Juan-Pablo Jimenez, the allocation of ESIF funds in energy related topics remains below 10 % for all regions, ranging from 4.5 % (ITF4 and BG) to 9 % (HU33). Public infrastructure and building renovation attract around 60 % of the total ESIF fund allocated (Juan-Pablo Jimenez) (see **Figure 18**).

Figure 18. ESIF fund allocation per thematic objective



Source: Juan-Pablo Jimenez presentation

2.2.3.2 European Local ENergy Assistance

The European Local ENergy Assistance (ELENA) (see **Figure 17**) was established in 2009, originally to support local energy projects, but has been expanded since. It is based on an agreement between the European Investment Bank (EIB) and the European Commission, managed by the EIB, and financed by the Horizon 2020 Framework Programme for Research & Innovation. Funds are available in grant form for preparation (not implementation) of investment programmes. More than EUR 100 million has been already awarded to projects supporting approx. EUR 3.8 billion investments. The grant covers up to 90 % of costs related to project development support, and the leverage factor is a pre-requisite (10-20 depending on the type of project), and the grant can be clawed back if this is not achieved. The grant is provided in a first come, first served principle. (Reinhard Six)

ELENA KfW (see **Figure 17**) is a financial scheme that supports local and regional authorities and other public bodies. The focus areas are energy efficiency in public and private buildings and street lighting, integrated renewable energy sources (RES), energy

efficiency and integrated RES in urban transport including freight logistics in urban areas, local infrastructures for energy efficiency and municipal waste-to-energy projects. KfW-ELENA consists of two elements, ELENA grant from the European Commission for Project Development Services and global loans to local participating financial intermediaries (PFIs) in order to target smaller investments (volume up to EUR 50 million). (Paolo Bertoldi)

2.2.3.3 European Energy Efficiency Fund (EEEF)

The **European Commission's European Energy Efficiency Fund (EEEF)** (see **Figure 17**) has a new assistance scheme to support ambitious public beneficiaries in developing bankable sustainable energy investment programmes. These projects shall relate to the energy efficiency sector, small-scale renewable energy and/or urban public transport. The technical assistance facility aims to bridge the gap between sustainable energy plans and real investments through supporting all activities necessary to prepare investments into sustainable energy projects. (Paolo Bertoldi)

Further sources for financing various aspects of energy efficiency improvements, buildings, heating and cooling and network improvements were listed by Eva Hoos:

- the new Research Programme (Framework Programme 9);
- Invest EU Fund – to de-risk, reduce interest loans;
- NER300 (emission allowances);
- the renewed Connecting Europe Facility, providing a strong element for cross-border support.

2.2.3.4 Smart Finance for Smart Buildings

The new "**Smart Finance for Smart Buildings**" initiative is created to unlock private financing. The initiative has three key components: effectively use public funding, assistance and aggregation, and de-risking (**Figure 19**). The initiative carries on earlier efforts such as within the EFSI and ESIFs (Timothée Noël).

Figure 19. Key components of the "Smart Finance for Smart Buildings" initiative

Source: Timothée Noël presentation

<u>More effective use of public funds:</u>

Making more use of financial instruments, to achieve high leverage ratios.

- Supporting the deployment of a flexible model of guarantee instrument at national level, mixing different strands of public financing (i.e. ESIF, EFSI).
- Making the use of Energy Performance Contracting more accessible to the public sector (Eurostat recently updated its guidance on the accounting treatment of Energy Performance Contracts).
- Sustainable Energy Investment Forums (public events, national roundtables, webinars)

Providing aggregation and assistance for project development:

- Reinforce Project Development Assistance (PDA) facilities at the EU level to help project promoters bring their ideas to maturity:
    - ELENA, via EIB (PDA facility funded through the European Commission's Horizon 2020 programme);
    - PDA calls launched by EASME for smaller projects;
- Development of dedicated local or regional one-stop-shops for project developers.

De-risking energy efficiency investments

Change the risks perception related to energy efficiency investments - in collaboration with the Energy Efficiency Financial Institutions Group (EEFIG) through providing similar examples, i.e. benchmarks.

An Underwriting toolkit on the value and risk appraisal of energy efficiency investments has been developed by the EEFIG group to assist the market: (released on 22 June 2017) – see http://valueandrisk.eefig.eu

2.2.4 International bank loans

Acknowledging the difficulties for energy efficiency projects, and thus projects in the area of Heating and Cooling in attracting financing, international financing institutions have been on the look to design their funding policies to match these needs in addition to traditional IFI financing targets.

At the workshop, Greg Gebrail, Principal District Energy Specialist at the European Bank for Reconstruction and Development (EBRD) and Reinhard Six from the Energy Efficiency Division of the European Investment Bank (EIB) presented the banks' strategies towards district heating financing.

The **EBRD** provides funds to public and private investors. At the national or sectoral level funding is available through "national framework agreements" or through "technical cooperation projects with government agencies". At the company level, both private and public organisations are eligible to use the funds for both supply and demand side improvements, for example for energy efficiency improvement, meter based billing and improved standards of service. Companies can get sub-sovereign loans often co-funded by donor grants.

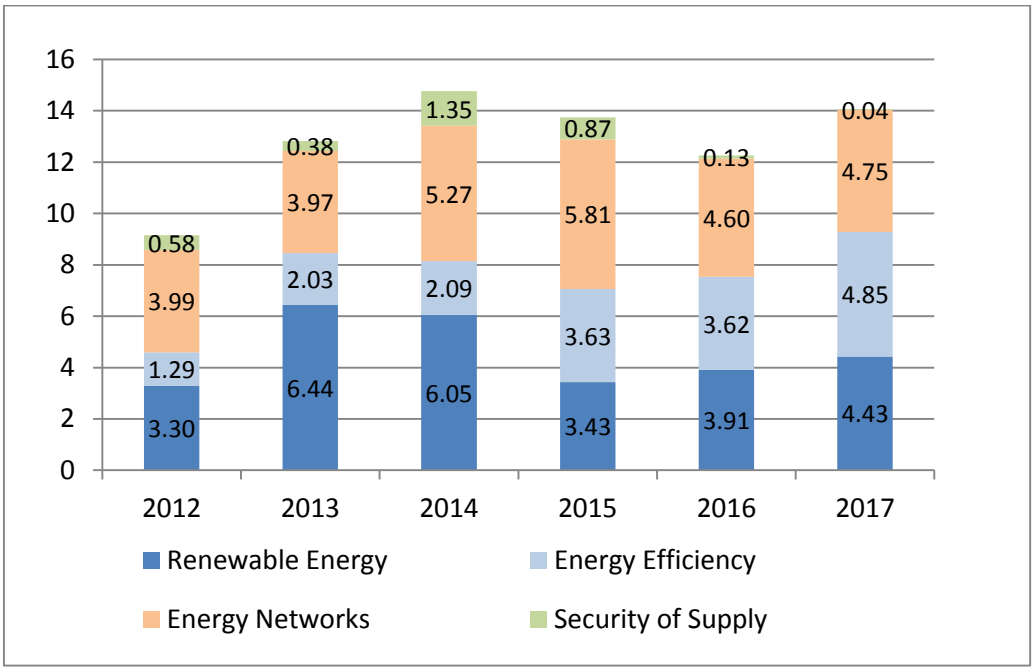
The EBRD adopted its Green Economy Transition approach in October 2015, with targets to direct 40 % of EBRD's annual business to be Green by 2020, which is equivalent to ca. EUR 4 billion. Since 2006, EBRD has provided over EUR 22 billion in Green finance (including 2016).

The **EIB** is the natural financing partner for the EU institutions since 1958, and around 90 % of lending is within the EU. The EIB offers lending, blending and advising. In 2017, almost 60 % of all lending was given out to RE and EE projects, reflecting around EUR 50-100 million per year for district heating and cooling. (Reinhard Six)

EIB offers three main types of support: "lending", "blending", and "advising". Lending is long-term, available for financing projects, and has specific tools, namely the SFSB, EFSI, and PF4EE. In blending, the loan combines EIB finance with EU budget (e.g. ESIF), and the typically higher risk projects e.g. for innovation fit here well. (Reinhard Six)

The EIB invests in 450 projects each year in over 160 countries. The energy project funding has grown by about 50 % and mostly focused on energy efficiency, RE and DH (**Figure 20**).

Figure 20. EIB Energy Lending 2012-2017 (in billion EUR).



Source: Reinhard Six presentation

The countries where IFI investments are usually directed at, typically have an outdated, old DH system that requires a general and overall refurbishment not only on the energy side. Therefore, the loans provided by the IFIs, e.g. through a framework contract in Kazakhstan by EBRD must be matched with a local/national grant to leverage a complex deep-refurbishment. In this case, the loan covers around 40 % of the total investment and is available with an interest rate of 5.8 % (Greg Gebrail).

