JANUARY 2014
BASREC

District Heating and Cooling, Combined Heat and Power and Renewable Energy Sources

BASREC - BEST PRACTICES SURVEY

APPENDIX - COUNTRY SURVEY

CONFIDENTIAL

NUORKIVI CONSULTING

COWI

NUORKIVI CONSULTING
Address: Asessorintie 9, FI-00690 Helsinki
Tel: +358 41 456 88 93
Email: energy@nuorkivi.fi

COWI

ADDRESS COWI A/S
Parallelvej 2
2800 Kongens Lyngby
Denmark

TEL +45 56 40 00 00
FAX +45 56 40 99 99
WWW cowi.com

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List of Abbreviations

BASREC	Baltic Sea Region Energy Co-operation
CC	Climate Change
CHP	Combined heat and power
DC	District cooling
DH	District heating
DHC	Both district heating and cooling
EE	Energy efficiency
EHP	Euroheat&Power - association
ETS	Emission Trading System of the EU
FIT	Feed-in tariff
GHG	Green house gases
GSEO	Group of Senior Energy Officials
IEA	International Energy Agency
PEF	Primary energy factor
RES	Renewable energy sources
TPES	Total primary energy source

CONTENTS

1 Country Surveys

1.1 Denmark

The Danish Government intends to lead by example and show that environmental sustainability and economic growth is compatible. When the *Energy Agreement* is fully implemented, Denmark will be on its way to the ambitious goal of 40 per cent greenhouse gas reduction by 2020. The government's *Climate Plan* provides a comprehensive picture of the government's approach to climate policy both nationally and at EU level. Denmark is a leader among OECD member countries in terms of policies for RES, EE and climate change. Denmark is an advocate of tougher climate-change mitigation measures. Through negotiations with the EU, Denmark is committed to increase the share of renewables in the system to 30 % by 2020, while the local ambitions are 35 %. Denmark’s long-term energy goal is to become completely independent of fossil fuels by 2050.

1.1.1 National Energy Policy

Emissions from the energy sector and energy-intensive companies are regulated centrally by the EU ETS. National efforts will therefore concern the sectors not covered by the quota system. These are agriculture, transport, heating of buildings, waste etc. Energy and climate targets are:

- 30 % RES in the energy sector by 2020
  - Wind power shall cover 50% of power production in 2020
  - 10% of transport covered by RES.
- Denmark's reduction targets for non-ETS sectors are 20 per cent in 2020 relative to 2005
  - 40 % reduced GHG emissions by 2020 when ETS sectors are included.
- All use of coal phased out by 2030

- Phase out of oil for heating in buildings by 2030
- 100% renewable power and heating by 2035
- 100% RES system by 2050.

Denmark shall be among the three countries with the highest growth in the share of RES in 2020 and be among the three countries with the highest EE by 2020. EE is a central part of the energy policy in Denmark. In the Energy Policy Act of 2008, it is stated that the gross energy consumption is to be reduced by 4 % by 2020 relative to 2006.

This makes Denmark one of the countries in the EU that has undertaken the highest reduction commitment percentage wise. Calculations from the Danish Commission on Climate Change Policy show that when domestic energy and transport systems no longer use fossil fuels, GHG emissions will be reduced by approximately 85%.

To reach these targets, the Energy Strategy 2050 states eight key elements for success:

- Highly-efficient energy consumption.
- Electrification of heating, industry and transport.
- More electricity from wind power.
- An efficient utilisation of biomass resources.
- Utilisation of biogas.
- Photovoltaic solar modules and wave power as supplements.
- Spreading RES-based DH and individual heating.
- An intelligent energy system.

1.1.2 Current Energy System

Despite the relatively small size of the Danish energy system, it is one of the more complex systems. The final energy consumption in Denmark was 163 TWh in 2011.

Table 1-1 Energy Balance for Denmark 2011[GWh]

	Fossils	Nuclear	Wind	Hydro	Biomass	Other RES	Total
TPES	156,679	-	9,774	12	32,714	18,527	209,305
Power	244	-	9,774	12	-	9,792	21,148
CHP	52,858	-		-	12,083	8,433	73,374

Heat	2,896	-		-	5,501	151	8,548

CHP plants fuelled by natural gas, biomass and coal combined with the transport sector being the second largest energy sector after households result in 75% of the total primary energy supply in Denmark being covered by fossil fuels.

District Heating

64 % of the heat demand in Denmark is from residences. Services account for 30%. Heating demands are covered mainly by DH as 62% of all Danish citizens are served by DH. In 2009, the DH sector delivered nearly 100 TJ to consumers who were billed on average 25.03 EUR/GJ resulting in a 2.5 billion EUR turnover.

The DH is mostly produced in CHP plants fuelled by natural gas, biomass, coal and waste.

District Cooling

A DC capacity of 30 MW is installed in the city of Copenhagen delivering 1400 full load hours each year.

Electricity

Denmark has been successful into integration of wind power reaching 30 % in 2012, the world’s highest share of wind in its electricity mix. Coal covers 40% of the production and natural gas cover 17%. A high share of wind power and heat bound CHP plants results in a high dependency on import to neighbouring countries to maintain flexibility in the power system.

Consumption of electricity is split in three equally big sectors: services, households and industry. As the railway in Denmark is in the process of being electrified, and the share of electric vehicles is expected to increase, the amount of electricity for the transport sector will increase in the years to come.

RES

RES policies have been at the heart of Danish energy strategy for almost three decades and with no hydropower resources of note, Denmark relies on wind and biomass for most of its RES. It was an early mover in the wind energy industry and today Danish technology is a world leader. Should Energy Strategy 2050 be fully implemented the RES sector will form the cornerstone of the new energy economy.

In 2010 the share of RES was 20.7% of TPES and 33.5% in electricity generation, whereas bio fuels and waste covered 17.1% of TPES and 13.2% of total electricity generation. Wind, as mentioned, covered 30 % of electricity production in 2012. Other RES are negligible. This obtained share of RES goes well with set targets in the *National Action Plan for renewable energy in Denmark*.

Table 2Source: National 2020 target and estimated energy share from RES in heating and cooling, electricity and transport. Source: National Action Plan for renewable energy in Denmark.

RES share by sectors [%]	2005	2010	2015	2020
RES for heating and cooling	23.2	30.8	36.0	39.8
RES for electricity	26.8	34.3	45.7	51.1
RES for transport	0.2	1.0	6.7	10.1
Overall RES for TPES	16.5	21.9	22.6	30.0

1.1.3 Planning

The Energy Strategy 2050 was published by the government in 2012. The strategy aims to transform Denmark into a low-carbon society with a stable and affordable energy supply. The first phase of the strategy includes a series of short-term initiatives to reduce dependence on fossil fuels. This will be done by strengthening and expanding existing policies in EE and RES. The two phases that follow will include schemes that stimulate development and implementation of long-term energy solutions.

It is optional for municipalities whether they will develop strategic energy plans. The strategic energy planning enables the municipality to plan towards a more flexible and energy-efficient energy system. In this way, the potential for implementation of energy conservation and conversion to RES is used in the socially most energy efficient way. Strategic energy planning includes all forms of energy and energy within the local geographical area, and as a general rule, the municipalities are responsible for the planning of onshore wind turbines

1.1.4 Legal and Regulatory Framework

Building Regulation

For residential housing, dormitories, hotels etc., the buildings' overall energy demand for heating, ventilation, cooling and DHW should not exceed 1 650 kWh/year plus 52.5 kWh/m² heated floor area per year. For non-residential buildings such as schools, offices, institutions etc., the regulations state a maximum heat demand of 1650 kWh/year plus 71.3 kWh/m² heated floor area per year.

Table 1-3 Energy limits

Total energy consumption [kWh/m²]	Residents	Non-residents
Energy demand for new buildings	1650/A + 52.5	1650/A + 71.3
Energy class 2015	1000/A + 30	1000/A + 41
Energy class 2020	20	25

Where A is the heated area [m²]

All new buildings are to be energy labelled before being used or at notification of completion. All public buildings must be energy labelled. The energy label is valid for either ten or seven years, depending on the energy savings potential.

All new buildings must be insulated to perform according to given u-values. The requirement for minimum thermal insulation is not only an energy related matter, but is also related to comfort and risk of condensation. The specified minimum heat loss applies to the entire building element

There is a ban on installing electric heat as the main heating source. Properties with central heating systems are not allowed to replace radiators, hot water heater, etc. by electrical heating. It is prohibited to establish electric heating in all new and existing residents with water-based heating system, if the building is or will be in an area that will be provided with natural gas or DH. There are some exceptions for heat pumps, vacation homes and less used space.

The municipal council may impose all or part of the municipality of compulsory affiliation or obligation to stay connected to either individual natural gas supply or DH. The obligation means that the utility can charge a connection fee or an annual fixed fee. However, the house owner is not obliged to buy energy from the collective system. Exceptions can be given if the property is furnished with a RES system or is a low-energy building. In addition, the municipal council may grant exceptions for retirees and if the building is expected demolished within a few years.

Price regulation

The rules for price regulation in the heat market are administered by*Energitilsynet.* DH companies are not allowed to accumulate profit, but are obligated to balance revenue and investment, operation and maintenance. Price caps are a limit on the price of the heat sold by waste incineration plants for further distribution. The price caps are determined by possible alternative heat supply run in an efficient way within the energy policy guidelines. If the waste incineration plant is located in a natural gas bearing area, the alternative plant would be an effective run natural gas-based CHP plant.

Competition on Heat and Power Sector

The Gas Supply Act took effect in July 2000 and opened for greater consumer access to freely choose their gas supplier. The Electricity Supply Act include similar elements, though less stringent in some areas. The Heat Supply Act with effect from July 2000 introduced new price regulations, but no competition between different suppliers of DH.

The electricity market has undergone liberation since the late 1990s. The precondition for liberalization of electricity markets has been the establishment of the internal energy market in the EU. The internal market is to improve the efficiency and competitiveness, while having regard to security of supply and environmental protection into account. Production and trade of electricity are subject to competition. The grid and operation of grid is public price regulation, and is an infrastructure that shall serve all users of the system.

Feed-in-tariffs for CHP and RES

Electricity produced on the basis of renewables are supported through price premiums and fixed feed in tariffs.

Table 1-4 RES Support schemes

Technology	Owners / Site	Size	Tariff øre/kWh	Duration
Wind – on shore	Private (residential)	<25 kW	60	22,000 FLH
Wind - on shore	Business	>25 kW	25 [1]	22,000 FLH
Wind – off shore	Business	All	Tendering*	
Wind – off shore	Horns Rev II	200 MW	*51.8	*50,000 FLH
Wind – off shore	Rødsand II	200 MW	*62.9	*50,000 FLH
Biomass	All	All	15 [2]	n.a.
Bio-gasification	All	All	74.5 [3]	n.a.
PV	All	All	60/40	10+10 years
Wave	All	All	60/40	10+10 years
Fuel cells (RES)	All	All	60/40	10+10 years

There is also a support scheme for biogas:

Use of biogas	Support Kr/GJ	Duration
All	26	Subsidies will be reduced equivalent to prices rises by natural gas.
All	10	Subsidies will be reduced by 2 DKK/GJ each year from 2016 to 0 or/GJ in 2020.
CHP and supply to natural gas grid	79	n.a.

[1] Additionally 2.3 øre/kWh is given throughout the entire lifetime of the turbine to compensate for the cost of balancing etc.
[2] For electricity. In CHP plants, the heat produced using biomass is exempt from energy taxes.
[3] If the biogas is mixed with other fuels, the part of the electricity produced from biogas receives a price premium of 40.5 øre/kWh.

Transport and process industry	39	n.a.

Emission Trading Scheme

The National Allocation Plan (NAP) is a key element of Denmark's commitment to reduce its greenhouse gas emissions. NAP is a carefully planned national climate action for the period 2008-2012. By the Kyoto Protocol, Denmark has committed itself to reducing greenhouse gas emissions in the period 2008-2012 by 21% compared to 1990 levels. Denmark adjusted CO2 emissions in 2010 dropped by over 23% compared to 1990. Denmark is a part of the European Union Greenhouse Gas Emission Trading Scheme (EU ETS).EU Member States can auction off a portion of the CO_2 quotas. In period 1 up to 5 % and in period 2 up to 10 % of the total number of allowances from 2013, according to common rules.

› In period 1 (2005-2007), Denmark chose to sell 5% of the total number of allowances in the market. The total number of shares sold was 5 025 000. Quotas were sold directly on the market by means of two agents.

› In period 2 (2008-2012) is not allocated an auction pool, but companies may sell their surplus quotas.

› In period 3 (2013-2020) a significant share of the CO_2 quotas are auctioned. The European Commission has adopted a regulation on the scope, timing and method of auctioning of allowances in period 3.

Carbon Tax

The tax rate depends on the energy product. CO2 tax on electricity is today called energy saving tax. The CO_2 taxes are usually levied alongside other energy taxes on the invoice from the energy supplier.

Investment Grants

The Ministry of Climate and Energy along with the Ministry of Science and some other associations administrates most clean energy R&D programs.

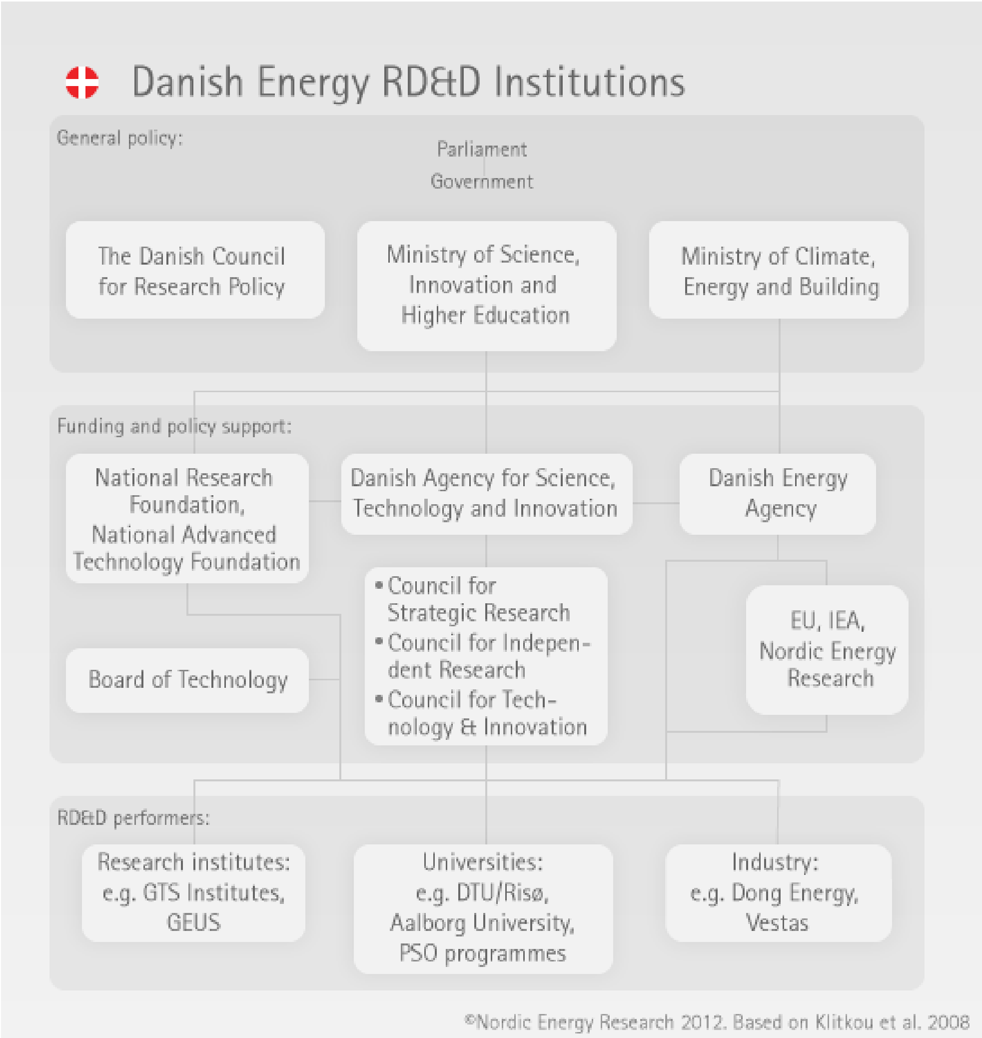

Figure 1-1 *Source: Nordic Energy Research* http://www.nordicenergy.org/thenordicway/country/denmark/#key-institutions-in-the-funding-of-low-carbon-energy-rdd-in-denmark

The *Energy Agreement* includes investments of 90-150 billion DKK in RES and EE until 2020. Development and demonstration of new energy technologies are supported by the Energy Technology Development and Demonstration (EUDP) fund which distributes 750 million DKK in 2009 and 1 billion DKK in 2010.