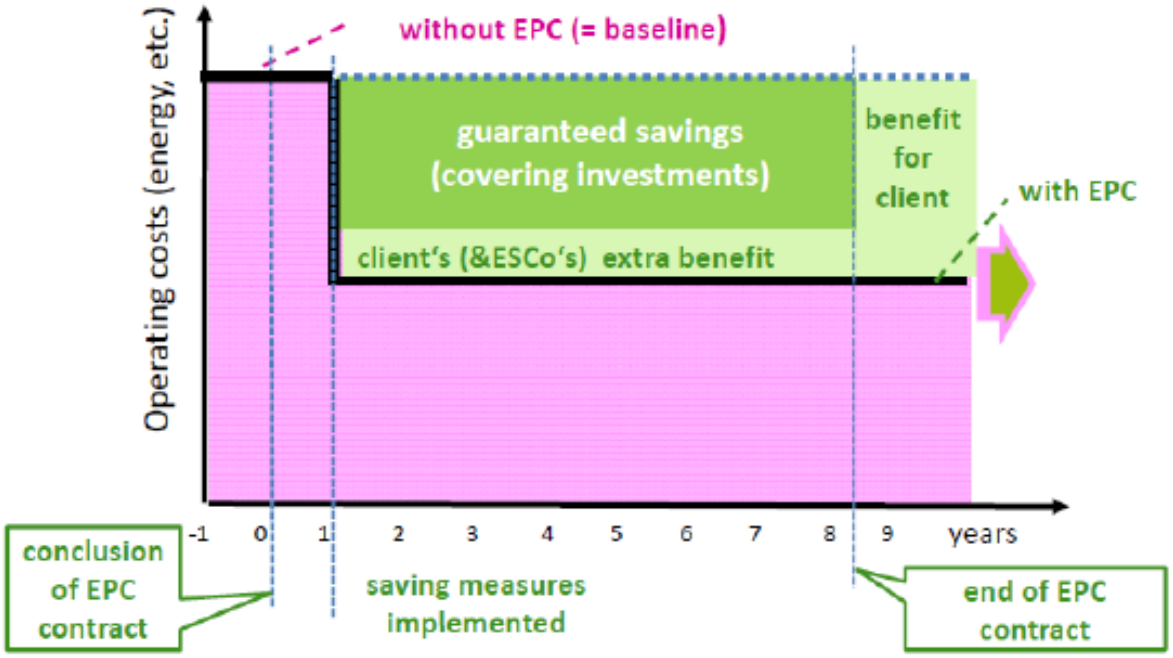
The example projects presented by EBRD and EIB at the workshop are described in Section 2.2.6.

2.2.5 Business models: EPC

The European Commission, Joint Research Centre (JRC) has been monitoring the European Energy Services (ESCO) market since 2005, publishing regular updates every 2-3 years, Paolo Bertoldi presented.

The concept of an Energy Performance Contracting (EPC) is that the energy cost savings cover the up-front investment and the operation of a new/renovated equipment of site. The third-part or contractor implements the energy efficiency and takes over technical and/or financial risks. Its remuneration is linked to the success of the project and the level of energy savings achieved. See **Figure 21**.

Figure 21. The basic EPC scheme

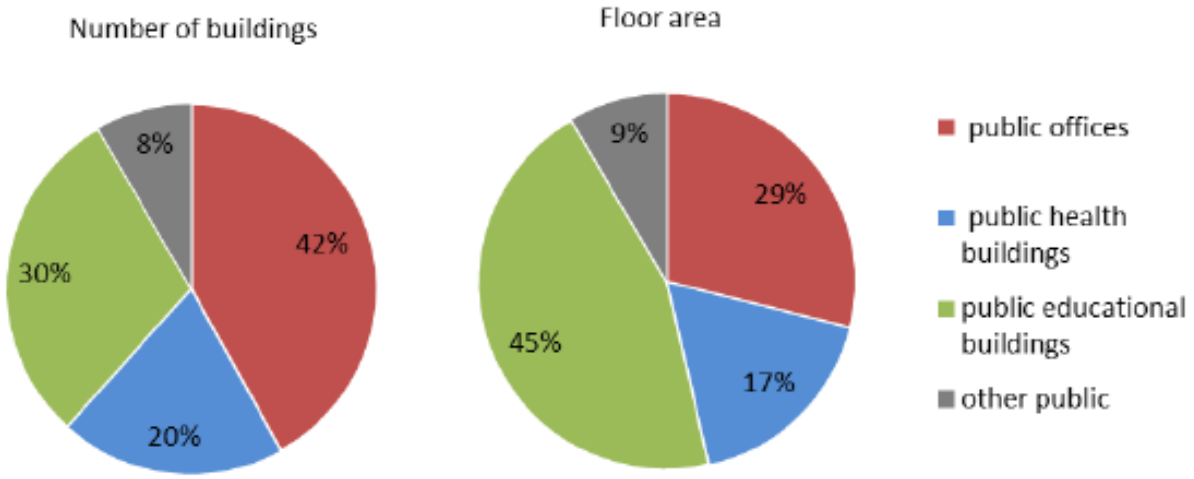


Source: Transparence project 2015 quoted by Paolo Bertoldi

The size of the EU ESCO market was estimated by Navigant as USD 2.7 billion to USD 3.1 billion, the EC-JRC as EUR 2.7 billion, and the Economist as USD 56 billion (Simone Alessandri).

The JRC analysed the EPC potential in the EU public sector. The number of buildings and floor area of different public buildings were first estimated (see **Figure 22**). Based on this, it was determined that EPC renovation measures are applicable to the 60 % of existing public buildings, resulting in an estimate of 34 and 58.5 TWh can be saved in the EU public buildings of sizes larger than 1000 m^2 and 500 m^2 respectively. This would result in economic savings of EUR 2.7-5 billion at European level. To achieve this, a total investment of EUR 21.3–39.4 billion is needed. This total amount can be translated in an average renovation cost per building of about EUR 27 000 and an average cost per square meter of around EUR 17.5/m^2 (Paolo Bertoldi).

Figure 22. The share of number of buildings and floor area in different building types



Source: Paolo Bertoldi presentation

Buildings owned and/or managed by the public sector make up more than 10 % of the overall EU building stock. Very often public buildings also need maintenance, refurbishment and have a low efficiency. The public sector proceeds slowly in improving energy efficiency due to a number of barriers, including limited financial resources, limited human resources in numbers and in profession, split incentives, etc. The sector is an excellent target for EPC, because EPC brings in private funds for financing a public project.

The picture of the current status of using EPC in the public sector is very diverse. There are only a few countries, where a well-developed EPC market could be identified in the public sector (Denmark, Germany, UK), and several which are well advanced (Finland, Czech Republic, the Netherlands). France is special case, with a moderately advanced EPC market in the public sector, because the EPC definition actually misses the core EPC value, i.e. repayment from the savings, as a result of the French legislation.

The outlook for the EPC market in the public sector is good. Most of the markets are expected to grow in the near future, even those that are still in a preliminary phase.

The European System of National and Regional Accounts (referred to as ESA 2010) entered into force in September 2014, and raised concerns about how to treat EPC in public accounts. After long deliberations between Member States, industry representatives and EUROSTAT, a resolution was passed only recently. (Paolo Bertoldi and Simone Alessandri)

The EPC market was boosted by the European Code of Conduct for EPC, developed by the Transparence project, setting up industry-driven values and ethics. Currently there are 149 EPC Providers, 70 EPC Facilitators, and 15 Associations of EPC signatories, most of them in the Netherlands (41), Spain (19), Czech Republic (17) and the UK (17). eu.ESCO and European Federation of Intelligent Energy Efficiency Services (EFIEES) are jointly the European administrators. (Simone Alessandri)

2.2.6 Business models: how to achieve deep-energy retrofit?

During the question and answers sessions about EPC, workshop participants discussed about the difficulties and potentials of ESCO projects to go beyond the "low-hanging-fruits". Since EPC works on a market basis, energy savings usually achieve up to 30 %, locking in major potentials. It was agreed that a combination different financial schemes,

e.g. EPC combined with grants for the respective parts of the projects (social vs. private benefits) should be considered.

This was followed by a presentation by Rüdiger Lohse about the IEA work and ACE project about the assessment of deep retrofit financial strategies.

The IEA Annex 61 "Business and Technical Concepts for Deep Energy Retrofits of Public Buildings" project (2014-2018) was aimed at the R&D of innovative and highly cost-effective bundled packages of Energy Conservation Measure Bundles (ECMBs) of H&C and thermal envelope. Annex 61 aimed to develop and demonstrate innovative, highly resource-efficient business models for refurbishing buildings using appropriate combinations of public and private financing and to support financiers and decision makers in evaluating the efficiency, risks, financial attractiveness, and contractual and tendering options conforming to existing national legal frameworks.

The ACE project (2017-2019) was funded by the German Department of Energy to develop standardized financial and technical evaluation routine for standard energy efficiency investments from the perspective of financiers. Furthermore to create a "Bundling Platform", where standardised approach is promoted for the evaluation of EE projects by financiers and ESCOs, as well as to develop a "Best Practice Platform" to display evaluated EE projects. Finally, a proposal for aligned subsidy programs was requested.

An issue is the lack of reliable data on implemented deep-retrofits. The above projects succeeded to collect 26 well documented and evaluated projects in Europe, US and China in a "Best Practice" guide. While the data on costs was the biggest issue, from the few projects that provided this, an average incremental costs for deep-energy retrofit in comparison to national minimum requirements was calculated at EUR 150-600/m².

Another issue, which increases indirect costs was found to be the investment risk, which was partially due to the perceived risk by building owners and financiers. There should be programmes and solutions that can mitigate this.

A "Technical Guideline" was prepared to decrease the perceived risk through providing a description of cost- effective deep-energy renovation measure bundles for different climate zones.