1.1.5 R&D

The Danish wind industry has grown to be a large export commodity, and Denmark was at no point recognized as one of the world leaders in the technology.

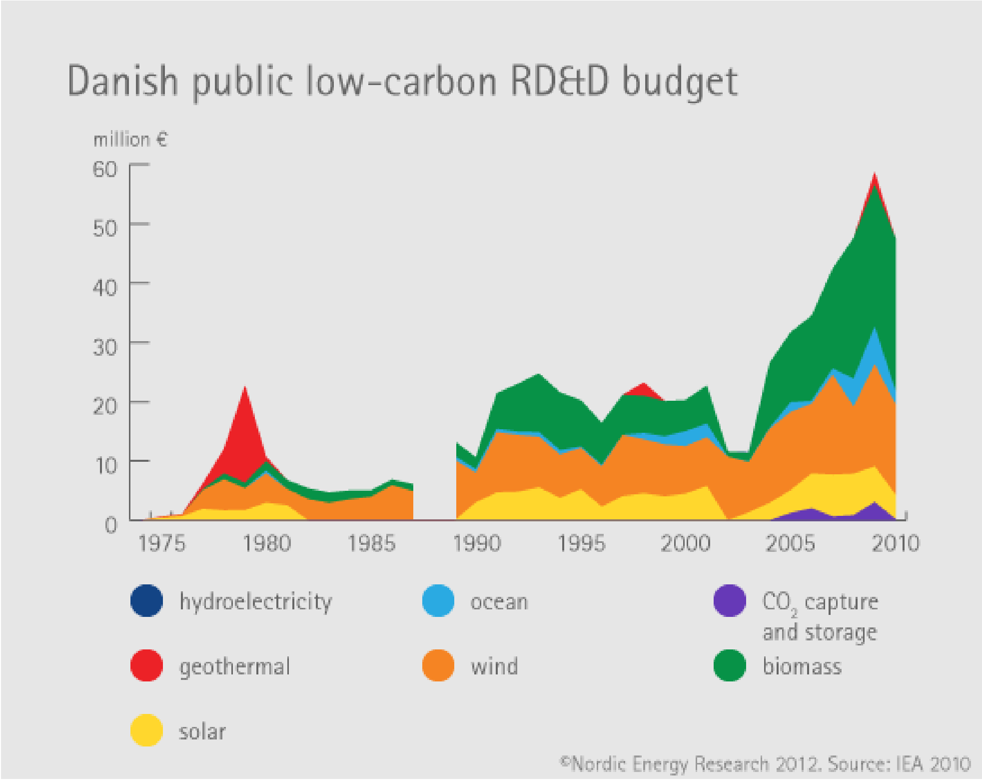

Figure 1-2 *Source: Nordic Energy Research* http://www.nordicenergy.org/thenordicway/country/denmark/#steady-support-for-wind-power-recent-focus-on-biomass

Research in wind technology has made Denmark one of the leading markets in the world on wind power. 2006 funding for wind research was 17 % while funding for hydrogen and fuel cells was more than 30 %. RD&D in biomass is increasing.

1.1.6 Heat Customers

Today, Denmark is enjoying a historically high security of supply. The average Danish electricity consumer had electricity for 99.99% of the year in 2007. Denmark will have a surplus supply of gas for the next ten years. All in all, there are minimal risks for consumers that they will lose their access to any energy deliverance.

The intention of the provision of the Electricity Supply Act is to ensure that the price of DH only includes costs that are necessary for DH production. Loss of electricity production must not be passed on to DH customers.

The economic attractiveness of localised CHP has been so high that a number of small, completely new CHP-based DH schemes have been established. Some were clearly too small and too vulnerable to the increase in gas prices after 1999, and had to be given extra state support to be able to operate with tolerable heat prices for their consumers. However, the number of DH consumers affected by these problems only equalled around 1 % of all DH consumers in Denmark.

1.1.7 Ownership

The massive expansions of DH networks in the 1980s and 1990s, has formed an attractive basis for developing the large integrated DH systems for optimal use of waste heat from cogeneration. With an objective to further increase the overall efficiency of the Danish Energy system through introducing high efficient CHP also in small cities, the development of the decentralized CHP on natural gas has been initiated. Electricity production at these plants has partially replaced production at the large, central and coal-based condensing/extraction plants near the major cities.

The ownership structure outside the central CHP plant is typical that a company owns one or more units within coherent DH networks. However, there are more and more examples of companies / municipalities own production units in several contiguous DH network.

The traditional Danish cooperative is consumer- or producer -controlled corporations, where each individual member owns a part of the corporation, and where the members of the corporations divide the eventual year-end financial surplus amongst them. Much of the electricity and DH distribution outside the major cities are organized as cooperatives. In the cities, electricity and heat distribution is mainly carried out by municipal utilities, but unlike elsewhere, these utilities are not allowed to finance other municipal activities such as schools or buses.

This form of organization, without a traditional profit motive, offered little resistance to government intervention in the sectors for electricity and heat. In some cases, changes were introduced and implemented through a political agreement between majorities of parties in the parliament, with the legislative instrument left as an unused but clear threat.

1.2 Estonia

1.2.1 National Energy Policy

There are several strategy documents determining the current Estonian energy policy, including the Estonian electricity Sector Development Plan to 2018 and the National Development Plan of the Energy Sector until 2020, adopted by the Estonian Parliament in 2009. These policy documents outline the medium-term strategy for the oil shale industry and the direction of the electricity production to balance the overall energy mix. However, the country lacks a longer-term vision and the Ministry of EAC has commissions working on a new Energy Strategy to 2030 with the outlook to 2050. The Estonian Development Fund leads the preparation of the initial draft and its approval is foreseen in mid-2014. Estonia aims at setting goals for the diversification of energy supply through the construction of new connections and ensuring a more even distribution of energy sources in the energy balance.

Estonia is developing new energy policies and taking decisions about resources, infrastructure, investment, competition, trade and innovation. This should enable higher levels of social welfare and economic performance to 2030, with a perspective to 2050.

1.2.2 Current Energy System

District Heating

Estonia has 630 000 dwellings. The energy intensity of the Estonian building stock amounts to 200 kWh/m² a year, typical for cold climate countries with building stocks dominated by older multi-story commercial and residential buildings. The national target is through comprehensive renovation to bring the heat intensity of the existing buildings down to 150 kWh/m² per year.

Electricity is commonly used only for appliances and lighting.

In Estonia, the DH market share covers about 70% of the population, and DH accounts for a relatively large part, over 30%, of the total household energy consumption.

There are comprehensive DH networks of over 1 400 km long in total. Most networks are old and inefficient. The government has set a goal to reduce heat losses from the prevailing 22% to 15% by year 2017. Better insulation and greater EE measures have reduced heat demand already, but this has been offset by growth in the number of customers.

DH services are provided by approximately 200 utilities in 230 heating districts.

Estonia is actively developing diversity in new DH plants by utilising various low-grade energy resources such as biomass, municipal waste, and heat recovered from CHP plants. Recent progress includes new biomass and peat fuelled CHP plants in the major cities such as in Tallinn, Pärnu and Tartu.
.
Data provided by Statistics Estonia indicate that the total volume of heat produced in 2011 was 9.1 TWh, of which 3.5 TWh was produced in power plants and 5.6 TWh in heat only plants. The volume of heat produced for DH systems in 2011 was 6.3 TWh, compared to 7.1 TWh in 2010 and 7.6 TWh in 2005. Approximately 3.9 TWh of heat was consumed by households in 2011 compared to 4.2 TWh in 2010.

Many DH systems have inadequate or no metering at both building and household levels.

District Cooling

For the time being, there are no DC systems in Estonia.

Electricity

The electricity sector is dominated by the state-owned power generator Eesti Energia, which accounts for 89% of production and also owns the distribution network. In January 2013, the electricity market was opened to full retail competition.

The share of CHP in Estonia is 10.4% of total electricity generation. The Development Plan of the Estonian Electricity Sector to 2018 sets a target for a CHP share of 20% by 2018. Achieving this target depends on various factors such as the dynamic between growths in demand for electricity; a potential decline in demand for DH from CHP as DH investors may move to bio energy, and the retirement of oil shale power generation units. A transparent process in DH pricing will be important in attracting investments in new CHP plants.

As stipulated in the Electricity Market Act of 2007, the TSO, Elering, shall pay a premium added to the market price of electricity. This premium (EUR 0.0537 /kWh) is not technology-specific and applies to electricity generated from all RES, including biomass fired in efficient CHP mode. A different premium (EUR 0.032/kWh) is paid to electricity produced in other efficient CHP plants. As of December 2012, the amount of the subsidy did not depend on the actual market price of electricity although a draft law envisages changing this approach. The subsidy is guaranteed for 12 years.

RES

In 2012, RES provided 14.6% of Estonia's TPES. This is mainly explained by the extensive use of biomass in the heating sector. About 70% of the heat in Estonia is produced by firing biomass.

Estonia's RES policy is mainly driven by its obligation under the European Union (EU) Renewable Energy Directive to increase the share of RES in the gross final energy consumption to 25% from 16.6% in 2005. Estonia is on track to meeting its overall RES target and is expected to have a surplus that can be sold to other EU member states through flexibility mechanisms. A more challenging task will be to reach the 10% RES target in the transport sector.

Key policies to support RES in the three sub-sectors include:

› a premium for electricity produced from renewables;

› investment support for projects aiming to use RES for heating;

› a planned bio fuel blending obligation for oil products in the transport sector;

› an electro mobility programme; and,

› planned measures to support biogas in transport.

Since May 2013, the new waste-to-energy CHP plant has been operating, which consumes 220 kt of municipal waste a year. The plant is rated at a capacity of 17 MW of electricity and 49 MW of heat.

As discussed above, the heating sector and RES are closely interrelated as over half of the heat is fuelled by biomass. At the same time, SWH systems are likely to become more widely used, thus reducing demand from DH in the warm months. Installation of heat pumps is also expected to expand in the near future. The independent Estonian Geothermal Association plans to assess the potential of geothermal energy in Estonia. Today, the use of biomass for heating is an economic option in many cases without any government support. Access to financing is a key barrier to increased investment in modernising heat boilers and switching from the use of fossil fuels to biomass.

Therefore, specific measures to promote RES in the heating and cooling sector are limited to investment support.

The KIK manages a national programme – in the framework of the GIS – "Extended use of RES for the generation of energy and reconstruction of DH networks" financed from the CO_2 quota sales. It supports three activities:

- construction of CHP plants that use RES;
- reconstruction of boiler houses; and,
- reconstruction of DH networks to reduce thermal transmission losses.

In 2009, the KIK awarded grants to local governments, non-profit associations, businesses and foundations under the programme "Broader use of RES for the generation of energy" that used funding from the European Regional Development Fund (ERDF)". The budget for the 2009 application round was approximately EUR 9.6 million (then 150 million kroons) and 17 projects received grants for the reconstruction of boiler houses, DH networks and construction of CHP plants. No more application rounds are planned from this ERDF measure.

The KredEx Fund provides grants, funded through CO_2 quota sales, for the renovation of apartment blocks and smaller houses. The eligible tasks include:

- replacement or reconstruction of the heating systems, *e.g.* installation of RES technologies, such as solar water heaters;
- reconstruction of the ventilation system or installation of a system with heat recirculation;
- switching from the existing DH network to an individual or collective heating option is allowed only if the new heating system is based on RES.

1.2.3 Legal and Regulatory Framework

Building Regulation

The modern building codes have been in place since 2008. These have recently been revised to achieve a 20% to 30% improvement in stringency. At present, new single-family dwellings need to achieve 160 kWh/m² total annual weighted energy consumption, and multi-apartments to achieve total weighted energy levels of 150 kWh/m² per year. New stricter energy performance requirements for all buildings have been in effect since 9 January 2013.

The Estonian government copied a successful German KfW scheme where finance from different funds was offered to private banks to make loans to home-owner associations. Essential elements were in place. For instance, energy audits were required as part of granting the loans. This started in 2009. Interest rates are fixed for ten years at less than commercial rates (4.4% maximum with loan average interest at 4%). Grants are 15% to 35% of the cost of the project, scaled to the effort, and 35% grant for comprehensive retrofits, including heat, ventilation and air-conditioning upgrades and triple glazing.

Price regulation

The District Heating Act (DHA) regulates the activities related to the production, distribution and sale of heat through DH networks and connection to networks. The DHA entered into force in February 2003 and has been amended a number of times since. It requires a heating company to maintain separate accounts for the production, distribution and sale of heat and for other areas of activity, including for the costs incurred in CHP.

The DHA also stipulates that the price of heat produced in CHP processes is subject to approval by the Competition Authority. According to the Electricity Market Act (EMA), a producer in a dominant position as defined in the Competition Act and who generates electricity in a CHP plant shall, at the request of the Competition Authority, submit information on the allocation of revenue, and on expenses, separately for the generation of electricity and of heat together with the relevant reasons. The task of the Competition Authority is to co-ordinate the price of district heating in a manner in which cross-subsidising of electricity is avoided in the allocation of costs.

On the basis of the DHA, a heating company may apply to the Competition Authority for approval of a price formula for a period of up to three years. This price formula is used if factors which are beyond its control and which affect the price of heat become evident. At the end of 2012, the weighted average of DH maximum prices was EUR 57/MWh; the lowest price was EUR 27.48/MWh (excluding 20% VAT) and the highest price was EUR 90.3/MWh. As a rule, the maximum price is considered as the actual selling price.

The procedure or methodology for co-ordinating the maximum price was developed by the Competition Authority and, since November 2010, all DH providers must seek co-ordination of their maximum prices from the Competition Authority.[13] Previously, only providers with annual production of over 50 GWh required price co-ordination by the Competition Authority, while others needed to co-ordinate their prices with local municipalities. The regulation of maximum price is based on *ex ante* cost-based principles. If the price does not cover all of the costs and a reasonable profit, the company must propose a new price. When the actual price is 5% or more below the approved price, a new maximum price must be co-ordinated.

Competition on Heat and Power Sector

The Estonian electricity market has been fully open and deregulated since 1 January 2013.

In Estonia, the DH supply providers may be in a dominant market position for several reasons: either because conversion to another type of heat supply is technically complicated and often even impossible; or installation of an individual heat source would require an emission license; or extra power capacity is not available owing to limitations in the electricity supply system.

Furthermore, many municipal authorities have established DH supply areas that make the local DH a monopoly with exclusive rights, in which a heat mode conversion is made impossible. The only exemption is heat produced from RES; in that case local heating in a DH supply area is allowed.

Pursuant to the DHA, a local government is entitled to establish DH regions within the boundaries of its administrative territory. The only permitted heating option to be used in these regions is DH (except for persons who did not use DH at the time DH regions were established); consumers cannot choose alternative heating methods and the heating company obtains a monopoly status.

Pursuant to the Establishment of Price Limitations to Monopolies Act, only the Competition Authority oversees implementation of the DHA and co-ordinates the maximum prices of heat sold by heat suppliers. The maximum prices for heat are co-ordinated for each DH region.

Section 14^1 of the DHA allows heat producers and network operators to conclude contracts of up to 12 years to ensure investment security. To conclude such contracts, the network operators must first organise procurement tenders in case there is a need for new production facilities and/or several heat producers have provided the network operator with a written declaration of their interest in concluding a contract.

There is variation in the cost of these services: in 36 of the 164 DH systems audited by the National Audit Office in 2009, DH was more expensive than electric heating. The causes of the high cost of heating are linked to higher fuel prices, ageing boilers and heat losses caused by the poor technical condition of heat networks. On average, between 10% and 30% of all heat is lost in pipelines before it even reaches consumers.