2.2.7 Best practice examples

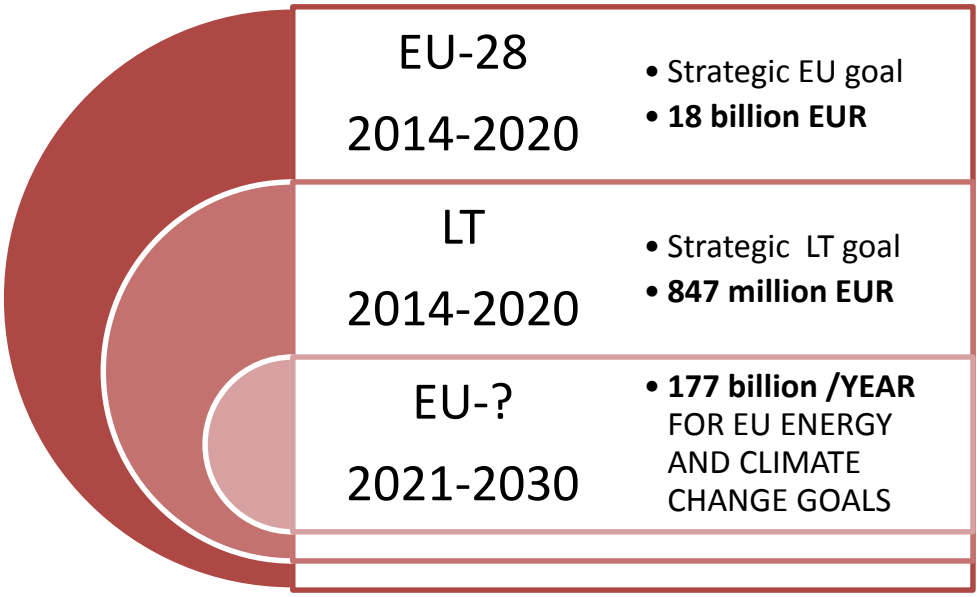
2.2.7.1 Multi-apartment buildings and public buildings

Lithuania

Sustainable energy goals and measures in Lithuania are framed by EU legislation. Equally, the bulk of the funding stream originates from the EU in the form of Structural Funds (see **Figure 23**).

Energy efficiency is considered in its multi-benefits in Lithuania: it contributes to increasing energy supply security, decreasing greenhouse gases and other pollutant emissions, and it also helps in the transition to a resource-efficient economy. To comply with the EED provisions, Lithuania has set a target of cumulative 11.67 TWh of energy savings by 2020. Furthermore, an Energy Efficiency Obligation Scheme draft is being prepared, and the promotion of faster development of Energy Service Companies is planned, as well as the speeding up of the rate of public and multi-apartment building renovations and modernization of street lightning.

Figure 23. Energy efficiency goals and financial conditions in the EU and in Lithuania



Source: Presentation by Agnė Kazlauskaitė

It is a top priority to place the consumer at the centre of green energy future.

Although the efficiency of Lithuania's energy consumption has decreased steadily during 2010-2015, it is still 57 % higher than the European Union average.

By the end of 2014, The Government of Lithuania adopted the program for the improvement of energy efficiency in public buildings. The program aims to renovate public buildings (total area of 700 000 m^2, of which 470 000 m^2 belong to the state and 230 000 m^2 are owned by municipalities) and to achieve 60 GWh savings of final energy by 2020. The Public Buildings Energy Performance Improvement Program involves public buildings with building energy efficiency classes D, E, F, managed by budget state institutions and institutions. The program sets the main requirement for renovation of buildings - Public building after renovation must achieve a class C energy efficiency class not less than C.

An Energy efficiency fund was established on 18 February 2015 using the European Structural and Investment Funds to achieve building renovation and the modernization of street lightning, with 79 million EUR allocated funds. Two financial products will be introduced:

- Loans for central government owned public buildings modernization (ESCO);
- Guarantees for street lighting projects. About 100 000 luminaries will be refurbished.

Public buildings renovation measures were prepared by VIPA and the Ministry of Energy in 2014, but no public building has been renovated until today. The Ministry of Energy is preparing the necessary changes to bring about 25 000 m² of the most inefficient central government buildings to be screened this year and in 2018.

Lithuania also has a multi-apartment modernization program: the goal of the program is to reduce the costs of heating in multi-apartment buildings by at least 20 %, that is, at least 1 000 GWh/p.a. through upgrading at least 4 000 apartment blocks by 2020. As of 2013, 1046 multi-apartment buildings have been renovated, and EE in buildings increased by 65 %.

There are programmes also for transport and industry in a similar size.

Consumer information agreements obligations have been introduced to complement financing programmes. These oblige all energy providers to raise awareness among consumers about the potential of saving energy and changing their behaviour. About 40 agreements have already been concluded.

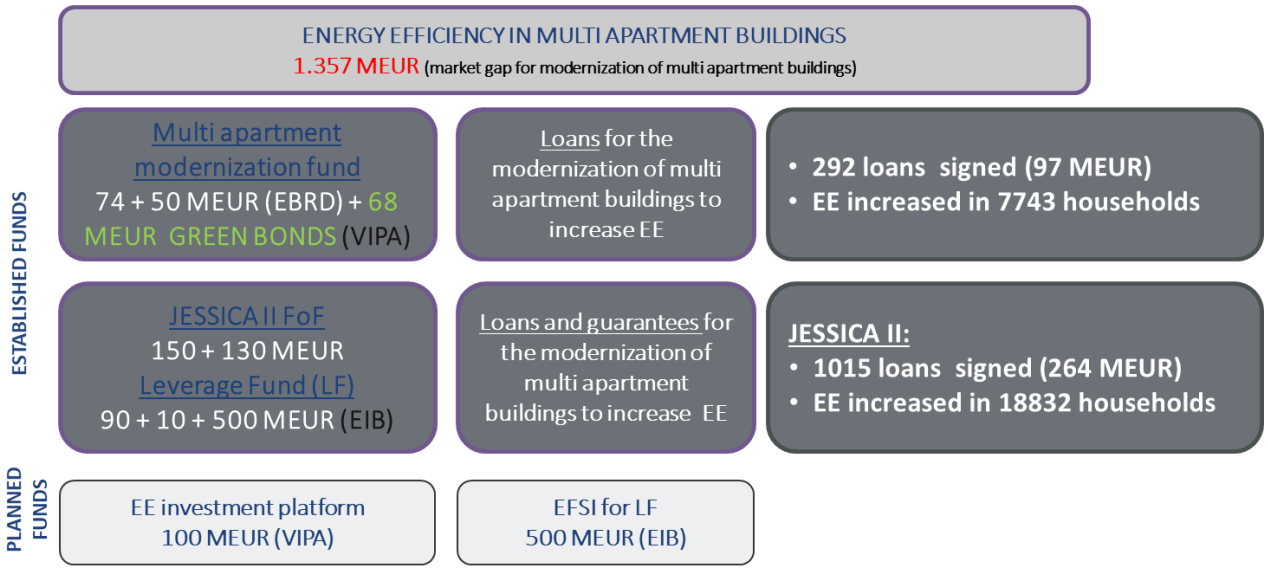
Energy suppliers will be required to inform business consumers, to enter into agreements with energy companies (ESO, Ambergrid, Litgrid) on energy savings. The program is expected save an annual 14 000 tonnes of greenhouse gases.

SME financing has been based on ERDF funds. As of 2013, 3886 loans/portfolio guarantees were granted to SMEs, 3089 individual guarantees granted to SMEs, and 100 venture capital investments made.

The EUR 80 million public fund has leveraged more than EUR 460 million.

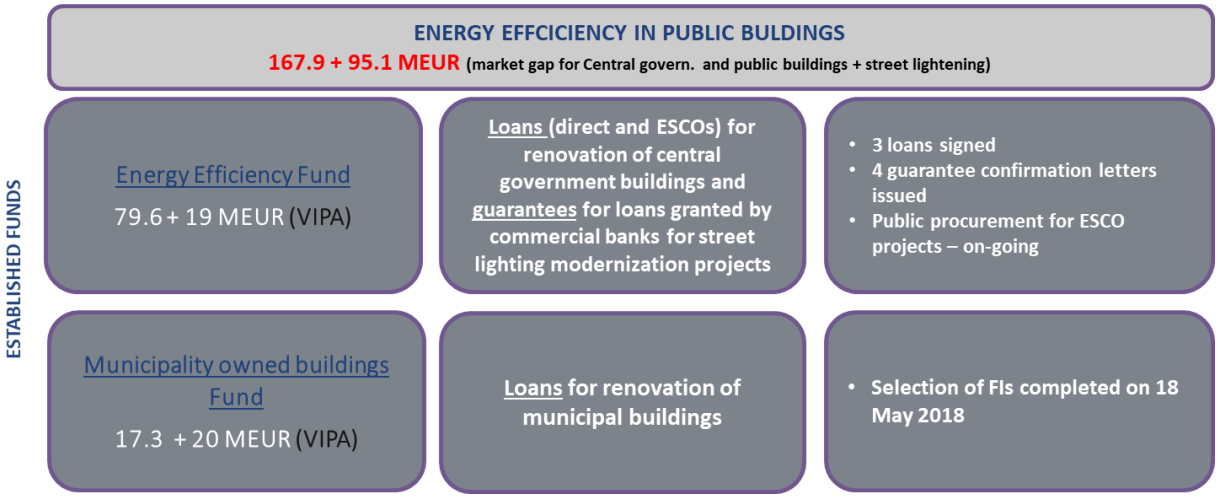
The multi-apartment renovation programme and the public sector renovation programme make use of various complementary funds (see **Figure 23** and **Figure 24**).

Figure 24. Energy efficiency financing for multi-apartment buildings in Lithuania



Source: Agnė Kazlauskaitė presentation

Figure 25. Energy efficiency financing for public buildings in Lithuania



Source: Agnė Kazlauskaitė presentation

Latvia: the Latvian Baltic Energy Efficiency Facility (LABEEF)

The previous EPC+ structure combined with an ecosystem approach became the "ESKO EKOSYSTEM" construction. It considers environmental, social, and governmental aspects of energy efficiency improvement of multi-apartment buildings. The target is to deal with the legacy of 3 billion m^2 floor area that needs energy and structural renovation.

Besides improving the energy performance, Latvian homes need a serious improvement of comfort and security.

One key challenge is to disseminate information because the expressions and taxonomy used is often very varied by different stakeholders.

Other key challenges relate to the change management, because the LABEEF offer is disruptive to existing business models. There is a lack of understanding and a general fear of change.

LABEEF:

- Focus on quality (20Y guarantees)
- Separating execution and payment risk
- Separating short term and long term funding and financing base
- Enable scale through standardisation and online platform
- Introducing aggregation mechanism
- De-risking
- Introducing self-sufficient and sustainable financing instrument

LABEEF signed agreement with EBRD in December 2016 to leverage EUR 7.5 million to implement renovation of 6 buildings. The ESCOs and LABEEF ecosystem were also supported by 2 Horizon2020 projects – Sunshine and Accelerate Sunshine (EUR 3 million in total). Sunshine and Accelerate Sunshine aim to generate around EUR 50M in projects

LABEEF motivated the supply side, and a number of large local players are interested to start the ESCO business when LABEEF starts operations, targeting the potential in public EPCs.

The next steps for LABEEF are scaling up operations by attracting additional equity/debt financing.

Milan: social housing

Milan has a number of complex and complementary action plans and strategies. Milan is a partner in the C40, a signatory of the Covenant of Mayors, and the Compact of Mayors.

The average temperature in Milan has increased by 2°C between 1901 and 2017, and the heat island effect has a large impact on the wellbeing of the city. Therefore the City of Milan has set out targets in the area of soil usage, biodiversity, water, climate, energy transition, and has adopted measures to establish a circular economy.

Actions and demo-projects have been initiated for green roofs, for water saving and pumping, and energy improvements in social houses.

A new building code has been adopted that sets minimum energy performance requirements for new buildings and provides incentives (in terms of increased building volume) for new and retrofitted buildings respecting specific parameters concerning energy performance and sustainability.

2.2.7.2 District heating

The EBRD has invested in over 60 district heating and cooling projects 16 different countries (Greg Gebrail).

Jordan District Energy

The **Jordan District Energy**, a PPP company for the provision of district energy services, received a loan of EUR 26.6 million from the EBRD (for a EUR 42 million EPC contract) to construct a large thermal store that significantly reduces peak electricity demand. The storage works as a 100 MW heating and a 110 MW cooling facility, using ammonia as coolant. Jordan has sharp night-time drop in temperature, while there is a serious water scarcity, requiring a special cooling innovation. Savings are in the range of ca. 15 000 tonnes CO_2 per year, and around 40 % of lower energy demand than individual air tempering (Greg Gebrail).

DH in Banja Luka (BA)

The EBRD also supported the **City of Banja Luka**, in Bosnia and Herzegovina, with a loan of EUR 8.35 million to help in the purchase of an equity stake in a new district heating company. The DH company will convert expensive and polluting heavy fuel oil boilers to biomass boilers. As a result 14 200 tonnes of CO_2eq/yr were saved. In Prijedor a loan of EUR 7.0 million and a grant of EUR 2.0 million was provided to cover the costs of a new biomass boiler and CHP plant and to combine these with demand side measures (Greg Gebrail).

Kyrgyz Republic

In the **Kyrgyz Republic** a loan of EUR 6.4 million and a EUR 3.5 million grant was provided by the EBRD to aid the reconstruction of municipal network pumping stations and to help with the new network control system (SCADA). DH systems in the area are a legacy of the Soviet system, and are very old and obsolete, have not been properly managed and were not regularly maintained. The population has been increasing steadily, but the DH size has not been growing and the customers at the end of the line did not get good service. Therefore, the result of 18 900 tonnes of CO_2eq/yr saving was achieved as opposed to individual thermal control.

DH in Krakow and Skawina

A project co-financed by the EIB and with European Structural and Investment Funds in Poland concerns the improvement and extension of the district heating network in the city of **Krakow** and **Skawina** municipality in Poland including 1) the extension and densification of the network to replace existing solid fuel based heating systems, and particularly coal stoves, 2) the renovation and replacement of piping and related network equipment, 3) new substations replacing old, inefficient ones, and 4) extension of the DH network to newly developed areas of the city. The project is based on pooling small scale projects to make them bankable for EIB loan. The loan amount is EUR 46 million, into a total project cost of EUR 117 million. (Reinhard Six)

DH and DC renovation in France

A complex renovation of both DH and district cooling in **France** is supported with an EIB loan of EUR 260 million within a total project cost of EUR 360 million. The project consists of a refurbishment programme of heat distribution pipes and the extension of pipeline networks to new customers as well as of building new renewable heat/cooling-generation capacity. Individual projects spread all over France in cities, where Engie France Réseaux, the investor, is concessionaire of DH or DC networks. (Reinhard Six)

DH and electricity from waste in Sofia

The EIB supports the **Sofia municipality** with a loan of to carry out the Phase III of Waste Management Programme between 2018-2022, whereas district heat and electricity will be produced from refuse derived fuel (RDF). A grant funding from the EU Structural Funds is foreseen to be combined, and the municipality uses a wide range of technical assistance to complete a pre-feasibility study, feasibility and CBA, the grant application, and capacity building. The combined sources are from ELENA, Jaspers, European Investment Advisory Hub, the Municipal Project Support Facility for Eastern and

Neighbourhood states, and the Economic Resilience Initiative for the Western Balkans and Southern Neighbourhood. (Reinhard Six)

More examples for the development of DH systems in Barcelona, Austria, Germany, Bulgaria were described in Section 2.1.6.

2.2.7.3 Complex projects with EPC

Three example projects were presented by Simone Alessandri (eu.ESCO) that successfully used EPC to implement municipal building renovation. The savings targets and guarantees were set up in cost (financial) savings and not in physical energy savings.

City of Berlin

The City of Berlin renovated 164 municipal buildings (research centers, day-care, sport facilities) in an EPC contract with a duration of 12 years. The following technical solutions were implemented:

- Development and realization of an energy efficiency concept;
- Regulation of heat generation/distribution;
- Renewal of air conditioning and ventilation technology;
- Replacement of lighting systems;
- Installation of water technology;
- Controlling, monitoring and maintenance measures.

Results and benefits:

— EUR 1.14 million immediate budgetary saving for Berlin;

— EUR 5.30 million guaranteed energy cost savings annually;

— EUR 47.7–63.6 million guaranteed savings for Berlin over contract period;

— 29 000 tonnes/p.a. reduction in CO_2 emissions annually (25 %).

Niederösterreich/Lower Austria

Federal schools in Lower Austria were renovated. Technical and non-technical solutions involved were:

- New regulation and control systems;
- Single room control;
- Application of reference detectors and thermostats;
- Hydraulic equipment;
- Damping and insulation of the windows;
- Condensing boiler and exhaust chiller;
- Heating pumps and solar plants;
- Heat recovery at ventilation systems;
- Optimising of the ventilation systems;
- Energy saving lamps;
- Time switch towards stand-by;
- Project "user motivation for energy-conscious behaviour".

Results and benefits:

— Reduction of the energy costs, cut of the high maintenance efforts;

— Annual energy costs before modernisation of EUR 3.12 million;

— Guaranteed annual cost savings of EUR 722 330 (23.15 %);

— Reduction of annual CO_2 emissions of 2.880 tonnes.

Amstetten (Austria)

A complex of 27 buildings was renovated based on a 10 year long EPC contract with an investment of EUR 735 000, including both technical and non-technical measures:

- Boiler upgrade;
- Solar collectors for domestic hot water at the stadium;
- Upgrade control technology;
- Rebuild hydraulic systems (distributors, pumps, etc.);
- Window insulation, replacement;
- Partial upgrade of lighting systems;
- Adding meters and energy management;
- Environmental awareness through user motivation in schools and kindergarten.

Results and benefits:

— Energy costs before modernisation: EUR 355 000;

— Guaranteed energy costs savings: EUR 75 000 p.a.;

— Reduction of CO_2 emissions: 25 % p.a.

3 Conclusions

Energy efficiency is the a cost-effective way of achieving Energy Union objectives, and there are strong EU policies. To support policy commitments, many different funding sources are available designed to support energy efficiency in heating and cooling, and a lot of exemplary projects can be capitalised.