Green certificate

Under the Kyoto Protocol, Estonia has been using two flexibility mechanisms: International Emissions Trading (IET) and joint implementation (JI). Estonia, as other former economies in transition, has had significant volumes of excess AAUs, which are carbon credits to sell internationally. Estonia started selling AAUs in

2009, under the Green Investment Scheme (GIS), and has earmarked the proceeds for projects that facilitate emissions reductions.

Examples include wind farms, CHP installations, improving DH networks, retrofitting boiler houses, improving EE in buildings and industry, and introducing more efficient buses and trams and electric vehicles.

By the end of 2011, Estonia had sold around 60 million AAUs (net) and by October 2012, the value of total AAU sales was nearing EUR 400 million, according to the government. This corresponds to almost 1% of the country's GDP for each of the three years in which the GIS has been in full swing. The major purchasers include the governments and/or companies of Japan, Switzerland, Spain, Luxembourg and Austria.

By the end of 2012, Estonia had 12 JI projects in operation, mostly on biomass and wind power. The first projects had been initiated already in 2002, and the two most recent ones in December 2010. Since their initiation until the end of 2012, the projects were expected to reduce emissions by around 1.9 Mt CO_2-eq. Investors in the projects are Austria, Finland, the Netherlands, Sweden and the Nordic Environment Finance Corporation (NEFCO), an international finance institution established by Denmark, Finland, Iceland, Norway and Sweden.

Estonia has harmonised its national measures with EU regulations to a large extent in order to improve the efficiency of common household and office appliances on a feasible and cost-effective basis, acceptable for all stakeholders. Since 1 September 2012, imports of incandescent light bulbs have been banned.

Emission Trading Scheme

Estonia a member of the EU-ETS. Under EU law, Estonia is obliged to limit the growth in GHG emissions from outside the EU-ETS sector to 11% from 2005 to 2020. According to the second NAP for 2008-12, the non-ETS sector accounts for around one-third of the country's total GHG emissions. Around half of these are emissions of CO_2.

Within the ETS in Estonia, the focus is on electricity generation, which produces around 80% of the emissions. Those emissions, in turn, come almost all from oil shale combustion at the state-owned Eesti Energia's Narva power plants.

Carbon Tax

A pollution charge for emitting CO_2 applies to heat producers within the DH system. Since 2009, the rate has been EUR 2 per tonne. The heat supply companies may avoid the charge by choosing to invest in environmental protection measures which reduce pollutants or waste. A pollution charge used to apply also to electricity generators, but instead since January 2008 these are subject to an excise duty. The latest duty amounts to EUR 4.47/MWh since 1 March 2013.

1.2.4 R&D

The Estonian Energy Technology Programme is a co-operation programme involving research, business and the state to develop oil shale technologies and new energy resources, mainly RES. Wisely, the government has narrowed down the focus to just a few technology areas. This is a rational approach for a country with limited resources. An area where a stronger focus could be considered, however, is efficiency-related RD&D, for example in buildings where a large potential for improvements remains. Most R&D in Estonia is performed at the universities. In the case of energy, the main public research universities are the University of Tartu and the Tallinn University of Technology.

In 2011, the Ministry of Education and Research and the MEAC launched the preparations for two new strategies: the RD&I Strategy and the Entrepreneurship Strategy for 2014-2020. The 2007-2013 RD&I Strategy identifies key technology areas and areas that are important for the socio-economic and cultural development of the country. National R&D programmes are implemented in these areas. The programmes focus on areas where Estonia already has high-quality research and which are important to the Estonian economy to attract private-sector participation, including funding.

Energy technology is one of the six national R&D programmes included in the 2007-2013 strategy. The other five are information and communications technology (ICT), biotechnology, health, environment technology and materials technology.

The Estonian Energy Technology Programme (ETP) is a national R&D programme in the energy sector. It is a co-operation programme involving research, business and the state to develop technology in three focus areas: oil shale, RES, and other new energy technology. The focus areas are detailed below. They reflect domestic potential for energy sources and scientific know-how as well as the country's European Union (EU) commitments in the energy sector and the priorities set by the European Union's Strategic Energy Technology (SET) plan.

The ETP involves the Ministry of Education and Research, the MEAC, the Ministry of Agriculture and the Ministry of the Environment. Co-operation with the private sector and research institutions is based on their voluntary contribution.

International co-operation, at present, is based on *ad hoc*, direct contacts with various R&D institutions. International collaboration is mainly carried out in the EU context. Under the EU 7th Framework Programme for Research and Development (2007-2013), Estonia has participated in the ERA-NET Smart Grids. Estonian R&D institutions also have bilateral activities on energy, for example the Estonian Science Foundation with the United States Civilian Research & Development Foundation.

The ETP was launched in 2008 and by the end of 2011 it had organised two calls for proposals and committed all of its EUR 7.5 million in funding. It was the first of the six programmes under the 2007-2013 RD&I Strategy to do so. The ETP mid-term evaluation was carried out in 2011-12, with no major changes to the programme up to 2013.

The ETP projects are monitored by their individual expert groups at their regular meetings. Any bottlenecks or priorities defined at these meetings are, in turn, discussed by the ETP Advisory Body, comprising representatives of universities, enterprises and trade unions. As a result of those discussions, propositions are put forward to the Steering Committee, made up of representatives of the relevant ministries and the qualified representatives of final beneficiaries. Required amendments are executed as the Steering Committee Resolutions. The facilitator for these processes is the ETP management team, which consists of the one full-time ETP employee and representatives of implementing bodies.

Bio energy research is mainly carried out at the Estonian University of Life Sciences and at the Tallinn University of Technology. The former has a Centre of RES where the suitability of various woody and herbaceous plants for producing bio energy, including liquid bio fuels, and their economic viability has been analysed.

At the Tallinn University of Technology, the biomass combustion characteristics as well as the construction of boilers have been studied. Research has also been done on theoretical and technical bio energy resources, characteristics of new bio fuels and possibilities of using them to produce heat and energy. Several thermo-technical tests of larger bio fuel boilers and measurements of emissions have been carried out to determine specific emission characteristic of bio fuels.

1.2.5 Investment Grants

Subsidies are excluded from the approved heat price and are paid only in the form of investment grants. The Environmental Investment Centre (KIK), a subordinate body of the Ministry of Economic Affairs and Communications (MEAC), may subsidise the renovation and construction of CHP units, boiler houses and heat distribution pipelines.

1.2.6 Ownership

Eesti Energia, covering 85% of electricity generation in Estonia, is a state owned company. The biomass and peat fuelled CHP plants of Pärnu and Tartu are owned by foreign company Fortum, biomass and peat fuelled CHP plant in Tallinn is owned by Estonian origin company Utilitas. The latter companies operate the DH systems in those two cities as well. The majority of DH systems are under private companies, municipal utilities operate in some smaller DH areas.

Synergy allocations

The allocation of the CHP costs to power and heat is stipulated by the Competition Authority.

1.3 Finland

1.3.1 National Energy Policy

The objectives of the energy policy[4] are to

- support economic growth;
- maintain and improve competitiveness;
- maintain security of supply; and,
- ensure availability of energy in the long term,

In addition, energy production and use shall offer working opportunities. The government is underway of determining the Energy and Climate Route Map to 2050. About 80% of all GJG emissions in Finland are caused by energy production and use. The government aims at reducing the GHG emissions by 80-95% by year 2050, which means virtual elimination of most emissions related to energy. In the route map work, the alternatives will be surveyed and analysed.

The cleantech business is set one of Finland's economic policy priorities. The Government aims to make Finland a pioneer in clean technology. On 1 February 2012, the Ministry of Employment and the Economy launched a Strategic Programme for Cleantech. The programme is aimed at spurring Finnish companies towards sustainable growth and renewal through clean technologies. Its goal is to prompt the creation of 40,000 jobs within the cleantech sector in Finland by 2020, and to double the total turnover of cleantech businesses from approximately 20 billion Euros to 40 billion by 2018.

Strengths of the Finnish cleantech sector include the production of clean energy, energy-efficiency of manufacturing and buildings, resource-efficient industrial processes, water treatment and waste management and recycling.

The four focus areas for the Strategic Programme for Cleantech are:

- Embedding cleantech across the administration – support for the cleantech sector's growth through the State's corporate steering
- Creating the best domestic markets for cleantech companies aiming at international markets

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[4] Sources:
National Report 2013 – Energy Market Authority, Finland
District Heating Strategy (Kaukolämpöstrategia) adopted 2013– www.energia.fi
District heating statistics of Finland – www.energia.fi
Electricity statistics of Finland – www.energia.fi

- Spurring business growth through internationalisation

- During the first two years of the programme (2012–2013) the focus will be on the promotion of clean energy, EE (using ICT) and environmentally friendly mining industry as pilot sectors, in addition to developing an operating environment that supports the growth of cleantech business in general.

During 2008-2012 the Finnish Innovation Fund - SITRA – implemented the Energy Programme of €20 m that stimulated new product development, new co-operation practices, financing mechanisms, demonstration cases and other initiatives that helped EE and RES become a central focus in Finnish life-style.

1.3.2 Current Energy System

District Heating

DH covers about 47% of the entire building stock in Finland. The specific heat consumption of the buildings has constantly declined, currently being at 38 kWh/m³. The figure includes the room space heating and domestic hot water. The network length is about 10 000 km.

In 2012, the average consumer price was 67€/MWh including the VAT, both fixed and variable charges.

The number of DH enterprises was 169, some 67 of which with CHP and the others mainly with heat-only-boiler plants as main heat sources.

All customers, the building owners, are connected with building level substations as typical in Sweden for instance. All customers are with heat metering.

A new strategy for DH was adopted in August 2013, the main features of which are:

- DH sales will grow some more ten years but in about 2030 saturate and turn to decline because of new EE buildings and warmer climate conditions expected.

- DC will expand as the complementing product as the business can no longer be based on energy growth, new ways to use heat and new products shall be developed to substitute the declining traditional heat energy consumption.

- In free market competition prevailing in the Finnish heating sector, heat pumps and hybrid heating - a combination of various heating modes in a building - have entered as competitors to DH.

- In general, the customers are happy with DH but more flexibility and in pricing and technical solutions are desired.

Already be 2012, the DH sector has strongly invested in carbon neutral future by means of new RES fuelled CHP and boiler plants.

No more fossil fuel based power generation capacity is expected, but in the next few years 1600 MW nuclear, 100 MW hydro, 120 MW CHP and 280 MW wind power capacity is expected to come on the market.

District cooling

The DC system in Helsinki is the 3rd largest in Europe and similar applications are in place in Turku and under construction in Tampere.

Electricity

As much as 70-80% of DH is based on CHP in Finland, with close links of DH to the electricity market. In Finland, some 36% (2012) of all electricity generation is based on the real CHP process, not just on CHP plants, which is one of the highest shares in the world.

RES

The DH sales of 33.6 TWh in 2012 were supplied by some 40% of RES and domestic peat, while the balance of 60% by fossil fuels, mainly natural gas and coal. The share of RES is strongly increasing and phasing out fossil fuels.
In Finland, peat is classified as a slowly renewable bio mass fuel. With a share of approximately 6 per cent, it holds a significant position in the energy balance. As a domestic fuel, peat has an important impact on regional policy and employment, and is having a growing effect on security of energy supply. The national energy and climate strategy aims to maintain the position of peat as a competitive alternative in energy production.

1.3.3 Legal and Regulatory Framework

Building regulations

Finland has set an ambitious goal to meet the 20% energy consumption reduction target set by the EU by 2020 to materialize in Finland three years earlier, in 2017 already.

The implementation of building EE is managed under ERA-17 programme, in which ERA stands for energy efficient buildings. ERA-17 was initiated in 2011 as a multilateral and comprehensive approach covering several ministries, construction companies, NGOs and other stakeholders, all being involved with the building sector.

The upgraded building code for new construction was commissioned in 2012 and for reconstruction in 2013. Moreover, the energy certificate system was upgraded in year 2013 as well based on the total primary energy consumption of the buildings. The new buildings need to meet the zero energy requirements by year 2020, and the public buildings by 2019 already.

Laws

There is no specific law stipulating the DHC and CHP but the general energy market law and customer right protection legislation are applied in DH as to any other products.

Price regulation

There is no price regulation on the energy sector at all but the prices are based on real costs and market conditions.

Competition

Free competition prevails both on electricity, cooling and heating sectors.

Feed-in tariffs

A feed-in tariff is available for

- New wind power plants
- New biogas power plants (gas produced by digestion)
- New wood-fuelled power plants which also produce heat for utilization
- Timber chip power plants

The FIT for wind, biogas and wood fuel power plants comprises the target price less the three-month mean market price of electricity. The target price is EUR 83.50/MWh. However, wind power plants receive an increased target price of EUR 105.30/MWh until the end of 2015. The FIT payable to timber chip power plants is determined according to the three-month mean price of emission rights and the energy tax on peat.

The FIT paid in Finland comprises a state subsidy granted by the Energy Authority. Electricity producers that receive the FIT are responsible for the sale of the electricity they produce and any arising net energy costs. The FIT is applied for from the Energy Authority in three-month periods in arrears.

Emission trading scheme

The Emissions Trading Act is applied to carbon dioxide emissions of combustion installations with a rated thermal input of more than 20 MW and of the smaller combustion installations connected to the same DH network, of mineral oil refineries and coke ovens, as well as of certain installations and processes of the steel, mineral and forest industries. An installation belonging to the sphere of emissions trading needs an emissions permit, pursuant to which it has the right to emit carbon dioxide into the atmosphere. The issuance of permits lies with the Energy Authority. In Finland, the number of installations needing a permit is around 530.

The monitoring and reporting of emissions data are an essential part of the permit process and the control of emissions trading. For this emissions monitoring, the Commission has adopted Decision 2004/156/EC, which specifies the monitoring requirements and accuracy levels of the emissions data.

Carbon tax

Energy taxation is a major source of financing for the state. State revenues from excise tax on energy amount to almost EUR 3 billion.

In addition to the fiscal meaning (impact on public financing), energy taxation is a key instrument of energy and environmental policy. As such, it is used to curb the growth of energy consumption while guiding energy generation and use towards alternatives that cause lower emissions.

The current energy taxation system has been in use since 1997. Energy taxes are excise taxes, which are levied on transport and heating fuels and electricity. In addition to energy tax, a security of supply fee is charged on energy products. Energy tax is divided into the basic tax and additional tax.

The basic tax is fiscal in nature and is levied only on oil products. The basic tax on petrol and diesel is staggered in accordance with their grade and environmental characteristics.

Additional tax is levied on oil products and other fossil fuels and electricity. The additional tax on fuels is determined on the basis of their carbon content. Natural gas is an exception which has been granted a 50% discount on the additional tax. The additional tax on peat was eliminated as of 1 July 2005.

Electricity is taxed during the consumption phase. The fuels used for power generation are tax exempt. Electricity tax has been divided into two taxation categories, the lower of which, category II tax, is paid by industry and professional market gardeners. Other consumers pay the higher category I tax.

Additionally, the energy taxation system also entails various kinds of subsidies, the most important of these from the energy policy perspective being the tax support paid for power generation based on renewable sources of energy.

Energy taxation is governed by the Act on Excise Tax on Electricity and Certain Fuels (1260/1996), and the Act on Excise Tax on Liquid Fuels (1472/1994). The Ministry of Finance is responsible for legislation on energy taxation. The Ministry of Employment and the Economy participates in the preparation of energy taxation, in order to ensure that taxation supports energy and climate policy goals as efficiently as possible. National Board of Customs and regional customs districts answer for the levying of taxes and the payment of tax support.

The European Union aims to harmonise energy taxation in the member states. A minimum tax directive concerning all energy products entered into force at the beginning of 2004.

Investment support

The regulation 1063/2012 set general rules for energy subsidies. The subsidy can be paid for such climate and environment friendly investment and study projects which:

- promote production and use of RES
- promote energy saving or improve the efficiency of energy production and use
- reduce environmental impacts of energy production and use.

The subsidy may cover up to 30% and 40% of the investment and study costs, respectively. Particularly in cases, the project includes new technology, the percentage can be raised by 10% points.

1.3.4 Ownership

Municipality role

Some 97 % of about 150 DH companies representing 86 % of heat sales are under municipal ownership and the balance are private.

Synergy allocations

The CHP cost allocation can be freely chosen by the companies provide the allocation does not cross-subsidize either product.