While overarching decisions and directions are made at EU and national levels, the local level, i.e. regions and cities, have the on-the-ground experience and thus the responsibility and capacity to make these happen. They must also have a growing role in collecting, interpreting and transferring the needs and preferences of the users and other local stakeholders to the higher decision-making levels. This way, the local administration must be now empowered to place the user at the centre of the energy system.

In this context, a three-day workshop was held in Brussels organised by the JRC under the auspices of the Smart Specialisation Strategies Platform on Energy (S3P-E) on regional heating and cooling priorities, which gave the representatives of the regions an opportunity to discuss examples, methods, tools, strategies and funding opportunities to either engage successfully in an energy transformation in their territories, or stimulate the local economy by reinforcing a competitive edge in regions through new R&I projects.

The workshop touched upon a lot of important aspects of H&C at the regional level that are summarized below.

3.1 Challenges and barriers

H&C is the biggest energy demand sector in the EU and offers large saving potential. H&C is best to be tackled at local level, while national/EU levels should focus on providing a general framework. Therefore, it is key that local energy strategies with a focus on facing H&C aspects, or even separate local H&C plans are prepared.

These strategies have to be embedded in national programs and aligned with them, but action and benefits occur at local level. It is imperative that the framing of the general policy directions is made with a strong knowledge and acknowledgement of the local situation, potentials and capacities.

Key challenges, which have an impact on the wider distribution of efficient H&C technologies or an impact on the strategies, have been identified during the workshop, including:

- diverging trends of decentralization/autonomy vs. centralization (e.g. DH), which seem to be competing and difficult to consolidate in a (local) strategy;
- many technological options are available, and it is demanding for regions to prioritize or select from among them locally;
- many decisions on local H&C systems imply long-term lock-in due to infrastructure investments and developments;
- stagnation in the innovation rate of certain technologies;
- some of the technologies need large investments and need a supplier profile change (e.g. restructure offers of gas-based heating to district heating and cooling or to a combination of large scale renewable based heating and cooling), or significant infrastructural changes;
- competing important public issues (e.g. poverty);
- complexity of the H&C sector in terms of sustainability, which should take into account the human, the social and the environmental perspectives;
- impact on the economic value of individual properties. From the user perspective, those with sufficient resources could improve the value of their properties lagging

behind those that cannot benefit from local H&C projects either because of lack of financial resources or social barriers. This makes a public affairs decision difficult.

- difficulties to engage the users, and difficult to cooperate with financiers;
- difficulty in raising enough funding.

Local and regional administrations need to (or put it different have an opportunity) deal with other related issues, when designing strategies for heating and cooling, in particular in the areas of:

- GHG emission reduction;
- energy efficiency;
- energy security;
- affordability and housing;
- urban planning;
- job creation;
- democratization;
- smart democratization of the energy sector;
- smart integration;
- energy poverty;
- health improvement;
- end-user engagement;
- to name a few.

There are many challenges in the H&C sector and while (financial) resources are available, better coordination and simplification are required to access them more effectively and connect the demand and supply sides better. The coordination and simplification have to be achieved across all the different levels namely; local, regional, national and European levels.

3.2 Policy directions

According to Eva Hoos, "concrete and decisive action in the H&C sector is paramount for a cost-efficient achievement of the 2030 target. The proposed heating and cooling Articles (23 & 24) of the recast Renewable Energy Directive aim to ensure that the largest energy using sector is addressed within the post-2020 renewable framework and contribute to the EU renewable target."

The EU aims to achieve integrated goals with the recast RES Directive, which is expected to ensure around 1 percentage point (indicative) yearly increase in RES between 2020 and 2030, modernise district heating systems and ensure it becomes a vehicle to deploy RES and EE in heating. It is also imperative that energy efficiency and RES are addressed jointly to take advantage of their potential synergies.

The current and the foreseen EU level policy framework seems to provide a solid basis for action. Revisions of the EPBD, EED or the new and renewed funding schemes (e.g. Cohesion Policy) and new mechanisms, such as the "Action plan on sustainable finance" and the "Smart Finance for smart buildings" were discussed in detail. Placing the consumer at the centre of H&C systems is a common characteristic of new developments. Another goal of the changes is to increase "smartness" across the system. There is more focus on renovations than before and financing energy efficiency has been placed in focus. Renewable H&C technology solutions are also prioritised. Flexibility (of choices, in the electricity system and in implementation) is promoted. Finally, the local level and its connection to higher administration is imperative for the overall success.

3.3 Data availability

Heating and cooling makes up half of the total final energy consumption in the EU or ca. 6500 TWh, with space heating consuming 27 %, process heating 16 %, space cooling 1 %, and hot water 4% of total final energy consumption. Around 75 % of heating and cooling demand is supplied from fossil fuels, making it a dirty energy demand sector.

There are some scenarios about the future development of the energy demand, of which TUW and Fraunhofer results were presented. While heating energy demand seems to have peaked, cooling demand is expected to grow rapidly in the coming years (around 40 % increase by 2030 compared to 2012 levels). This will increase the pressure on the electricity systems.

The German ACE project and the IEA Annex 61 project concluded that it is very difficult to collect data on EE projects, because investors are reluctant to share data that are perceived sensitive (e.g. costs and savings), and/or which are labour-intensive (technical solutions, performance, lessons learnt), therefore a lack of reliable reference data for implemented deep-renovation projects is a huge issue (Rüdiger Lohse).

3.4 Examples of local H&C experiences

The workshop opened up the opportunity to share experience and therefore many local examples were presented and analysed. Some of the key lessons learnt from them were collected by the participants:

- Barcelona: urban development kicked-off by two DHC system developments. Successful example of long-term policy commitment and cooperation between different administrations (local and regional).
- Complex, low-energy refurbishment projects of large multifamily buildings were demonstrated in Dunaujvaros (Hungary) and in Sofia (Bulgaria) in the SOLANOVA and the STACCATO projects respectively. These could showcase that deep renovation and the integration of energy efficiency improvement and RES were possible and taken well by the inhabitants. It is possible and rewarding to work closely with the local stakeholders and involve them deeply in all phases of the renovation project.
- Social policy can be implemented through renovation of buildings, and thus by lowering the bills and/or improving comfort, as shown by the case of Milan.
- Small and medium sized cities, such as Querfurt (Germany), Graz (Austria), and Gram (Denmark) are more suitable for modern DH systems, whereas large part of the DH supply is produced from renewable sources (geothermal, solar, heat pump, etc.), and combined with other RES and/or traditional boilers. Comprehensive district heating and/or cooling systems have featured a combination of technological solutions (e.g. Querfurt, Paris Saclay, Gram). Even large solar integration is possible into DH, e.g. Graz. The combination of DH and DC with other technologies (new and old) against standalone solutions at building / site level proved to be more sustainable and reliable;
- Buildings are to be considered as part of a large system, which implies interactions both with others services as the case of transport via the integration electric vehicle station in building and with the building sector itself via the operation of several building under a common energy strategy.
- A holistic assessment of local challenges, encompassing demographics and urban dynamics, local energy sources, social acceptance and local skills and expertise, is critical to design solutions, but also the most relevant local source and flexibility had to be considered. Local knowledge is essential, e.g. in North-East Region Romania the largest biomass/biogas plant was built with local expertise, taking into account the local energy mix, and working closely with local stakeholders;

- Benchmarking against a broad range of alternatives, which relies on long term life cycle criteria including market forecast and pricing of environmental externalities, was proven to be beneficial, such as the methodology employed in Solanova and STACCATO projects;
- There are many types of business models even for large scale and complex DH implementation, potentially combined with urban development. One of them is a local cooperative, whereas the users will fund, develop and own the grid/distribution systems (e.g. Gram).

Three main messages should be highlighted for the success of future projects:

1) Cross fertilization is an effective way to do more and successful projects. This means that learning from peers is one of the most effective ways to succeed.
2) Placing the user/tenant/owner at the centre of any initiative is more and more widespread and required. Their needs define the goal of the initiative, and their participation defines success. Thus, deep involvement of local stakeholders at all stages is critical, and many of them may even become active project partners as a consequence.
3) It is the local authorities that are closest and have the best position to link the users and the decision-making actors together.

3.5 Funding schemes

A large number of funding schemes are available and have been reviewed at the workshop. These have greatly improved over the last years, but still need adaptations in order to respond to market needs and increase investment implementation. When technologies and strategies are implemented at local level, which is mostly the case of H&C, the national facilitation and support is important, but a more empowered administration at the regional and local level is essential. This level is close to the public and to the actual implementers, i.e. to the consumers and to the suppliers, too.

Local and regional levels are directly attracted to a number of loan and grant programmes that were reviewed during the workshop, e.g. ELENA, Jaspers, EIB and EBRD funds, which are available to support the implementation and to help projects through technical assistance. For examples, the EIB strategy includes the support to increase energy efficiency, to reduce GHG and to increase business opportunities in Europe by substituting imported fuel. Several of the schemes foresee that partners aggregate small scale projects to make them feasible in a large grant or loan (see e.g. the EIB grants in section 2.2.4.).

The presented examples (especially by EIB and EBRD) show that it is useful to combine loans and grants to ensure that not only the energy related improvements happen, but a general complex renovation that goes beyond economically feasible (as done in e.g. in the reconstruction of municipal network pumping stations in the Kyrgyz Republic). The same conditions were experienced in Latvia that the energy cost savings are enough to cover the strictly energy-related improvement measures, however very often refurbishment projects include changes and improvement that are not economic, but related to aesthetics, comfort, health, general structural improvement, whose value cannot be defined in economic means. These are personal or political investments, and should be covered from private budgets or from grants.

Technical assistance is available and useful in many stages of a H&C project, including feasibility studies, grant preparation, communication activities, capacity building etc. TA sources can be combined very successfully, e.g. the Sofia Municipality uses at least 5 sources to support the Phase III of the Waste Management Programme: ELENA, Jaspers, European Investment Advisory Hub (EIAH), the Municipal Project Support Facility for Eastern and Neighbourhood states, and the Economic Resilience Initiative for the Western Balkans and Southern Neighbourhood (Reinhard Six).

Grants and loans have an important quota, too. Targets and types of projects that are supported will have a major impact on what kind of projects are implemented. For example, if a grant/loan supports biomass project, it is the responsibility of the fund owner to make sure that the resulting projects are sustainable and will not deplete forest in return to gains through biomass CHP.

The current and the reformed Cohesion policy is an important driver for low-carbon investments for the 2014-2020 period, and for the 2021-2027 period respectively. There is a clear political commitment to the role of regions in the development and implementation of high-quality projects, including H&C projects.

3.5.1 Perceived risk

Mitigation of perceived risk has to be highlighted when talking about funding for energy efficiency and RES investments in H&C. A lot of effort has been tried out to overcome or mitigate high risk perceived by owners and financiers, and new ideas are being developed. Some examples have been discussed at the workshop.

- A "Technical Guideline" was prepared within the ACE project (see Section 2.2.6) to decrease the perceived risk through providing a description of cost- effective deep-energy renovation measure bundles for different climate zones.
- The EIB managed EFSI has funds to provide guarantees to cover a first loss protection, in order to establish financing to higher-risk projects than the market would normally take up (see Section **Error! Reference source not found.**).
- The Energy Performance Contracting is another scheme that has energy saving guarantee functions and could contribute to mitigate the perceived risks.
- De-risking through transposing the risk from the building owner to a dedicated entity, such as the ESCO or one-stop-shops.
- De-risking through providing similar examples, i.e. benchmarks, as it is done by the De-risking Energy Efficiency Platform (DEEP), an open source database containing real performance data of energy efficiency projects (http://deep.eefig.eu).
- Risk management can also been augmented by the combination of high-volatile (energy savings, energy prices) and low-volatile components (avoided maintenance) savings. The life-cycle cost approach can identify a number of additional values of an EE investment.

Finally, the general approach to many energy efficiency projects, especially those aiming at deep-energy retrofits should depart from a least-cost approach from the investment vs. energy cost saving tangent. There is a need to monetize additional values and to consider the social/health/aesthetics, etc. benefits.

4 Future perspective, key messages

The city of the future and thus the energy system of the future will be different from what we are used to now. They will be smarter cities, which will be inclusive and efficient, and will rely on flexible infrastructure. To achieve this, multi-purpose technologies, buildings, and services have to be widespread and normal (e.g. a car recharge station device can deliver smart charging information, but also provide flexibility and balancing services to the grid, and traffic related information to users).

The potential **combination of various scales of infrastructure** into a globally efficient pattern is foreseen. An example of In line with this idea, waste water treatment project, which was presented by the Romanian region at the workshop, where workshops, represents an example on how a small-scale solution boosts the overall efficiency of centralised grids. by treating toxic effluents.

Service is becoming the centre of attention and the way of measuring the success of the energy transition. The energy sector is moving towards its digitalisation in order to gain transparency and thus providing evidences of the quality of the energy service. To monitor the effectiveness of new energy services a new set of equipment and business models are required.

The trends show that smaller scale solutions prevail (e.g. decentralized energy supply), but the workshop has shown and discussed that there is a **strong future of large scale solutions**, such as district heating. While the benefit of large scale solutions is the lowered unit cost (among many others, such as no need for technical knowledge or attention by the user), the challenge is to ensure a sizable customer base to make it cost-effective.

Another trend is **automation**. The scope for autonomy rises in all main fields of infrastructure: models of autonomous houses with respect to waste recycling, water cycle, energy production and consumption are technically at hand, and question the relevance of large scale grid infrastructure.

The **user/consumer** will be **at the centre** of the energy system. Decisions and flexibility will depend on the user. Local and regional authorities are closest to the user and thus will gain more power and responsibility to satisfy the needs of the user and empower them to sustainably develop. In the same lines, the role of buildings and energy communities in the regional energy ecosystem increases and should be taken into account when planning.

4.1 Messages for EU and national level

The policy framework seems to be strong with a number of overarching energy efficiency and RES targets and strategies. These include technical, specific and holistic regulations, as well as technologies for heating and for cooling, and for buildings. Many of them are under revision. The changes to the EPBD and the RES directive were considered as promising by the workshop participants at EU and national level.

A few recommendations announced at the workshop are:

- set realistic, but ambitious targets;
- foster partnerships;
- promote dissemination of experiences, demonstration projects;
- reflect on shared local problems, e.g. on technical or financial issues;
- improve collection of data and modelling not only at aggregate (MS) level, but more effort is needed at the local scale, and more effort to know more about cooling;
- simplify funding procedures and documentation burden;

- provide help in fund mining (assistance, tools, training);
- a move from grants towards new financial instruments is already being made and should be supported also at the local level;

The success factors of EE financing schemes in Member States were:

- robust ex-ante assessment, understanding ex-ante conditionalities;
- use of "trigger points" to unlock investments;
- preparing the supply chain;
- planning a piloting phase;
- effective communication with the target audience;
- allowing flexibility in the funding scheme design;
- monitoring of progress;
- project champions;
- technical assistance.

4.2 Messages for other regions

Planning and strategies

Local planning should be developed either to specifically cover heating and cooling, or have it mainstreamed in overall energy system planning. These decisions must be made consciously, and technical and financial support should be designed according to the goals pursued.

Technical assistance is available from various sources, as discussed and presented at the workshop, and these should be wisely used for local purposes.

Project Development Assistance (PDA) facilities and local one-stop-shops are expected to boost local H&C strategy implementations/assistance to turn plans to implemented projects. These have the potential to turn bankable, technically feasible, but owner-activity limited projects to realize.

Even though, regional strategies may have different objectives or priorities, strategies should be developed together or in **close consultation** between local and national administrations.

Sharing of experiences among different regions and locations is imperative, as the planning stage is critical for a long-term commitment, as the heating and cooling decisions are.

Technologies

There is no silver bullet. A lot of technologies (innovative and traditional) were discussed at the workshop during the presentations and question and answer sessions. Decarbonizing the individual technology solution as well as the system is clearly the way forward.

The system has to be prepared to deal with flexibility and varying load, but this has been shown to be possible. A combination of technologies seems to be most appropriate in almost all cases, because they can overcome the challenges that one technology entails, and/or this way the demand is lowered before a supply system is designed at an adequate size.

Select the appropriate sequence of actions, e.g. energy efficiency first, or decentralized systems first, and size DH systems to the lower demand.

Financing

The Lithuanian and Latvian experience in launching wide-scale and multi-sectorial energy efficiency programmes provides valuable insights in how to prepare successfully for an energy transition, using EU and private funding.

It is better to slow start financial instruments, which can be preceded with raising public awareness and changing mentality.

Other

Participate in networking and develop partnerships. Peer example can be very helpful. Local targets and achievements will encourage others.

Often there is need for national reforms before local action can be taken. Building the foundations for a consistent and long-term cooperation between local and national administrations should be pursued.

Raising public awareness and subsequent change of mentality require a lot of information provision and time and security. A move from subsidies to loans/revolving funds was/is challenging.

It is challenging to "go first", and there is a higher risk of failure. These should be compensated by public support.

Assurance of on-going political support is imperative, which requires a thorough work with politicians.

In large scale initiatives, it may happen that demand outweighs supply (e.g. in Lithuania for multi-apartments): a high sudden demand for refurbishment cannot be supplied with the previously available suppliers, and results in a lack of technicians and a threat of under-performance.

Finally extend your impact. Identify local problems and communicate about them to higher levels (national, EU).

5 Annex. Summary of individual presentations

The individual presentations delivered at the workshop are briefly summarized in this section. The slides can be downloaded at the Smart Specialisation Platform website: http://s3platform.jrc.ec.europa.eu/heating-and-cooling

Introduction and welcome

Author: Tudor Constantinescu. European Commission, DG Energy

Contact: Tudor.CONSTANTINESCU@ec.europa.eu

Contact: https://ec.europa.eu/energy/en/home

Brief content: Mr. Constantinescu welcomed the workshop participants. He outlined the EU energy policy framework for heating and cooling and emphasized the underpinning role of the local and regional levels. He stressed how a close cooperation of the EU and national levels with the regional and local level is imperative to achieve the goals. Thus, considering that the Heating and cooling sector is responsible for 45-46 % of total energy consumption in Europe, smart strategies and smart solutions at local level are needed.

5.1 Strategies, priorities, and technology solutions in the EU regions

The first part of the workshop took place during May 30, and the morning of May 31, 2018.