1.3.5 Planning

Integrated resource planning

An innovation to integrate urban and energy planning has been introduced in the city of Porvoo (Borgå). In the new way, the energy experts and the urban planners start working together in the general plan stage already. The impacts of various plans will be quantified in terms of energy consumption, investment and operation costs as well as emissions. The particular plan will be chosen for implementation which offers the lowest lifecycle costs and emissions. In city of Porvoo case in Finland, for instance, the new urban plan that was based on maximizing the share biomass fuelled CHP and DH appeared to be the best choice from environmental point of view, and moreover, with the overall life-cycle costs much lower than the traditional plan would have caused. In other words, the new combined energy and urban planning was a win win approach from both the reduced emission and the lowest cost point of view that was highly appreciated by the local decision makers.

In the Finnish city of Porvoo, a new management approach was adopted in planning of the new urban area, named Skaftkärr. In the very initial stage of planning both the urban and energy planners were invited to work together. As the reference for their co-planning, the Skaftkärr plan from year 2007 was adopted, but assuming that passive energy houses would be used apart to those assumed in the plan of 2007. The reference plan was a sub-urban plan traditionally dominated by small houses to be located so that personal cars would need to be used. As heating sources in the reference plan, a combination of DH, electricity and heat pumps was assumed.

Co-planning started with a few studies about how people live; move and what are their expectations. Co-operation among the urban and energy planners was not that simple in the beginning, but some time was needed for them to learn each others' way of work and thinking. A year was mentioned as a period of time that was needed to harmonize their co-operation.

Finally, the co-planning methodology provided four options to the urban scheme to be applied in Skaftkärr. All four options had the primary energy consumption and the emissions 30-70% lower than the reference plan.

1.4 Germany

1.4.1 National Energy Policy

The German energy policy focuses on reducing CO_2 emissions and primary energy consumption. The overall targets of the CC plan still remain with a 40% CO2 reduction expected by 2020, 55% by 2030, 70% by 2040 and 80-95% by 2050, all compared to 1990 levels. Nuclear power plants are to be phased out gradually until 2022. The CC plan also sets high requirements regarding EE improvements and RES expansion. In both, DHC and CHP have an important role to play.

One of the targets to achieve EE improvements, reduce CO2 emissions and primary energy consumption is to raise the share of CHP electricity from currently 15.4% (2010) to as high as 25% in 2020. As a precondition for such CHP expansion to materialize new heat sinks have to be made accessible for DHC. The government is aware of the need for new incentives to trigger such a heat sink expansion.

1.4.2 Current Energy System

District Heating

CHP is the main supplier of DH, covering about 80% of the annual heat energy.

In quantitative terms DH in Germany is, together with Poland, the largest market in the EU. The market share of DH in the building stock (residential) amounts to 13.2%; some 8% in the western part of Germany and 31% in the eastern part. The market share grows slowly because the EE investments to existing buildings and new buildings provide a very low heat demand increase. The number of the substations is steadily growing, even though the individual unit size is slightly declining.

District Cooling

There are some few industrial DC applications and other DC schemes but in general, in the German DC sector there is no coherent political strategy to develop DC.

Electricity

CHP has been on the forefront of strategic development due to CC. Therefore the legislative framework has been updated with the aim of favouring CHP development in order to achieve a CHP share of 25% of the net electricity production in 2020. The CHP share in 2012 amounts to 17 % (Prognosis, 2013). The updated CHP Act incentivizes investments both in DHC and CHP, The framework will be evaluated in 2014 in order to check i.e. if the measure is adequate to meet the ambitious targets.

Act on granting priority to RES (EEG) aims to (unofficial translation of the Federal Ministry for the Environment, Nature Protection and Reactor Safety): "…facilitate a sustainable development of energy supply, particularly for the sake of protecting our climate and the environment, to reduce the costs of energy supply to the national economy, also by incorporating external long-term effects, to conserve fossil fuels and to promote the further development of technologies for the generation of electricity from RES". To achieve this purpose, this Act aims to increase the share of RES in electricity supply to at least 30 percent by the year 2020 and to continuously increase that share thereafter."

As a basic instrument the Act obliges grid operators to connect power plants producing electricity from RES to their grid and give priority to buying their electricity at a fixed tariff.

For electricity from energy sources a FIT system is introduced by the Act. Grid operators are obliged to buy the electricity from RES at this fixed tariff at any time, regardless of actual demand. Alternatively, the power plant operator can sell his electricity directly on a month-to-month basis. The difference between the fixed tariff and the average electricity price is rewarded as a market premium and is accompanied by a management premium and a flexibility premium for installations using gaseous biomass. Operators can therefore achieve even higher revenue than with the fixed tariff, if they sell their electricity above the average price but face the risk of not being able to do just that. By means of a management system the costs are shifted towards and divided in general upon all electricity customers. These costs include the difference between the FIT paid to the operator and the wholesale revenue of the marketed electricity and the costs for the different premiums associated with the direct marketing of RES electricity. The FIT depends on the type of RES utilized and is by far the highest for electricity from photovoltaic, although it only provides a very low amount of electricity overall.

A review on the FIT is debated. The costs for the FIT have been climbing steadily. Both industry and consumer groups have been complaining about rising costs for electricity. Due to the very high installed capacity of RES electricity plants, especially wind and photovoltaic and their volatile feed-in, the support system puts a lot of stress on the energy system as a whole. Plant operators are incentivized to produce as much electricity as possible at any given moment, regardless of the demand in the grid, and RES electricity plants are often not erected close to the centres of high demand, leading to regional shortfalls (e. g. wind turbines in the north and high share of industry in the south). This means wholesale prices drop a lot during increasing time spans. Plants with relatively high marginal costs, such as

CHP plants, get priced out of the market (merit-order-effect). This situation needs a remedy, which will be one of the major challenges of the 2014 government in terms of energy policy/legislation.

Additionally there are two major flaws within the system which put DHC based on CHP at a disadvantage. The first is the so called “exclusivity-criterion”. Only installations that use RES exclusively benefit from FITs. That is a barrier to the most efficient co-use of biomass in bigger CHP plants.

Another criterion that proves to be a barrier for the use of biomass in bigger CHP plants and therefore in DHC as well is the limitation of the FIT system for the use of biomass up to 20 MW.

Therefore both the exclusivity criterion as well as the limitation for the system to 20 MW should be revised to encourage the efficient use of biomass in large scale CHP plants.

RES

Due to the “Energiewende” (energy transition) Germany has been and is very active in expanding the use of various types of RES in the energy market. Biomass and waste use in CHP plants is expanding likewise. Moreover, substantial support to solar and wind energy have led to extensive application all over the country.

The “Act on the promotion of RES in the heat sector (EEWärmeG) is targeted to (unofficial translation by the Federal Ministry for the Environment, Nature Protection and Reactor Safety): “…facilitate sustainable development of the energy supply and promote the further development of technologies for the generation of heat from renewable energies, especially with a view to climate protection, efficient use of fossil resources and the reduction of import dependence. In order to fulfil this purpose while maintaining economic feasibility, the aim of this Act is to contribute to increasing the renewable energies' share in final energy consumption for heat (space heat, cooling and process heat and hot water) to 14% by 2020.”

The basic instrument is an obligation to use energy from RES to a certain extent in newly built buildings (or existing buildings if the federal states so desire, see below). DHC is not considered a RES per se but if the heat is produced by a substantial share of RES, by a share of at least 50% CHP, by a share of at least 50% waste heat or a combination, DHC is considered an alternative measure, and the obligations to use RES are deemed to be met.

The Act targets owners of newly built buildings. The federal states are empowered to extent the scope of the Act to cover existing buildings as well, only Baden-Württemberg used this possibility so far, extending the obligation to existing buildings if their heating system is being replaced.

The “EuroparechtsanpassungsgesetzErneuerbareEnergien” (Law on the transformation of European law on Renewable Energy Sources) transformed the Directive 2009/28/EC (Renewable Energy Sources Directive) into national law and changed a number of details in the EEWärmG, such as the inclusion of cooling into the framework. However the review did not change the general framework of the Act. The legislator stated explicitly that from a legal perspective, the system of acknowledging EE measures (such as DHC based on fossil CHP and waste heat or improved insulation) as an alternative measure for the obligatory use of RES does not collide with the regulations required in the RES Directive.

EE measures such as DHC based on RES and/or CHP and waste heat as an alternative measure demonstrate that EE measures such as DHC and the use of RES complement each other. The DHC industry would however welcome a clarification that DHC should not necessarily cover the total thermal energy demand, consisting of heat and cold demand. This would leave room for DC solutions with central absorption chillers and on-site DC solutions based on a combination of absorption and compression chillers for peak demands.

1.4.3 Planning

All municipal codes in Germany enable municipalities to enforce mandatory heat planning for certain areas of their territory through byelaws. In these areas all property owners are obliged to connect their buildings to the DH network and use DH exclusively as a means of heating. Most municipalities making use of mandatory heat planning incorporate exceptions for heating based on RES like solar thermal heating into their byelaws although it is not necessary from a legal standpoint.

If a municipality uses mandatory heat planning for the DH supply it must fulfil certain criteria and secure a sufficient control over the local DH utility.

The Act EEWärmeG stipulates that municipalities may choose to introduce mandatory heat planning for global climate and environmental policy reasons.

Initial investments necessary for DH supply are high due to the infrastructure needed on top of the production facilities. The heat can only be delivered to customers living in the proximity of the production facility, therefore effectively limiting potential customers. Because of these circumstances investors may shy away from investing in the technology. In order to deliver a stable environment for investments, offsetting the initial investment costs needed, mandatory heat planning can be used to secure DH supply for certain areas. Therefore the legislation serves as a toolset for municipalities to secure investments in DH, especially in areas which have not yet been connected to a DH network.

1.4.4 Legal and Regulatory Framework

Building regulation

In order to improve the EE of buildings the Energy Saving Ordinance (EnEV) targets the reduction of the primary energy demand of buildings, reducing the use of resources and GHG emissions. The target is to reduce the primary energy demand for heating and warm water consumption by 30 % from the current average of 126 kWh/m² in the building sector.

The ordinance has a holistic approach on the building envelope, the systems engineering and the primary energy sources which are being utilized. Balancing the different measures is possible. For instance the obligations can be fulfilled by either using insulation levels above the minimum threshold or more efficient systems engineering or primary energy sources. The system in general therefore reflects the efficiency benefits of DH and CHP.

An analysis involving abatement costs for CO_2 would prove beneficial in this regard in order to maximize economic efficiency.

Price regulation and heat cost allocation

The Heating Cost Ordinance (HeizkostenV) was introduced to incentivize end-use energy savings through obligatory metering of energy use of collective installations used for heating and warm water, as well as creating a framework for heating cost allocation amongst the different apartments. In Germany a large share of people live in rented apartments. Usually the contractual relationship in regards to heat providers is between the landlord and the heat provider, not the individual tenants. Therefore, the landlord pays the bills and allocates the costs for heating and warm water among the individual tenants.

In order to give an incentive to energy savings for each individual tenant, the costs have to be allocated in such a way that it reflects their personal energy use. In general 70% of the costs allocated towards the individual tenants have to be based on the actual energy consumption. The remaining 30% are allocated according to certain criteria, reflecting conditions the user has no influence on. These conditions include the position of the apartment within the building. If the apartment is located on top of an apartment building, energy use will be higher due to the exposed nature of the apartment. The same holds true for apartments which have a lot of walls facing outside.

The obligation to use a certain type of metering for DHW production for DH involves high costs for the landlords without providing any benefit in terms of the ordinance. The “AVBFernwärmeV” already contains an obligatory metering for heating and DHW consumption. Due to the technical framework for DH installations the specific type of metering were not foreseen in the past and thus provide technical problems as well. Although DH utilities are in most cases legally not obliged to pay these costs, landlords still use their market power in order to force these costs upon the utilities.

Energy taxation

The Energy Taxation Act (EnergieStG) is used to tax different fuels. Electricity is taxed under a different law, the Electricity taxation act, which has no influence on DHC directly. DHC as such does not fall under the scope of the Act either; it is only indirectly affected by the potential taxation of the fuels being used to produce the heat and/or cold. There is the possibility of a tax refund for fuel being used in CHP (and in power plants in general). CHP plants are eligible for such a refund if their annual or monthly use efficiency is at least 70%.

Competition on the heating and power Sector

DHC in general operates on free market conditions, and therefore has to be competitive to individual gas and oil boilers or individual compression chillers to succeed. The ETS provides a barrier to DHC competitiveness as small boilers below 20 MW are left out of the scope of the ETS, thus favouring the small gas and oil boilers. Germany, unlike other EU member states, has no direct CO2 tax. Therefore, the ETS provides a serious disadvantage for DHC.

FIT substituted by market premium for CHP electricity

As a basic instrument, the CHP Act obliges grid operators to give priority to buying electricity from CHP. A similar priority exists within the framework for electricity produced from RES and is ranked equally. The grid operator is obliged to pay a premium on the top of the market price (market premium), not a FIT as it is the case for electricity based on RES. In addition to the premium the CHP act offers incentives for investment in distribution systems (pipes) and storage systems. These possibilities apply also to cooling. The costs of the premium are allocated to the electricity consumers by means of a management system. The premium is valid for a certain period of time in order to cover the elevated cost levels of a CHP plant compared to a similar power-only plant. CHP support comes at a low cost to society, at present, the levy resulting from the support within the CHP Act amounts to 0.025 to 0.178 cent/kWh (2014), depending on the yearly electricity consumption (the levy for RES support is set at 6.240 cent/kWh for 2014, around 35 to 250 times the amount of the CHP levy).

However, due to the distortion on the electricity market caused by the framework for RES electricity, CHP installations, in particular based on natural gas, which causes high marginal costs, are becoming increasingly unprofitable to operate. This hampers the development of CHP, and consequently DHC (see above).

Emissions Trading Scheme

DHC as such is not directly covered by the scope of the ETS. The production facilities for the production of DHC however fall under the scope of the act as long as they fulfil the criteria, especially the size restriction of 20 MW net heat output.

With the third trading period the system of emissions trading was fundamentally changed to the disadvantage of CHP and DHC. Though there still is free allocation for the heating side of CHP installations this allocation will decrease over time. Due to the size threshold DHC and CHP installations are the only installations on the heating market for residential buildings which fall under the scope of the ETS, leasing to a competitive disadvantage for these low carbon solutions.

Carbon Tax

Unlike for instance in Scandinavian countries, there is no direct CO2 tax in Germany to accompany the ETS for smaller installations.

Investment Support

The investment support for DHC networks within the CHP Act has been raised from 20% of the eligible costs to 30% (for an average pipeline diameter of above DN100) and to 40% (for an average pipeline diameter of below DN100).

There is an overall cap on the support based on the CHP Act, limiting its amount to € 750 million per year, earmarking € 150 million per year on the support for DHC networks as heat sinks for CHP and thermal storage to further develop the flexibility of CHP installations and integrate RES electricity into the electricity market. The costs associated with the CHP support are very low compared to other support mechanisms, such as RES support. At present, the levy resulting from the support within the CHP Act amounts to 0.025 to 0.178 cent per kWh (2014), depending on the yearly electricity consumption (the levy for RES support is set at 6.240 cent per kWh for 2014, around 35 to 250 times the amount of the CHP levy).

Heat Customers

The Ordinance on General Conditions for the Supply of DH (AVBFernwärmeV) stipulates the rights and responsibilities of the DH suppliers and customers. The “normal” framework for the relation between customers and companies was deemed inappropriate to handle the specific technical and economical features of DH supply on the one hand and customers’ needs on the other. Therefore the ordinance sets a general framework for standard business conditions for the supply of DH to residential customer, regardless of whether these customers are consumers or businesses. The supply of industrial customers with DH does not fall under the scope of the ordinance.

Customers which are connected to DH have the right to be supplied according to the general conditions laid out in the ordinance if standard business conditions are being used. The DH utilities on the other hand may only deviate from these conditions with the explicit consent of the customer.

The DH industry sees the ordinance as an important part of the legal framework; therefore no review is needed from their perspective. On the contrary, according to the DH industry preserving the ordinance and its regulations is important for the envisioned development of DH in Germany.

1.4.5 Ownership

Most DH companies are owned by municipalities. The companies own the networks and often the heat sources as well. The consumer substations are owned by the customers (*needs verification*).

1.4.6 R&D

The Federal Government has allocated approximately € 3.5 billion for funding the research and development of energy technologies between 2011 and 2014 that is 75% more than during the previous research period.