Presentation 5.1.1 Introduction to the workshop

Author: Johan Carlsson, European Commission – JRC

Contact: Johan.CARLSSON@ec.europa.eu

Brief content: Mr. Carlsson welcomed the participants and introduced the eight participating regions:

- Sofia, Bulgaria
- Bulgaria (country)
- Nord-est, Romania
- Slovenia (country)
- Andalucia, Spain
- Western Macedonia, Greece
- Castilla-Leon, Spain
- Lubelskie, Poland

Presentation 5.1.2 Analysis on priorities/barriers/challenges of regions based on the information from questionnaires/assessments

Author: Juan Pablo Jimenez Navarro, European Commission - JRC

Contact: juan-pablo.jimenez-navarro@ec.europa.eu

Brief content: The Smart Specialisation Strategies Framework is a) smart because it is fact-based, it is a dynamic entrepreneurial discovery process, involving all forms of innovation (social, business, etc.), and has an ecosystem approach. The specialization aspect is seen in differentiation, concentration, synergies, and place-based economic transformation.

The EU has a comprehensive legislative framework relevant for H&C, including "An EU Strategy on Heating and Cooling. COM(2016) 51 Final."

The presentation reviewed the status of MSs and Regions in terms of overall energy efficiency and RES targets, as well as their energy consumption and H&C trends. The forecasts for H&C development and related technology development was discussed.

Energy poverty as a key local and social issue was highlighted, and the link to the European Energy poverty Observatory was made. Barriers to effectively deal with H&C demand were collected in the JRC survey. Types of projects implemented at local level were shown. Features and potentials of regional energy systems were discussed, along with barriers and experiences.

Presentation 5.1.3 Renewable heating technology solutions including heat pumps

Author: Lukas Kranzl, TU Wien

Contact: Lukas.Kranzl@tuwien.ac.at

Brief content: The results of the Invert/EE-Lab related to heating and cooling scenarios were described. A 28 % decrease in final energy demand for heating and cooling using current policy, and 38 % in ambitious policy scenario is possible by 2050, with a parallel 3 fold increase in final energy demand for space cooling.

Alternative examples of H&C decarbonisation projects were presented: increasing the share of RES in the district heating generation portfolio (example of Herten), large solar installation for district heating with or without heat pumps (example of Graz), electricity to heat options (heat pumps), refurbishment, etc. The issue of the impact of heat pump loads on the electricity system was discussed.

Decarbonisation is an opportunity and a challenge, and to achieve it all ingredients (technologies and planning) will be required.

Presentation 5.1.4 Renewable cooling technology solutions including heat pumps

Author: Sibylle Braungardt

Contact: s.braungardt@oeko.de

Brief content: After reviewing the share of cooling demand in total final energy demand currently and in forecasts, the comparison of existing cooling technologies was given. This was followed by specific explanation of the basic concepts of snow cooling, sea water cooling, and Seasonal Aquifer Thermal Energy Storage (ATES).

Finally, a definition of renewable cooling was proposed following the idea of renewable heating.

Presentation 5.1.5 District heating and cooling systems

Author: Cyril Roger-Lacan

Contact: www.tilia.info

Brief content: The presentation showcased three fully operational or implemented projects of large scale district heating and district cooling solutions. Key common features were drawn and the critical role of the user was emphasized.

Presentation 5.1.6 Sustainable buildings

Author: Andreas Hermelink, Ecofys/Navigant

Contact: a.hermelink@ecofys.com

Brief content: Looking at buildings entails not only looking at the "object", but also the users and actions, the emergence and consequences. A sustainable building must stay

within its environmental limits, including emergence, use and disposal. It must also meet occupants' needs and meet society's needs (present and future generations).

The triangle of sustainability was reviewed in reference to buildings. The Human dimension referred to health related impacts of highly efficient buildings. The social dimension was reflected through exploring the additional economic value of a refurbished property (increased sale and rent prices). The environmental dimension has to consider the whole life-cycle costs and impacts. The SOLANOVA project was presented as an example.

Presentation 5.1.7 Heat Roadmap Europe – Democratising knowledge bottom-up and top-down

Author: Brian Vad Mathiesen, Aalborg University

Contact: bvm@plan.aau.dk

Brief content: The content and activities of Heat Roadmap Europe were described, followed by statements based on Hear Roadmap Europe data and analysis. The presentation explored the different impact of energy efficiency on the demand and the supply sides.

Presentation 5.1.8 Evaluation of economic energy efficiency potential in H&C sector

Author: Johan Carlsson, European Commission – JRC

Contact: johan.carlsson@ec.europa.eu

Brief content: The presentation explained the main elements how to evaluate the economic energy efficiency potential for a Cost-Benefit Analysis supporting an application for EU structural funds. The example of waste incinerator with heat recovery was used, and the project appraisal steps were overviewed.

Presentation 5.1.9 Experiences from setting up energy partnerships

Author: Fernando Merida Martin, European Commission – JRC

Contact: JRC-B3-S3PLATFORM-ENERGY@ec.europa.eu,

Fernando.MERIDA-MARTIN@ec.europa.eu

Brief content: The presentation summarized the content of the S3P-E partnership, giving some historical background and future objectives. It was followed by specifically introducing the already existing partnerships, namely: bioenergy, marine renewable energy, smart grids, solar energy, sustainable buildings. Finally lessons learnt were told.

Presentation 5.1.10 Example of advanced cities in Europe — Barcelona

Author: Manuel Torrent, Agència d'Energia de Barcelona

Contact: mtorrenta@bcn.cat

Brief content: The presentation showcased two district heating development project in Barcelona, which served as examples of urban development based on implementing a modern, large scale, flexible DH system adapted to the local conditions.

Presentation 5.1.11 Smart Specialisation Platform on Energy - Heating and cooling initiative

Author: Evgeni Atanasov and Martina Nenova, Sofia municipality

Contact: e.atanasov@sofia.bg, mnenova@sofia-agk.com

Brief content: Sofia has mainstreamed key sustainability targets, such as reduction of air pollution, resource management and circular economy, energy-efficiency and greenhouse gases reduction, and adaptation to climate change. They participate in the Covenant of mayors and the Compact of Mayors. One flagship project, Staccato was presented. Other projects were mentioned, in particular programmes and grants that allowed the renovation of large numbers of homes and public buildings, and municipal waste treatment, and CHP plant.

Presentation 5.1.12 Case study North-East Region Romania Heating and Cooling S3 Platform

Author: Gabriela Macoveiu, North-East Regional Development Agency

Contact: adrnordest@adrnordest.ro, www.adrnordest.ro

Brief content: After a short presentation about the region's demography, economy, and energy sector, the key energy investments, programs & projects were shown. The role taken up by the region in the S3P partnership was explained in detail. A few concrete implementation projects were shown.

Presentation 5.1.13 S3P partnership: biomass

Author: Rafael Ayuste Cupido. Regional Energy Agency of Castilla y León

Contact: dompermi@jcyl.es, Ilari.havukainen@lapinliitto.fi, Javier.gomez@ec.europa.eu

Brief content: The Interregional Partnership for S3 on Bioenergy was introduced, its objectives, participants, contents, key elements and priority areas shown. The summary of recent activities was given regarding governance (internal and external meetings and arrangements). Synergies/ complementarities have been identified for each topic, in order to tackle specific challenges and embrace opportunities. Partners have joined pilot areas, where they can work together.

Presentation 5.1.14 S3P partnership: sustainable buildings

Author: Joaquín Villar. Regional Energy Agency of Andalucía

Contact: joaquin.villar@juntadeandalucia.es

Brief content: The Sustainable Buildings partnership was introduced, its objectives, participants, contents, key elements and priority areas shown. The summary of recent activities was given, which included internal development of the partnership, as well as development of tools, participation in events and the first pilot project in 2017. The Smart Campus Project was selected under the Partnership and runs in 2018, including an assessment, pilots, definition of requirements and finally dissemination of experience and results.

5.2 Policy framework and financing for improved heating and cooling solutions

The second part of the workshop took place in the afternoon of May 31, and during June 1, 2018.

Presentation 5.2.1 H&C decarbonisation policies and related EU financing

Author: Eva Hoos, DG ENER

Contact: Eva.Hoos@ec.europa.eu

Brief content: The presentation provided an overview of the European policy framework for heating and cooling, including international and EU level targets and key policies. The presentation explained the relevance of the upcoming recast of the Renewable Energy

Directive, in particular the heating and cooling Articles (23 & 24). This should help the EU to remain on track to achieve 27 % of renewables in heating and cooling, as opposed to the current business as usual scenario of 24.7 % in 2030.

The share of H&C in final energy demand was reviewed, emphasizing the high share of fossil fuels used in this sector. The key inefficiencies on the demand side were looked at, including buildings, heating equipment and district heating.

The consumer/user will be in the center and play a significantly larger role than in the past.

Presentation 5.2.2 Main Financial Mechanisms for district heating and cooling ESCOs and Energy Performance Contract activities in district heating

Author: Paolo Bertoldi, European Commission – JRC

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Brief content: The central problem for energy efficiency projects is that local financing institutions (local banks) perceive the risks too high and the traditional asset-based lending to corporations is not appropriate for energy efficiency projects (EEPs), which require cash flow-based project financing. On the other hand, EEPs are too small for international financing institutions, and due diligence is too cumbersome.