The document “Research for an environmentally sound, reliable and affordable energy supply, 6th Energy Research Programme of the Federal Government” sets long-term objectives that are of particular importance to the future direction of energy research policy. The key targets for 2050 are as follows:

- Reduce emissions of greenhouse gases by between 80 percent and 95 percent compared with 1990 (by 40 percent by 2020)
- Cut primary energy consumption by 50 percent compared with 2008
- Curb overall electricity consumption by approximately 25 percent compared with 2008 (by 18 percent by 2020)
- Ensure that energy from renewable sources accounts for 60 percent of gross final energy consumption (18 percent by 2020) or 80 percent of gross electricity consumption (at least 35 percent by 2020)

The Programme comprises three areas of research that involve DH and CHP, namely

- Energy storage
- Electric Grid
- Energy Efficient Cities

Under the Energy Efficient Cities there are two funding initiatives such as *EnEff:Stadt* (e.g. energy efficient city) and *EnEff:Wärme* (e.g. energy efficient heating) which both are subdivided into two modules: *“R&D projects”* and *“Pilot projects”*.

1.5 Iceland

Iceland has a vision of containing reductions of net emission of greenhouse gases by 50- 75% until the year 2050, compared to 1990.

Due to electricity and heat being virtually CO_2-free, Icelandic GHG emissions are predominantly from the transport sector and from industrial processes. The sharp rises in emissions the past years are due to the new aluminium smelters.

1.5.1 National Energy Policy

In Iceland, energy issues are placed under the Ministry of Industies and Inovation. The government agencies responsible for the energy area are Orkustofnun (the National Energy Authority) and Orkusetur (the Energy Agency).

1.5.2 Current Energy System

Iceland is mountainous and volcanic with much precipitation. The country's geographical peculiarities have endowed Iceland with an abundant supply of geothermal resources and hydropower. Around 15% of the primary energy used in Iceland is imported, and 85% is produced domestically. The main sources of energy are hydropower, geothermal, oil and coal. 84% of Iceland's primary energy is renewable, with the remaining 16% oil used almost exclusively for transportation.

Table 1-5 Energy Balance in Iceland 2011

	Fossils	Nuclear	Wind	Hydro	Biomass	Other RES	Total
Power	12	-	-	12,514	-	19,992	32,517
CHP	-	-		-	-	16,433	16,433
Heat	-	-		-	-	384	384
TPES	10,781	-	-	12,514	12	43,357	66,652

Primary energy use by Iceland has increased by large amounts in the last few decades. Due to the high volume of electricity consumption by the aluminium industry, and the country's population of just 320,000, Iceland has the world's highest electricity consumption per capita. The primary energy use in 2010 was approximately 750 GJ per capita. Almost half of Iceland's energy is used in the industrial sector, most of which can be attributed to metal manufacturing.

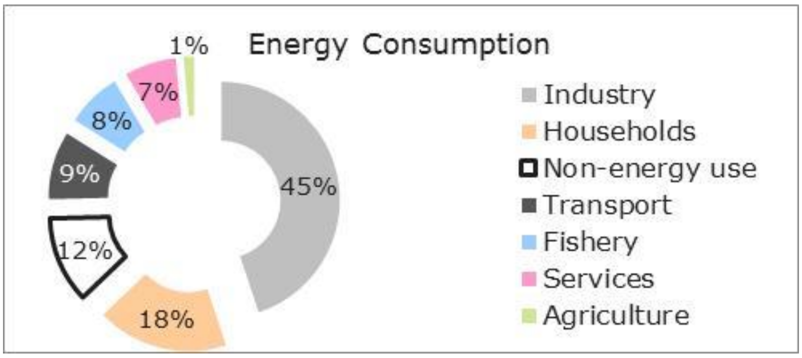

Figure 1-3 Source: IEA

As the heat demand in Iceland is covered by geothermal heat, waste is intended to be utilized to produce methane at the landfill in Álfsnes. It is estimated that the gas collected there would suffice for 4,000 – 6,000 methane-powered automobiles.

District Heating

99 % of the Icelandic population is served by RES and DH satisfies 92% of the heat demand in the residential and service sector. In 2009, the DH sector delivered heat to an average price of 2.58 EUR/GJ, only a fraction of the heat cost in other European countries. The DH sector turned over 66 M EUR in 2009. 84 % of the heat was utilized in private households and the remaining in the service sector. 10,300 TJ of heat was produced in geothermal plants, and the remaining 11% of

the demand was covered by electric instalments. The direct utilization of geothermal heat for DH is still being increased with the support of the government, which assists small communities in obtaining long-term low interest loans for geothermal development.

Electricity

In 2011 27.3 % of the electricity was produced from geothermal power plants and the remaining from hydro power stations. 77% of the electricity consumption is allocated at the power intensive industry, 71 % at the aluminium industry, and 6%at the ferro silicum plant.

Table 1-6 Power system in Iceland 2011

	Hydro	Geothermal	Oil	Total
Installed capacity [MW]	1,884	663	120	2,668
Produced Electricity [GWh]	12,507	4,701	2	17,210

Indisputable, geothermal power is a renewable technology. However, it is important to distinguish between renewable and CO_2 neutral. Geothermal plants emit about 5% of the carbon dioxide emitted by a coal-fired plant of equal size, and certain types of geothermal plants produce near-zero emissions. However; the CO_2 emitted from geothermal plants is already part of the CO_2 cycle and is already vigorous degassing from geothermal and volcanic areas.

1.5.3 Planning

Iceland’s ambitions for RES and the related national targets are fully commensurate with the EU energy policy objectives and the targets addressed to Iceland under the Renewable Energy Directive. The main goals for the energy policy in Iceland are:

› Energy supply to the public as well as the industry will be secured, both in short term and long term.

› Energy utilisation will be recognised as a key factor in the building up of new and diversified industries and new job opportunities.

› Energy security will be ensured by investments in the electricity grid

› Utilisation of new renewable energy resources will be supported and at the same time new and smaller energy possibilities will be supported to suit domestic industry.

› Energy supply will be in accordance with the need of the diversified industry.

› Power generation shall at all times use the best available technology to maximise efficiency and minimise pollution.

- The share of renewable energy in the transport sector will be increased and infrastructure and access will be developed.

- Iceland will participate in the cooperation of neighbouring states concerning oil exploration and research in the Arctic. An Icelandic state oil company will be established to safeguard Icelandic interests in the area.

- Emphasise will be put on energy research, i.e. with be participation in international cooperation

- Data and statistic on energy shall be available to support energy strategy and informed discussion on energy in Iceland.

- The Icelandic government will facilitate a consensus on power generation and encourage a diversified utilisation of the energy resources with improved regulatory framework and support schemes.

The 2020 target for RES in gross final consumption is 72%, where the gross final consumption is expected to be 3161 ktoe. The major implementation to reach this target is to have 10% of transport fuelled by RES.

1.5.4 Legal and Regulatory Framework

The Energy Law of 1967 provides municipalities with the right to monopoly to operations of DH systems, provided that 51% of the organization is publicly owned.

Building Regulation

Iceland was granted derogation from Directive 2002/91/EC on energy performance of buildings, under the EEA Agreement. Iceland has requested that the recast Directive 2010/31/EU on energy performance of buildings does not apply to Iceland due to the special features of Iceland's energy situation. For similar reasons, Iceland has requested derogation from Directive 2006/32/EC on energy end-use efficiency and energy services.

As stated Iceland has high use of RES, space heating contributes to only 0.5% of the greenhouse gas emissions in Iceland, compared to 36% in the rest of the EU. Furthermore, national building codes ensure that high levels of EE are attained; European standards are in force as Icelandic standards. Harmonised standards and European Technical Approvals also are in force in Iceland. In addition, there are requirements for insulation, heat loss, and heat transfer and air change rate.

Table 1-7 Building requirement in new buildings - U-values. Ti is indoor temperature

	Allowed max U-value [W/m²K]	
Building component	Ti ≥ 15°C	15°C >Ti ≥5°C
Roof	0.15	0.25
Ext. wall	0.25	0.30
Windows	1.7	2.0
Door	1.7	2.0
Skylight	1.7	2.0
Floor	0.20	0.25
Exterior walls, average (wall area, windows and doors)	0.80	1.10
	Thermal bridge/line loss [W/mK]	
Foundation	0.12	
Doors, windows and ext. walls	0.03 W/mK	
Roof/skylight	0.10 W/mK	

Carbon Tax

A committee report on the taxation on vehicles and fuels was published in 2008. Following the committee‘s recommendations, a carbon tax on fossil fuels was adopted in 2010 and a total reform of the taxation of vehicles was introduced in 2011. There are tax exemptions on bio-diesel, methane, and methanol. The refund on CO2 for public transport will be removed.

Investment Grants

The National Energy Authority (Orkustofnun) focuses on energy research, monitoring of energy resources and knowledge sharing internationally, especially in respect to geothermal technologies.

Iceland’s Energy Agency (Orkusetur) promotes EE in households and industry, and a reduction in the use of fossil fuels for transportation.

Energy R&D in Iceland is also funded through The Icelandic Centre for Research (RANNIS) which is under the Icelandic Ministry of Education, Science and Culture.

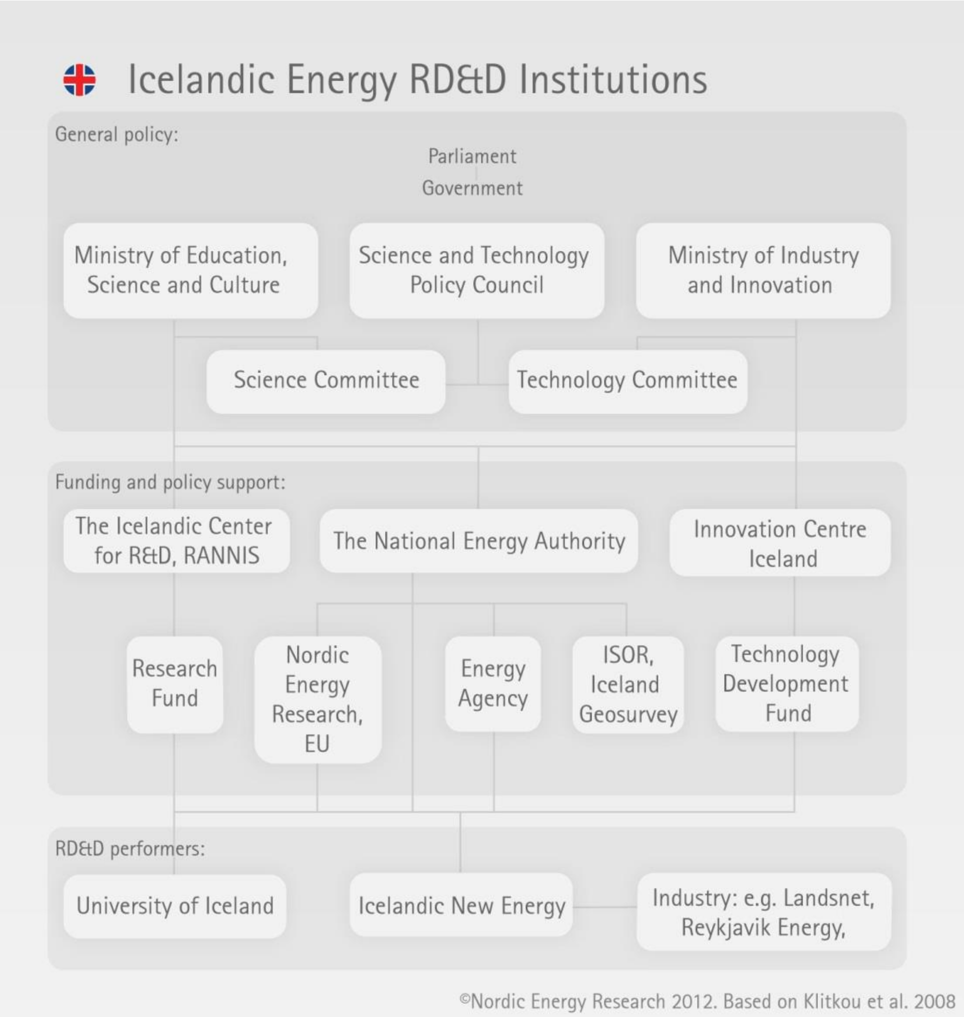

Figure 1-4 *Source: Nordic Energy Research*
http://www.nordicenergy.org/thenordicway/country/iceland/#key-institutions-in-the-funding-of-low-carbon-energy-rdd-in-iceland

In short, energy research in Iceland focuses on the abundant geothermal resources, most of which have already been managed. Iceland spends a significant 3.1 % of GDP on public RD&D, often allocated as competitive funds or grants.

1.6 Latvia

Energy intensity and CO_2 emission intensity in Latvia are more than double of the average values in EU. The largest EE gains can be achieved within building sector as it is the largest energy consumer at the moment. There is a need for speeding-up the process of the implementation of the housing insulation.

Over 60% of the total primary energy supply is covered by imported oil and gas, making the Latvian energy system heavily dependent on Russian supply.

On account of the local biomass production and the hydropower stations established in Latvia many years ago, the country has one of the highest shares of the RES in the whole European Union. The renewables cover approximately 1/3 of the total energy consumption.

Implementation of RES projects is being discussed in Latvia. There is a lack of knowledge about the future energy consumption in Latvia, which is a precondition for evaluating various RES.

1.6.1 National Energy Policy

The institution responsible for Energy Sector Policy (including the EE policy) in Latvia is Ministry of Economics of the Republic of Latvia.

Latvia has set the following targets within the energy sector for the coming years:

- EE of the heat production should be 80-90% by 2016.
- Heat losses in heat distribution system should be reduced to 14% by 2016.
- Energy intensity indicator should be reduced to 280 kg oil equivalent/ 1000 Euro GDP (gross domestic product) by 2020 and to 220 kg oil equivalent/ 1000 Euro GDP by 2030.
- Energy consumption of the buildings should be reduced to 100 kWh/m²/year by 2030 (energy consumption for multi-storey apartment buildings built during the Soviet era varies between 150 and 200 kWh/m²).
- 40% RES in gross final energy consumption by 2020.

National Energy Policy in Latvia is described and controlled by the following laws, regulations and guidelines:

- The Energy Law (adopted on September 3, 1998 by the Parliament of the Republic of Latvia) – the purpose of the energy law is to regulate the energy sector in Latvia as an economic sector. This includes acquisition of energy from various sources, conversion of the energy following purchase, storage and transmission to the final distribution, trade and use of the energy.
- The Electricity Market Law (adopted on May 5, 2005 by the Parliament of the Republic of Latvia) – controls various activities within electricity market, such as production, transmission and distribution of electricity as well as trade of electricity.
- The Energy Development Guidelines for 2007-2016 (approved on June 27, 2006 by the Cabinet of Ministers) – describes the medium-term and long-term government policy, main development targets and priorities in the energy sector, including promotion of EE as well as use of RES in energy sector.
- The Building Energy Performance Law (adopted in 2008) – the main goals are to promote a rational utilization of the energy resources as well as improve the EE of the buildings, including requirements for certification processes.

- The Energy End-use Efficiency Law (adopted in January 2010 in order to comply with EU requirements) – main goals are to set the main NEEAPs principles, implement monitoring of EE as well as form the environment which would make possible the development of a market for various services related to EE, including Energy Service Companies.

- Sustainable Development Strategy of Latvia until 2030 – the main goals are to ensure the energy sector's positive impact to Latvian economy as well as to increase energy security and promote use of RES.

- Regulations Regarding Electricity Production and Price Determination Upon Production of Electricity in Cogeneration (adopted 10 March 2009).

- Regulations Regarding the Production of Electricity Using Renewable Energy Resources and the Procedures for the Determination of the Price (adopted on March 2010).

- Sustainable Development Strategy of Latvia until 2030 – draft was presented on September 27, 2012.

1.6.2 Current Energy System

The energy sector in Latvia is dependent on energy import from other countries and has one of the highest imported thermal energy dependency rates in the entire EU. Russia ensures nearly 100% of natural gas and oil consumed in Latvia. Situation in the electric power section is slightly better but dependency with about 20% imported electricity is still an issue that needs attention.

Table 1-8 Energy Balance in Latvia 2011 [GWh]. Source: IEA

	Fossils	Nuclear	Wind	Hydro	Biomass and waste	Other RES	Total
TPES	32,390	-	71	2,887	14,247	-	50,835
Power	-	-	71	2,887	12	-	2,970
CHP	8,211	-		-	430	-	8,641
Heat	2,070	-		-	1,512	-	3,582

In 2011, 47% of the total primary energy supply was covered by local energy production. The net balance of imported energy was 33.5 TWh in 2011, equivalent to 66 % of the TPES.

In order to supply fuel, electricity and heat to residents, commercial consumers and sectors of economy both imported (electricity, natural gas and oil products, coke, coal etc.) and local energy resources (wood fuel, charcoal, peat, municipal waste for heating, straw, bio fuels, hydropower and wind) are used.

Heat and Power Sector

In 2012, the amount of electricity generated in hydropower plants and wind power stations reached 13.8 PJ. 60% of the total electricity consumed is produced from hydropower and approximately 33% from natural gas. The largest electricity consumer in Latvia is commercial and public services, followed by industry and residential sector.

Natural gas is the main fuel contributing to ~66% of the total amount of fuel consumed in 2011. Natural gas is used to produce 4/5 of the total amount of heat consumed in Latvia. Approximately 30% of the thermal energy is purchased from large cogenerations plants. The next largest source for heat production is bio fuels (16%). The residential sector is consuming more than 3/4 of the total amount of heat produced, while commercial and public services is second largest heat consumer using approx. 1/4 of the produced heat.

Table 1-9 Rīgas Siltums cogeneration plants

CHP plant	Electrical effect [MW]	Thermal effect [MW]
SC Imanta	48	48
KM Keramikas	2.33	3.2
SC Daugavgriva	0.6	4.8
KM Viestura	0.5	0.63

RES

Under the EU Directive 2009/28/EC member countries of the European Union are obliged to draft and submit to the European Commission National Renewable Action Plans (NREAPs) outlining pathway which will allow them to meet their 2020 RES, EE and GHG cuts targets.

Latvia 2020 RES targets:

- Overall target: 40% of share of energy generated from renewable sources in gross final energy consumption;
- Heating and cooling: 53% of heat consumption met by RES;
- Electricity: 60% of electricity demand met by electricity generated from RES;
- Transport: 10% of energy demand met by RES.

1.6.3 Planning

More detailed information about Latvian energy policy and planning within the energy sector can be found in *Guidelines for Energy Sector Development for 2007-2016*. Guidelines contain the government policy, development objectives and medium-term and long-term priorities in the energy sector. Future predictions in this document are based on the energy consumption data from 2006 which have changed significantly. Moreover these guidelines include neither developed energy projects nor those in progress which could not be predictable in 2006.

The main targets of energy policy development in Latvia are included in a long term policy planning document - *Sustainable Development Strategy of Latvia until 2030*, draft of which was announced at State Secretaries' meeting on 27 September 2012. The main objectives of the strategy described in the document are first of all the energy sectors' positive impact on overall Latvian economy, increase of energy security and promotion of RES.

Another guideline within energy sector in Latvia is called *Latvian energy long term strategy 2030 – competitive energy for society*. This guideline has two main targets – to increase energy security and to promote the use of RES. *Latvian energy long term strategy 2030 – competitive energy for society* supplements and expands energy targets of the *Sustainable Development Strategy of Latvia until 2030*.

1.6.4 Legal and Regulatory Framework

Building Regulation

Building regulation system in Latvia is based on the Building Law which was adopted by the Parliament of the Republic of Latvia (Saeima) in August 1995. The second level legal acts: Regulations and Latvian Building Codes are according to the Building Law issued by the Cabinet of Ministers. Local municipalities have rights for issuing the third level legal acts as local binding building regulations. Local building regulations have to be in compliance with the Regulations of the Cabinet of Ministers and Latvian Building Codes.

There are 24 applicable Latvian Building Codes and 15 applicable Regulations of the Cabinet of Ministers within the construction field in Latvia.

In order to make the Building Regulation system in Latvia more flexible, in September 1999 the Cabinet of Ministers accepted a new development concept. The concept is based on the principles used in Building Regulations of Scandinavian countries which only include administrative provisions, essential safety and performance requirements. There will be given references to different standards for more detailed information as calculation- and design methods, technology etc.

Price regulation

Institution defining tariffs and competition rules is The Public Utilities Commission.

Retail electricity and gas prices are regulated by the state of Latvia. Every month Joint Stock Company „RĪGAS SILTUMS" notifies heat consumers on the heat rates applied, which are set based on the monthly notification by the Joint Stock Company "Latvijas Gāze" on the final sales rates of natural gas in the relevant month.

As from 1 September 2013 the heat rate 40.99Ls/MWh (58.32 EUR/MWh) VAT excluded has been applied for settlements for the delivered heat. The rate was set based on the final sales price of natural gas of 205 Ls/thous.nm^3 (291.67 EUR/thous.nm^3) in September.

Competition on Heat and Power Sector

The electricity market in Latvia was liberalized in 2007. JSC Latvenergo still has the dominant role in the market as according to the Energy Law, power plants as well as electricity transmission and distribution grid and equipment can only be transferred to entities fully owned by Latvenergo AS.

As a consequence, there is no real competition within the national power sector in Latvia as Latvenergo A/S is the only local supplier of electricity. Latvenergo AS produces 60-70% of the electric energy needed in Latvia. To ensure continuous supply of electric energy in Latvia, Latvenergo imports the rest of the needed electric energy from Estonia, Lithuania and Russia and there is also a possibility to import it from Scandinavian countries.

Emission Trading Scheme

Latvia ratified Kyoto protocol on May 30, 2002 and is therewith participating in the International Emission trading system.

Feed-in-tariffs for CHP and RES

A complex support system based on a feed-in-tariffs including elements of a quota system and tenders is stimulating RES generation in Latvia.

Latvia adopted feed-in-tariffs in year 2001, however, due to unknown reasons, the existing feed-in-tariffs in Latvia won't be used until January 2016.

Carbon Tax

It is planned to introduce the carbon tax in Latvia in the time period until year 2030. Carbon tax will be adapted to the price for a ton of CO_2 defined by EU.

Investment Grants

Latvia is one of the 7 countries Norway grants close to 100 million EUR to green industry innovation. Investment and development Agency of Latvia (LIAA) is responsible for the programme called *Green Industry Innovation* (2009-2014) implementation in Latvia. The donor state programme partner is Innovation Norway.

Latvia has received investments from EU Structural Funds for increasing EE for heating appliances, especially in multi-storey apartment buildings.

1.6.5 Heat Consumer

On 21 October 2008 the Cabinet of Ministers adopted regulation Nr. 876 "Terms about heat supply and usage". It determines the way heat supplier has to deliver and heat consumer has to use the received heat as well as terms under which heat supplier has rights to stop heat delivery to consumer which has not paid for the received heat or has in another way breached its obligations.

1.6.6 Ownership

Utility responsible for generation and sale of electricity and thermal energy is the state-owned public limited company Latvenergo Group. Transmission and distribution of electricity is ensured by the two subsidiaries of Latvenergo Group – Latvijas elektriskie tīkli AS and Sadales tīkls AS, respectively.

Heating in Latvia is ensured by means of district-, local- and individual heating systems. Largest part of the heat used in DH network is produced in Riga, out of which 90% is produced in highly effective cogeneration process.

Several mainly municipalities owned heating companies ensure space heating and heating of the domestic hot water in other cities in Latvia. The global leader in energy services, Dalkia partially owns many of the heating companies in Latvia.

In minor cities and villages inhabitants are the ones responsible for the heat production by means of individual heating systems at their homes.

In 2012, heat to the DH networks in Latvia was produced in 663 boiler houses and 132 cogeneration stations located all over the country.

The main heat supplier of Riga is a joint stock company Rīgas Siltums. It is founded on September 25, 1995 by Riga City Council, the State owned JSC Latvenergo and the Latvian commercial bank Baltijas Tranzītu Banka. JSC RigasSiltums is responsible for production, distribution and sale of thermal energy as well as technical maintenance of inner heat supply systems in buildings.

The Joint Stock Company Rīgas Siltums manages and distributes 76% of the thermal energy in the city of Riga. RigasSiltums owns 72% of the 900 km long city's heating network.

Customers are free to choose a desired source of heating. DH enterprises face serious competition in the heat market. However, the DH enterprise JSC Rīgas Siltums, working in conditions of free market and competition, has succeeded in improving the quality of heat production and distribution.

1.7 Lithuania

Lithuania is experiencing many challenges in the energy system and security of energy supply is the major issue in Lithuania. Lithuania is heavily dependent on imported oil and gas and its dependency on Russia's gas is the main problem. Lithuania's electricity and gas networks do not have any direct links to Western European energy systems meaning that there is no alternative supply of natural gas, leaving Lithuania depending on a single supplier. Being tied to Russian gas production, Lithuania is a so called "Energy Island"; a situation that Lithuanian government is trying to change.

In accordance with the Effort Sharing Decision, the national emission target for Lithuania is the limit of 15% increase in greenhouse gas emissions in 2020 compared to 2005 levels.

1.7.1 National Energy Policy

The National Energy Independence Strategy (2012):

- The purpose of the National Energy Independence Strategy (henceforth – Strategy) is to define the main objectives of the Lithuanian state in the energy sector and to set national targets for the implementation of strategic initiatives until 2020, as well as to lay down guidelines for the development of Lithuania's energy sector until 2030 and until 2050. The main goal of this Strategy **is to ensure Lithuania's energy independence before the year 2020 by strengthening Lithuanian's energy security and competitiveness**. Lithuania's energy independence will ensure an opportunity to freely choose the type of energy resources and the sources of their supply (including local production) so that they best meet the state's energy security needs and Lithuanian consumers' interests to procure energy resources at the most favourable prices.

- Like many other countries in Europe, Lithuania is facing challenges in the energy sector on three main dimensions: security of energy supply, competitiveness and sustainability of the energy sector. This situation was determined by historic and political circumstances as well as scarce internal energy resources.

- Most of energy resources used in Lithuania is imported. After the shutdown of Ignalina Nuclear Power Plant, the country is not able to satisfy its internal electricity demand at competitive prices. The Lithuanian electricity network is not connected to the European electricity system and therefore electricity can be imported only from a very limited number of countries.

The issues are planned to be solved with a regional solution as Lithuania will have difficulties solving its energy issues alone. Some of the problems to be solved by the Baltic region are:

- Long-term reliability of natural gas supply

- Construction of the prospective new nuclear power plant

- Integration of the electricity system into EU systems

- Exacerbated balance of consumption after the closing of Ignalina nuclear power plant.

To deal with these problems, Lithuania drafted "The National Energy Strategy until 2025" after accession of the Lithuania to the European Union in 2004 and it adjusts targets and directions for the energy sector of the state to the general energy strategy of the EU. Lithuania will:

- Treat energy security as a national security issue.
- Ensure reliable energy supply and functionality of energy infrastructure.
- Diversification of energy supply sources.
- Reduce dependence on energy resource import (by reducing energy intensity and switching to alternative or RES).
- Develop a stable, environmentally friendly and economically acceptable energy supply.
- Integrate the Lithuanian energy sector into the energy systems of the EU.

The strategy also promotes a new liquefied gas terminal in the Baltic region, which could reduce the dependence on natural gas imported from Russia. Construction of gas pipelines to Eastern Europe from alternative sources, such as the Caspian Sea region or Norway and interconnection of gas pipeline networks of Lithuania and Poland would acquire possibilities of alternative gas supply.

This strategy of reaching energy independence is followed up in the *National Energy Independence Strategy* of June 2012, which define the main objectives of the for Lithuania in the energy sector and set national targets for the implementation of strategic initiatives until 2020, as well as to lay down guidelines for the development of Lithuania’s energy sector until 2030 and until 2050. The main goal of this Strategy is to ensure Lithuania’s energy independence before the year 2020 by strengthening Lithuanian’s energy security and competitiveness. The focus points are:

- Full Integration into the European Energy Systems
- Ensuring sufficient competitive local electricity generation capacities
- Implementation of the 3rd EU Energy Package

The main task in the heating sector is to increase energy efficiency in heat production, distribution and consumption while at the same time shifting from mainly gas based production towards biomass. The state will support initiatives aimed at increasing the heat consumption efficiency, utilization of waste energy potential and the use of biomass. By the year 2020 the target for decrease in households’ and public buildings’ heating consumption is 30–40 %.

The state will aim to reach the target of no less than 23 % of renewable energy in final energy consumption, including no less than 20 % of renewable energy in the electricity sector, no less than 60 % in the district heating sector.

Considering the energy efficiency, the target is to achieve annual savings of 1.5 % of the total final energy consumption in the period through 2020, and in such way to contribute to the enhancement of Lithuania's energy independence, competitiveness and sustainable development.

The initiatives outlined in the Strategy will have a positive impact on the environment, as their implementation will enable Lithuania not to emit additionally 11 million tons of greenhouse gas emissions in CO2 equivalent before 2020. This would amount up to 46 % of the actual greenhouse gas emissions in 2008.

1.7.2 Current Energy System

The Lithuanian energy system is heavily infiltrated by foreign fossil fuels. 41 % of the energy consumption comes from oil and natural gas covers 39 %. Lithuania imported 126,778 TJ of natural gas in 2011, mainly through Belarus. Lithuania imports a large amount of crude oil which is refined and mostly exported.

Table 1-10 Energy Balance in Lithuania 2011[MWh]

	Fossils	Nuclear	Wind	Hydro	Biomass	Other RES	Total
TPES	62,895	-	475	477	11,281	512	84,690
Power	-	-	475	477	-	477	7,699*
CHP	11,142	-		-	744	-	11,886
Heat	2,977	-		-	2,082	35	5,094

* 6,745 GWh of electricity was imported

Biomass is used for heating Lithuanian households is mainly produced locally, enough to cover 17 % of the total heat demand. Lithuania is net exporter of biomass.

Heat and Power

As the second –and the last - nuclear power plant reactor in Lithuania were closed down in 2009, natural gas has to cover a large share (74%) of the demand for heat and power. Natural gas powered CHP plants produce 55% of the electricity and 58% of the heat. Hydro and wind power make up most of the remaining electricity production. All this covers merely 42 % of the consumption and Lithuania has a net import for the remaining 6739 GWh.

2.7.3 Planning

The National Energy Independency Strategy of the Republic of Lithuania published by the Ministry of Energy in 2012defines the main objectives of the energy sector in Lithuania. The strategy sets national targets for the implementation of strategic initiatives until 2020, as well as to lay down guidelines for the development of Lithuania's energy sector until 2030 and until 2050.

The main goal of this Strategy is to ensure Lithuania's energy independence before 2020 by strengthening Lithuanian's energy security and competitiveness. The goal for 2020 is to have sufficient capacity to satisfy internal energy demands (estimated at 12–14 TWh per year), and to be able to compete on EU energy markets. This will be done with new nuclear and renewable energy.

The Strategy outlines the plans for start-up of the Lithuanian-Polish power link LitPol Link 1 in 2015 and extension of the link in 2020; also the completion of the extra Lithuania-Poland cross-border power connection (LitPol Link 2), and the Lithuanian-Swedish power link NordBalt in 2015. This will contribute to the development of the Regional Baltic States' electricity market and its integration into the Nordic and Continental European Electricity Markets and give way for Synchronous interconnection of the Lithuanian, Latvian and Estonian electricity transmission systems with the European Continental Network of ENTSO-E.

The Strategy sets target for reduced heat consumption in households and public buildings by 30-40%. This combined with higher efficiency and better DH distribution networks, can allow a high share of RES in the heating sector. There is focus on a fair competition and transparent enterprises to optimize the socioeconomic profit and to lower the heating price for consumers.

As a short term solution to the energy dependency to Russia, Lithuanian government is building a LNG terminal in Klaipeda, carrying out preparatory works to construct an underground gas storage facility, and a Lithuania-Poland gas pipeline construction project is moving ahead. These infrastructural changes in combination with liberalizing the gas market will promote competition.

The price tag of the government put on the Strategy (including the assets of state-owned companies, EU structural funds and other international support) is 11–13 billion LTL, and an additional 11–14 billion LTL will be attracted from private investors. The investment will yield annual savings of 3–4 billion LTL, which is 3-4 % of GDP. It is estimated that each household will on average save 500 LTL per year on heating costs and that 5–6 thousand permanent work places will be created in the energy sector.