The presentation gave an overview of financing alternatives: internal sources through own cash or own in-kind contribution, direct borrowing (loan), debt financing, third-party financing, leasing, ESCO, forfeiting, public-private-partnership (PPP), Public Internal Performance Commitments (PICO), energy cooperative, vendor financing, EE mortgage, on-bill financing, national and EU funding.

Presentation 5.2.3 Example of EBRD financing for district heating and cooling

Author: Greg Gebrail. Principal Engineer at EBRD

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Brief content: EBRD adopted its Green Economy Transition approach in October 2015, with targets to direct 40 % of EBRD's annual business to be Green by 2020, which is equivalent to ca. EUR 4 billion. Since 2006, EBRD has provided over EUR 22 billion in Green finance (including 2016).

Funding for district heating and cooling energy projects are awarded to national administrators and to companies alike (both private and public) and are available for the improvement of both the demand and the supply sides.

Examples from Jordan and Bosnia and Herzegovina were provided.

Presentation 5.2.4 Example of EIB financing for district heating and cooling

Author: Reinhard Six. Engineer for energy efficiency and renewables at EIB

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Brief content: The European Investment Bank (EIB) is the natural financing partner for the EU institutions since 1958, and around 90 % of lending is within the EU. The EIB offers lending, blending and advising. In 2017, almost 60 % of all lending was given out to RE and EE projects, reflecting around EUR 50-100 million per year for district heating and cooling.

The presentation explained the overall EIB and specific district heating and cooling project requirements for eligibility. Example projects in France, Poland, Sofia (Bulgaria),

Italy and Germany were shown. The triple option of "lending", "blending", and "advising" were presented.

The presentation also explained the advisory services and technical assistance within the ELENA, Jaspers, European Investment Advisory Hub, and other technical assistance funds.

Presentation 5.2.5 Cohesion policy funding for district heating and cooling

Author: Gergana Miladinova. DG REGIO

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Brief content: The presentation reviewed the 2014-2020 Cohesion Policy with some highlights related to the new 2021-2027 period. The three funds: European Regional Development Fund (ERDF), European Social Fund (ESF), and the Cohesion Fund (CF). Cohesion policy is under shared management, i.e. the principles and priorities are distilled through a process of consultation between the Commission and the EU Member States. The key principles and thematic areas were reviewed. The presentation also talked about the funding requirements and thematic objectives, and how these are to be changed for the new period.

Presentation 5.2.6 ESCOs and Energy Performance Contract activities in public buildings

Author: Paolo Bertoldi, European Commission – JRC

Contact: paolo.bertoldi@ec.europa.eu

Brief content: The European Commission, Joint Research Center (JRC) has been monitoring the European Energy Services (ESCO) market since 2005.

After an introduction about ESCOs and Energy Performance Contracting (EPC), the potential for EPC across Europe was described. The size and complexity of the ESCO market has been growing continuously in MSs, however remains way below its potential. The public sector in cities and regions is a key client of EPC. The status of EPC in the public sectors in MSs varies widely. The European System of National and Regional Accounts (referred to as ESA 2010) entered into force in September 2014, and raised concerns about how to treat EPC in public accounts. After long deliberations between Member States, industry representatives and EUROSTAT, a resolution was passed only recently.

Presentation 5.2.7 Region Experience

Author: Tomasz Harkot, Lubelskie region (Poland)

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Brief content: The management of H&C and DH in the region was explained. The region has no specific H&C strategy, but the topic is well integrated in the energy efficiency and the Urban strategies, therefore H&C is somewhat hidden. Municipalities have created plans for low carbon development. Thermal power plants are fired with hard coal in Lubelskie, which causes environmental and health issues, and a desire to move towards more sustainable solutions and promote district heating. Financial support is available from the Structural Funds for developing RES use for heating of buildings or to replace biomass boilers by solar collectors and local small energy sources, among others.

Presentation 5.2.8 Examples of Energy Performance Contract in building renovation (thermal insulation, renewable and conventional H&C equipment)

Author: Simone Alessandri, eu.ESCO

Contact: info@eubac.eu

Brief content: The European Association of Energy Services Companies (eu.ESCO)'s role and situation within the ESCO and EPC market was described, including the administration of the European Code of Conduct for EPC. A short description of the EU ESCO market was given. The support of the EPC market in the revised EPBD was described. The customer has become the center of play and thus rules the game.

EPC project examples at municipal and regional level were shown from Berlin, Lower Austria, and Amstetten (Austria).

Presentation 5.2.9 DER and HVAC in advanced Energy Performance Contracting Business Models

Author: Rüdiger Lohse, Klimatschutz- und Energieagentur Baden Württemberg

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Brief content: The presentation discussed the options to achieve deep energy retrofit across the building stock. The work and results of the IEA Annex 61 "Business and Technical Concepts for Deep Energy Retrofits of Public Buildings" and ACE project were presented. A number of technical papers have been prepared and are available that explain how to successfully bundle energy efficiency measures, what policy-makers should know to promote deep-energy retrofits. The ways to de-risking were reviewed. EPC examples were demonstrated.

Presentation 5.2.10 Energy Efficiency policies in buildings and the Smart Finance for Smart Building initiative

Author: Timothee Noel, DG Energy

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Brief content: Energy Efficiency is the most cost-effective way of achieving Energy Union objectives. The presentation gave an overview of new policy developments in the scope of the "Clean Energy for All" package, in particular related to EPBD and EED. The new initiatives of "Smart Finance for Smart Buildings" and the Action plan on sustainable finance were presented.

Presentation 5.2.11 Financial Instruments for Energy Efficiency in Lithuania

Author: Agnė Kazlauskaitė, Ministry of Finance of the Republic of Lithuania

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Brief content: Lithuania has started a very successful and comprehensive energy efficiency programme in all of its end-use sectors. The EU Structural Funds formulate the financial basis and the EU directives the legal basis for a wide-scale and deep energy efficiency improvement, including multi-apartment building and public building programmes. The framework and the programme details were presented.

Presentation 5.2.12 The "ESKO Ekosystem": Guidelines and platform, the key to scale in EE financing

Author: Nicholas Stancioff, LABEEF, Latvia

Contact: Nicholas Stancioff nicholas@stancioff.com

Brief content: The previous EPC+ structure combined with an ecosystem approach became the "ESKO EKOSYSTEM" construction. It considers environmental, social, and governmental aspects of energy efficiency improvement of multi-apartment buildings. The target is to deal with the legacy of 3 billion m^2 floor area that needs energy and structural renovation.

Presentation 5.2.13 City Experience

Author: Piero Pelizzaro, Municipality of Milan

Contact: piero.pelizzaro@comune.milano.it

Brief content: The presentation gave an overview of Milan's commitment to climate mitigation and climate adaptation. Milan is a member of a number of international networks and has taken significant steps to improve the local climate, including GHG emissions, air pollution and water usage.

List of abbreviations and definitions

AT	Austria
BaU	business-as-usual
BE	Belgium
BG	Bulgaria
CBA	cost-benefit analysis
CDD	cooling degree days
CF	Cohesion Fund
CHP	cogeneration plant
CY	Cyprus
CZ	Czech Republic
DC	district cooling
DE	Germany
DH	district heating
DK	Denmark
EBRD	European Bank for Reconstruction and Development
ECMBs	Energy Conservation Measure Bundles
EE	Estonia
EE	energy efficiency
EED	Energy Efficiency Directive
EEEF	European Energy Efficiency Fund
EEFIG	Energy Efficiency Financial Institutions Group
EEI	energy efficiency improvement
EEM	Energy Efficient Mortgage
EEP	energy efficiency projects
EFIEES	European Federation of Intelligent Energy Efficiency Services
EFSI	European Fund for Strategic Investments or Juncker Fund
EIAH	European Investment Advisory Hub
EIB	European Investment Bank
EIM	Energy Improvement Mortgage
EL	Greece
ELENA	European Local ENergy Assistance
EPBD	Energy Performance of Buildings Directive
EPC	energy performance contracting
ERDF	European Regional Development Fund
ES	Spain
ESA 2010	European System of National and Regional Accounts
ESCO	energy Service Company

ESF	European Social Fund
ESIF	European Structural Investment Funds
EU	European Union
eu.ESCO	European Association of Energy Services Companies
FI	Finland
FR	France
GHG	greenhouse gas
GIS	geoinformational system
GNI	Gross National Income
H&C	heating and cooling
HDD	heating degree days
HR	Croatia
HRE	Heat Roadmap Europe
HU	Hungary
ICT	information and communication technology
IE	Ireland
IFIs	International Financial Institutions
IT	Italy
JRC	Joint Research Center
LFIs	Local Financial Institutions
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PF4EE	Private Finance for Energy Efficiency
PICO	Public Internal Performance Commitments
PL	Poland
PPP	public-private-partnership
PT	Portugal
R&D	Research and Development
RDF	refuse derived fuel
RES	renewables/renewable sources
RES-E	electricity from renewable energy sources
RIS3	research and innovation strategies
RO	Romania
S3P	Smart Specialisation Strategies Platform
S3P-E	Smart Specialisation Strategies Platform-Energy

SE	Sweden
SFSB	Smart finance for smart buildings
SI	Slovenia
SK	Slovakia
TA	technical assistance
TPF	third-party financing
TUW	Technical University of Vienna
UK	United Kingdom

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