Further goals of energy system optimizing and sustainability are set for 2030 and 2050, after energy independence is achieved. In the period from 2020 to 2030, the Strategy aims at creating a competitive and sustainable energy sector. Lithuania will further enhance the energy sector infrastructure in order to fully support advancements in renewable energy production. By 2030, most of the energy produced from renewable energy sources and nuclear energy.

In the period from 2030 to 2050, the main priority of the Strategy is to further increase the sustainability of the Lithuanian energy sector. In this period, new breakthrough technologies will be selectively adopted, focusing on the sustainable and environmentally-friendly energy production and consumption. As a result, by 2050 Lithuania will be independent from imports of fossil fuel and produce its energy only from nuclear energy and renewable energy sources.

1.7.3 Legal and Regulatory Framework

The Lithuanian Law on Energy from Renewable Sources of May 2011 transposes EU legislations on the energy sector. The Law establishes the legal framework for administration, regulation and control over RES sector in Lithuania including system of FITs. The main objectives of the Law are:

- Ensure sustainable development of the RES sector:
  - Decrease consumption of fossil fuels;
  - Reduce GHG emissions levels.
- Decrease country's reliance on energy imports:
  - Increase energy security in Lithuania;
  - Increase the efficient use of local, renewable and alternative energy resources and the security energy supply.
- Promote and support research and application of innovative energy technologies;
- Ensure application of the EU Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

The Law sets the following mandatory energy targets to be achieved by 2020:

- 23% RES in gross final energy consumption
- 10% RES energy consumption in transport sector
- 20% share of electricity generated from RES
- 60% RES in Dh
- 80% share of heating from RES in households

RES capacity targets to be reached by 2020:

- Capacity of wind: 500 MW
- Capacity of PV: 10 MW
- Capacity of hydro:141 MW
- Capacity of power plants running on biomass: 105 MW.

Building Regulation

Directive 2002/91/EC EPBD was fully transposed into Lithuanian legal acts in 2006. The transposition of the recast EPDB and the national calculations of the cost-optimal levels of minimum Energy Performance requirements are successfully completed.

To ensure the quality of the energy performance in new buildings, a mandatory certification scheme was put in place in 2007.

Lithuania will, through the Programme for Modernisation of Multi-apartment Houses, and with support from the European financing mechanism JESSICA, continue to improve EE in buildings. An important part of this progress is information campaigns and educational programmes such as the Experts Training Programme for experts carrying out the Energy Performance certification of buildings. Lithuania intends to participate in the project BUILD UP skills supported through the Intelligent Energy Europe (IEE) Programme, to increase the number of qualified workers.

Price regulation

The National Control Commission for Prices and Energy (NCCPE) is an independent national regulatory authority regulating activities of entities in the field of energy and carrying out the supervision of state energy sector.

In Lithuania a regulator revises a tariff structure proposed by the DH company. NCCPE justifies costs and asset base for setting a 3-year tariff which is adjusted monthly and annually. DH price information that is authorized by NCCPE is constantly collected and published.

Feed-in-tariffs for CHP and RES

Guarantees of origin will be issued to the producers of electricity or heat from RES. After the political goals for capacities are reached, FITs will no longer be available.

Under the Law installations generating energy from RES are granted priority in terms of connecting to the national grid.

Emission Trading Scheme

The Law on Financial Instruments for Climate Change Management addresses the rights, duties and liability of the people engaged in economic activities resulting in greenhouse gas emissions as well as the sphere of competence of state institutions and bodies. The Law supports fulfilment of Lithuania’s obligation resulting from its membership in the EU and in the Kyoto Protocol.

Special Program for Climate Change: funds gathered through GHG trading system will be allocated to the program which will be responsible for management and distribution of the financial means for projects supporting end implementing EE, RES and reforestation, measures of adaptation and mitigation of climate change. Program also supports educational projects in previously enlisted areas.

Investment Grants

The establishment of the Lithuanian Environmental Investment Fund (LEIF) was foreseen in the Strategy for Environmental Protection of Lithuania that was adopted in 1996. Changed Statute of the Fund was approved in 2010.

The main goal of the LEIF is to support public and private sectors in realization of environmental projects and projects to reduce the negative impact of economic activities on environment in compliance with the Environmental Strategy of the Republic of Lithuania. RES technologies are eligible to benefit from the LEIF support. Budget of the LEIF is mainly supported by the revenues gathered via pollution tax (around 30% of the total annual budget).The fund supports investment projects in the form of soft loans and subsidies.

Subsidy is paid in two lumps of money. Firstly, 60% of the subsidy is paid to the applicant after purchase of the equipment, etc. The remaining 40% of the support is being paid to the beneficiary after a period of one year since the first transfer.

1.8 Norway

Fact book about Norwegian energy resources

The Norwegian Government states that it is important for the industrialized countries, including Norway, to demonstrate the willingness to take lead and reduce their emissions. In most cases, energy and climate issues are treated in the same legislations.

Although Norway is not a part of EU, Norwegian authorities have confirmed that the Renewable Energy Directive is also relevant to the European Economic Area (EEA), which includes most EU-countries and member states of the European Free Trade Association (EFTA), and that it therefore must be implemented in Norway. Through negotiations with the EU, Norway is committed to achieve a RES share of 67.5 % in 2020. Norway's RES share was 60% in 2005. In 2012 share of renewable energy was about 66 %

1.8.1 National Energy Policy

Norway has set ambitious targets for reducing greenhouse gas emissions. According to Norwegian commitments under the Kyoto Protocol, Norway may increase its CO_2 emissions in the period 2008-2012 by one percentage point compared to 1990. Within the Kyoto Protocol's first commitment period, Norway reduced the emission by an additional 10 % points, compared to the Kyoto commitments. In line with climate agreement in Parliament in 2008 and 2012, the Norwegian climate policy oriented towards the following overall objectives:

- By 2030, a binding goal for Norway’s carbon neutrality shall be in place. This will be as part of an ambitious global climate agreement in which other developed countries take on greater commitments.

- Until 2020 Norway will assume a commitment to cut global greenhouse gas emissions equivalent to 30 or 40[5] % of 1990 emissions.

[5]If an ambitious international climate agreement is achieved in which other developed countries also take on extensive obligations, Norway will undertake to achieve carbon neutrality by 2030. In fact, the European Union, Norway and Iceland have all explicitly stated that their ambition levels depend on the commitment showed by other countries and regions.

- Norway shall be carbon neutral by 2050 or 2030.
- Phase out the use of oil-fired boilers in households by 2020.
- 2/3 of emission reductions in 2020 will be domestic (the remaining 1/3 through flexible mechanisms).

There are no specific legislations that concern the environmental aspect of DH production. However, there are a number of political targets including:

- Reduced CO_2 emissions in Norway including waste incineration
- Increased share of renewables
- Reduced use of electricity in heating,
- Reduced total energy consumption,
- Utilization of waste heat and energy recovery from waste,
- Relieve power problems within power supply.

[6]Source: www.regjeringen.no

The targets are not necessarily compatible, as implementation of some DH technologies would fulfil some of the targets but counteract other. There is a general rule in the regulations that the evaluation of DH should be done on a system basis and include a consideration of which heat source the implementation of DH displaces.

1.8.2 Current Energy System

In Norway, roughly one quarter of the energy is consumed in the refining industry. The second biggest consumer group is private households followed by transport. The transport sector uses 56 % of the oil burned. The Norwegian Energy consumption is covered by 52.4 % RES, mainly from hydro power.

Table 1-11 Energy Balance in Norway 2011 [GWh]

	Fossils	Nuclear	Wind	Hydro	Biomass	Other RES	Total
TPES	186,871	-	1,293	120,836	16,813	5,377	327,233

6 http://www.regjeringen.no/nb/dep/kld/dok/lover_regler/retningslinjer/2009/planretningslinje-klima-energi.html?id=575764. http://www.regjeringen.no/upload/OED/pdf%20filer/22-konsesjonsrunde_2012/2012-0626_Handlingsplan_fornybardirektivet_250612.pdf

Power	7,350	-	1,293	120,836	407	1,291	128,107
CHP	209	-		-	722	1,755	2,687
Heat	663	-		-	960	2,332	3,954

The large share of hydro power makes a highly flexible power system and provides a low and stable electricity price. As a result, operations of CHP plants are mostly economically infeasible. Less than 2 % of the electricity produced in Norway is from CHP plants. The heat demand of 60 TWh is mainly covered by private installations as only 1 % of the Norwegian citizens are served by DH, and DH covers 7 % of the national heating demand. Biomass covers 13 % and includes mostly wood burned in domestic fireplaces and ovens. The remaining heat demand is covered by electrical heating, electrical boilers and electrically powered heat pumps.

District Heating

Although being a small market, the DH sector is growing and delivered 5 TWh in 2010. The produced DH is covered by a wide span of technologies where waste incineration is the largest, delivering 1.76 TWh in 2011, followed by biomass fuelled heat plants.

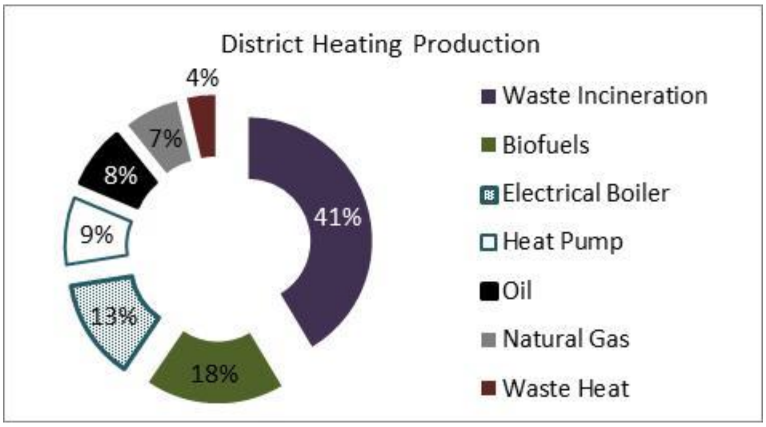

Figure 1-5 Source: IEA

District Cooling

Some DH companies with heat pump installations have also built parallel DC systems. Facilities in Lillestrøm, Bærum, Kristiansand, Moss, Oslo and Fornebu are examples of small systems that provide cooling from seawater.

Electricity

Norway has the second highest electricity consumption per capita in the world at 22.8 MWh per year per capita. This consumption is mainly related to the aluminium industry and used for space and water heating in buildings. Electricity produced in Norway, however, is almost entirely renewable, based on significant hydro power resources which deliver 95 % of the power. A natural gas power plant at Mongstad covers 3 % of the power production.

1.8.3 Planning

The government has imposed on local authorities to plan for future development towards a more sustainable and climate friendly energy system in their municipal area. The first planning period was to be completed 2009 and reviewed every fourth year. According to the Planning and Building Act, municipal areas should cooperate across local borders in this planning whenever it is beneficial to plan for large scale projects. Planning include specific goals for reducing emissions, documentation and publication of historical and current development of emission and energy usage, facilitate the participation of the private sector, and facilitate necessary infrastructural development.

1.8.4 Legal and Regulatory Framework

Building Regulation

There are two key regulations on energy use in buildings. One is the technical building regulations (TEK 10) that the requirements for EE and energy supply structures. The second is the regulation on energy labelling of buildings and energy assessment of technical systems (energy labelling regulations). TEK 10 states:

- It is not allowed to install oil fired boiler for fossil fuels for base load.
- Building of 500m² heated floor space or more shall be designed and constructed so that at least 60% of net heat demand can be covered with different energy than electricity directly or fossil fuels.
  - For all other building the requirement is 40%
  - There is made an exemption for buildings with a net heat demand of 15 MWh/year for the entire building complex.
- The demand for energy in the second and third paragraphs shall not apply if it is documented that natural conditions make it practically impossible to satisfy the requirement. For residential construction , the requirement for energy nor if the net heating is calculated to less than 15,000 kWh / year or requirement leads to additional costs of residential building life cycle.
- U-value for glass / window / door including frame / frame multiplied by the proportion of window and door of the building heated floor area should be less than 0.24.
- The total factor for glass / window (gt) must be less than 0.15 at south end facade, unless the building has cooling needs.

Total net energy for buildings shall not exceed the limits given in the following table:

Table 1-12 Energy budgets

Building Category	Total net energy (kWh/m²)
Small houses and holiday home of <150 m²	120 + 1600 / A
Apartment building	115
Kindergarten	140
Office building	150
School Building	120
University / college	160
Hospitals	300 (335)
Nursing	215 (250)
Hotel	220
Sports Building	170
Business Building	210
Culture Building	165
Light industrial / workshops	175 (190)

Buildings shall have the following qualities of energy:

Table 1-13 Building requirements

U-value exterior wall	W/(m² K)	≤ 0.22
U-value roof	W/(m 2 K)	≤ 0.18
U-value and flooring due to the open	W / (m 2 K)	≤ 0.18
U-value windows and doors including frame / frame	W / (m 2 K)	≤ 1.6
Leakage rate at 50 Pa pressure difference :		
Dwellings	h^{-1}	≤ 2.5
Other buildings	h^{-1}	≤ 1.5
Annual average temperature efficiency of heat recovery in ventilation systems:		
residential building,		≥ 70%
other buildings and areas		≥ 80%.

The Government has announced that from 2015 all new buildings have to be passive houses. Work on a new technical regulation began in the spring of 2013.

There are published two standards for low-energy buildings. NS 3700 contains criteria for passive and low-energy houses. NS 3701 contains criteria for passive and low-energy administrative buildings.

Energy Use

The municipality is under the Planning and Building Act given a central role in facilitating DH in buildings already in the planning process. A plan by municipal authorities determines future land use for the entire municipality. The municipality may impose an obligation to connect to DH infrastructure. This will apply to new buildings within the concession area for DH. This imposition does not apply for any DC systems. The municipality may grant full or partial exemption from the requirement to connect to the DH network, if it is documented that the use of alternative heating system is environmentally friendly.

Operators wishing to supply heat do not automatically have legal rights to connection to the DH infrastructure. It is a licensing requirement for DH systems with installed capacity of over 10 MW, but it is possible to apply for a license even for smaller plants. It is up to the players themselves to find agreements on a third party provider or third party access.

The Ministry of Oil and Energy has the authority to impose two DH providers to connect to a shared DH network, if this is possible.

Price regulation

In the Norwegian Energy Act it is stated that the price of heating shall not exceed the price of electric heating in that area. [3]

Competition on Heat and Power Sector

As TSO, Statnett shall ensure a balance between production and consumption of power at any time. Statnett is also responsible for an economically efficient operation and development of the national transmission grid, including transmission connections abroad. The geographical landscape in Norway and the associated bottlenecks in the transmission grid cause large differences in cost to the consumer which is counteracted through equalization scheme to balance grid cost between the costumers.

To prevent utility companies exploit their natural monopoly, the government has established a comprehensive monopoly control, regulating networks' activities. The aim is to secure users privileges, facilitating the smooth functioning energy market and an efficient operation and development of the network. Utility companies, which primarily derive its revenue from tariffs for the transmission of electricity, shall establish transmission tariffs so that the unit's actual income over time is not higher than what the Hydro- and Energy Directorate allows.

The Protection Plan for Water-courses protects certain water resources from hydro power.

Green certificate

Norway is part of a Norwegian-Swedish electricity certificate market, which will contribute to increased production of RES. Sweden and Norway have set a goal to increase power generation from RES by 26.4 TWh by 2020, equivalent to the electricity needs of more than three quarters of the end use in all Norwegian households combined.

Emission Trading Scheme

To reach Kyoto targets Norway is a part of the EU's CO_2 quota trading scheme also including UN quotas, meaning CDM- and JI projects. Companies can only use a limited amount of such allowances in the EU emissions trading system. Norwegian corporations that are subject to quotas are obligated to report to the Ministry of Environment who determines whether the corporation is entitled to free allowances.

Carbon Tax

Carbon taxes differ from one fuel to another and the highest tax is put on gasoline, jet fuel and diesel. Tax rates vary from approximately 3 €/ton CO_2 equivalent for natural gas to about 50 €/ton CO_2 equivalent for gasoline. It is given tax exemption, reimbursement or subsidies to biodiesel in mineral oil and bio ethanol in gasoline.

1.8.5 R&D

The Research Council of Norway Public administers most research funds for low-carbon energy, in accordance with the Energy 21 strategy.

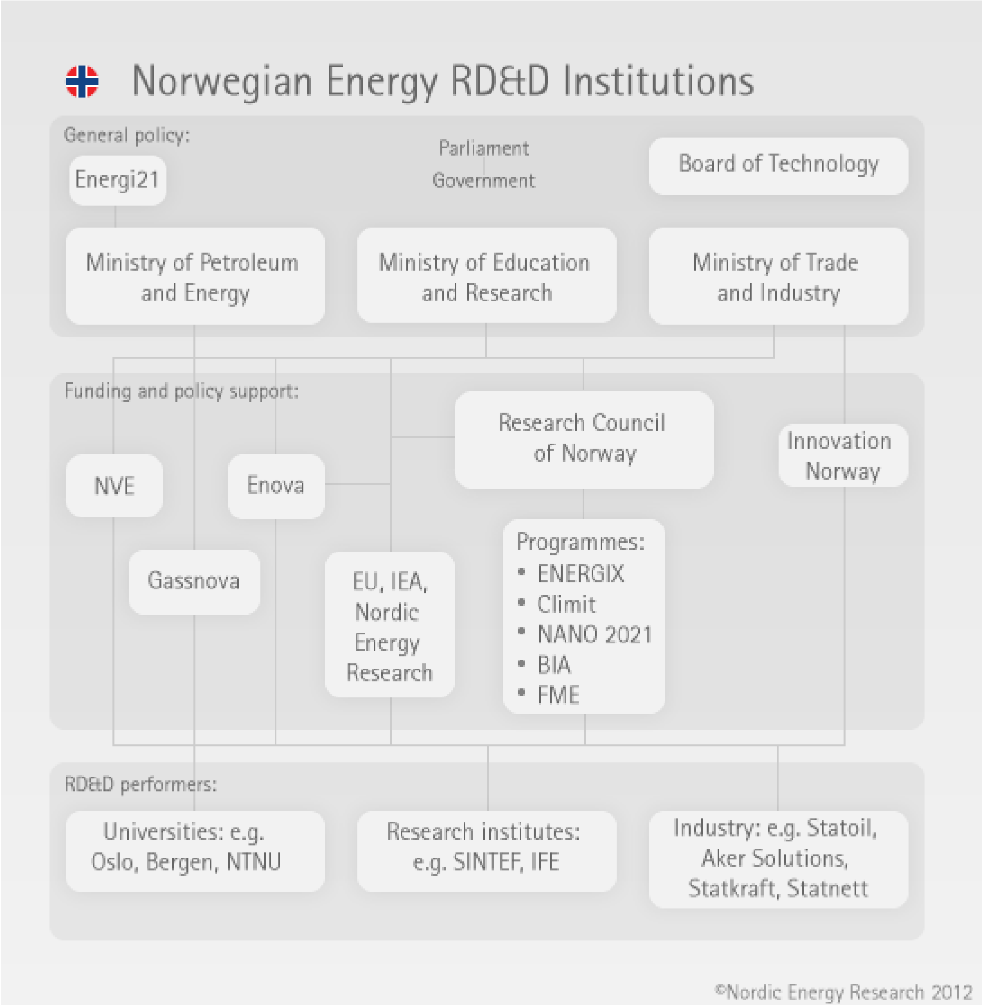

Figure 1-6 *Source: Nordic Energy Research*
http://www.nordicenergy.org/thenordicway/country/norway/#key-institutions-in-the-funding-of-low-carbon-energy-rdd-in-norwa

Norwegian public low-carbon RD&D support has seen a drastic increase since 2003. Innovation Norway, Enova, Gassnova and Transnova fund and support demonstration-, research- and development projects. Emissions and energy use in the transport sector is treated by Transnova. Gassnova manages the area of Carbon Capture and Storage (CCS).

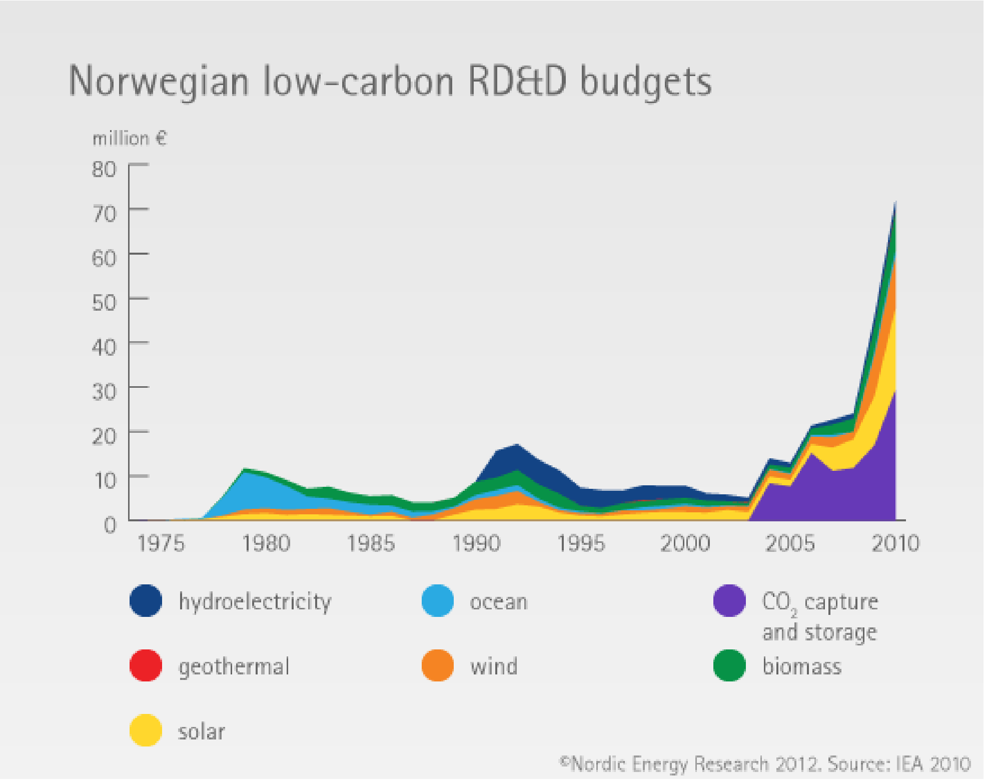

Figure 1-7 *Source: Nordic Energy Research* http://www.nordicenergy.org/thenordicway/country/norway/#carbon-capture-and-storage-high-on-the-agenda

Carbon capture and storage have seen significant support, building on the country's expertise in oil and gas extraction, and the potential for storage sites in the off the Norwegian coast. The project includes retrofit of CO_2 capture at a natural gas-based combined cycle power plant at Mongstad that produces 280 MW electricity and 350 MW heat. The project have tested two post-combustion technologies: chilled ammonia and amine-based capture. Operating cost of the plant is currently estimated to be about 250 million annually. The research project has cost over 7.2 billion NOK. The full-scale CO_2 capture project at Mongstad was terminated in September 2013 and replaced by a program for CCS. The Parliament is invited in the state budget for 2014 to adopt the goal of realizing at least one full-scale CO_2 capture project by 2020 and that the government ensures economic and other conditions that can trigger at least one such project in Norway.

Investment Grants

Developers of RES projects, both private households and corporations, may apply for financial support, primarily through Enova who manages the Energy Fund. The Energy Fund is financed by consumers via a small additional charge to electricity bills. Enova provided programs and support schemes to evoke energy saving and new RES production.

Up until 2010, Enova contracted energy production of 3.7 TWh to DH. If other heat projects are included, Enova has facilitated for an energy production of 4.7 TWh. It has been pledged 2.5 billion NOK in funding for heating projects.

1.8.6 Heat Consumer

Under the Energy Act no detailed requirements for temperature of delivered heat are provided, but it is a condition that heat received by customers at any time must have a temperature sufficient to cover the agreed functions for the customer.

The licensee is obliged at all times to meet the “N-1 requirement”, i.e. the largest unit from falling out of operation without incurring the plant cannot meet the demand power requirements

1.8.7 Ownership

The Norwegian Water Resources and Energy Directorate (NVE) is responsible for the administration of Norway’s water and energy resources. The Industrial Licensing Act states the principle that the country's hydropower resources belong and shall be administered for the benefit of the public. This will be achieved through public ownership of the state, county and municipal levels. In accordance with Industrial Licensing Act, there is given new licenses for rights to waterfalls, and licensing for further transfer of existing licenses only to government assigns. Private companies may own up to one third of the capital and voting rights in a public company that owns waterfalls, provided that the organization is such that it obviously is a public ownership. Hydropower plants can be rented for periods up to 15 years.

The licenses for hydropower provided by Industrial Licensing Act and the Watercourse Regulation Act set conditions for reversion. This means that the water fall and power plants go to the state free of charge at the end of the concession period. The reason for the condition at issue has been to safeguard the public interest in terms of ownership and management of water resources. Reversion after 60 years from the date the license is imposed most privately owned power plants, while the concession of public companies were given indefinitely without conditions on reversion. Today, the publicly owned power plants produce about 90 % of the power in Norway.

The Operator licensed to deliver DH services must own the DH systems, as well as to build and operate the facilities. Rental agreements established previous to the legislation date are not affected by the law.

Research Programmes in a report from the consulting Xrgia claimed that the development of the national grid is the only way to ensure reliable power supply in the Oslo region forward. - The report underestimates the potential for increased use of DH, according to Norwegian District Heating Association.

Xrgia consultancy was commissioned by Statnett assessed the extent to which EE, energy conversion and load management can be alternatives to the further development of the national grid in the Oslo area. The report has been commissioned as part of the cooperation project between Statnett and Hafslund called "Grid Plan Greater Oslo ", whose goal is to create a plan for the development of the national grid in the area until 2050.

The report concludes discouraging for DH, and states that the importance of DH is minor when compared to improving grid connection, and electricity transfer capacity to Oslo.

SINTEF Energy came to quite different conclusions in a study on power situation in the Oslo region from 2007. SINTEF report shows that without the use of DH in Oslo periods of cold and low reservoir will lead to forced rationing, as was the case in 2010.

NORSRTAT: Nordic power road map 2050 objectives:

› Build knowledge and understanding about possible carbon-neutral futures for an integrated Nordic power system.

› Develop a qualitative scenario analysis of impacts on the electricity, the transport and the heating system combined with the necessary governance aspects to enable the transformation.

› Build and disseminate knowledge about the Nordic region in the time perspective up to 2050.

1.9 Poland

Energy is one of the priorities on the policy agenda in Poland. The government has made commendable efforts over the last years to comply with the EU requirements and to develop a solid energy policy framework. *Energy Policy of Poland until 2030* (hereafter referred to as EPP 2030) set particularly significant challenges to the energy sector while requiring huge investments and an adequate policy and regulatory framework. Poland also has considerable EE potential in production, distribution and end-use consumption, partly stemming from the times of the centrally planned economy.

Energy intensity of the Polish economy has improved considerably since1990s, when it was twice as high as the IEA Europe average. By year 2009, as the overall energy intensity of the IEA countries has improved, the Polish energy intensity had dropped significantly to become only 22.5% higher than the IEA Europe on average.

2.9.1 National Energy Policy

Polish energy policy is driven mainly by EU directives and regulations. In particular, Poland had to liberalise its gas and electricity markets in line with the EU directives. Also, as part of the EU “20-20-20” goals, the following targets have been set for Poland for 2020:

› limitation of greenhouse gas emissions in the sectors not covered by the EU-ETS to 14% above the 2005 level (binding);

- reduction of energy consumption by 20% of the projected 2020 levels (non-binding); and,
- Increase of the share of RES to 15% of gross final energy consumption (binding).

Another driving force for Poland's energy policy is high dependence on Russia for energy imports. In 2012, for instance, Poland imported 82% of its natural gas from Russia.

The key policy document, *EPP 2030* was adopted by the government in November 2009. The main objective of the EPP 2030 is to enhance the country's energy security by observing the principle of sustainable development. The key directions of Polish energy policy are:

- to improve EE;
- to enhance security of fuel and energy supplies;
- to diversify the electricity generation structure by introducing nuclear energy;
- to develop the use of RES, including bio fuels;
- to develop competitive fuel and energy markets; and
- to reduce the environmental impact of the power industry.

As an Annex to the *EPP 2030*, the government adopted an *Action Plan for 2013–2016* outlining measures needed to meet the energy policy goals, as the second consecutive action plan.

The *EPP 2030* includes ambitious targets on EE and greenhouse gas mitigation. Poland has put in place market-based schemes (tradable certificates) providing incentives for developing RES and CHP, and is developing a similar support system for EE. There is also a strategy for increasing the production and use of both bio fuels and biomass. Efforts are being made in improving EE and establishing energy standards in the building sector.

In March 2012, however, Poland was the only member state to veto the EU's 2050 low carbon roadmap. Zero carbon emission is not considered as the ultimate aspiration of Polish public opinion, while energy security from Russia is. Moreover, Poland has not fully transposed the Renewable Energy Directive (2009/28/EC) (RED) as the government has not come to agreement on a Renewable Energy Act. Further, Poland has not fully transposed Directive 2009/30/EC on fuel specifications and quality monitoring into national law.

2.9.2 Current Energy System

District Heating

Due to the central planning history, a large share of total energy is used for heating. About 40% of population (if this information relates to people it should be 40% if all heat purposes it should stay 50%) is served by DH. Poland has about 20 000 km of DH networks. The installed heat generation capacity was over 58.1 GW_{th} in 2012.

Poland has taken many steps to modernise its DH systems. This includes installation of heat meters in individual buildings and improvements in customer services. However, many challenges remain. CO_2 emissions from the heating sector are high because of the predominant use of coal. In many municipalities, heat distribution networks are still of poor quality, and heat losses are high. The government plans to achieve emission reductions in the DH sector through a wider use of CHP.

There have been and still are projects going on in the DH network modernization through replacement of group substations with individual ones and concrete pipelines with preinsulated ones. Moreover, to some old substations the new service of domestic hot water is added.

Drop in demand for heat supplied has been experienced due to low-energy buildings, thermo-modernization and rationalization of heat consumption of existing buildings, and due to lack of marketing attitude within the DH companies. There has been little or no proactive approach in searching for new clients in many DH companies.

A possible threat to DH is loss of competitiveness. The raise in price of heat may be caused by the necessity of modernizations due to emission standards law and EU policy for CO2 reductions). Due to weakened competitiveness, set up of small individual heat sources and disconnections from DH networks may materialize. Challenge for the future is to build new heat sources to make generation more efficient and to build new installations on gas and biomass. New installations should be CHPs (in accordance to Energy Policy of Poland: doubling the energy from CHP, replacing heat only boilers with CHP).

District Cooling

There are some individual DC installations in industrial applications such and in mines (coal and copper) and in some industrial buildings, but not under DH and CHP branch. Nevertheless, several DH companies plan introduction of DC: Kogeneracja in Wroclaw, GPEC in Gdansk, and Dalkia together with PGNiG Termika. So far the technical aspects are tested but profitability is still questionable.

Also the DC business would be regulated by the Preseident of URE (the Energy Regulatory Office), as DC also would need a licence. The existing DH and CHP companies have a licence already, which does not specify the temperature of the provided water. Therefore, the same licence may be applied to DC as well.

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Electricity

In 2012, Polish electricity generation reached 162 TWh. Since 2000, it grew only modestly, at about 0.9% per year, less than the rate in demand for electricity. Usage of bio fuels in power production is rather negligible, but is expected to grow to some 20 TWh by year 2027.

Almost 85% of the power plant capacity of 37.2 GW in total is based on coal and lignite fuels. More than half of the production capacity is at least 30 years old.

Poland plans to introduce nuclear power by 2024. By 2035 there will be 2 nuclear power plants operating with combined capacity of 6 GW (4-6 units).

CHP is rather extensively used in Poland. Some 17.3% of total electricity and over 60% of heat comes from CHP. According to the government and industry, there is economic potential for further increasing the use of CHP in Poland. Inefficient heat-only boilers that provide over a third of heat in DH systems in many cases can be economically replaced by more efficient modern CHP systems including nuclear units in northern Poland.

EPP 2030 stipulates a doubling of electricity produced from highly efficient CHP 2020. To implement this ambitious target, the government has adopted a Programme for the Development of Co-generation in Poland to 2030. This programme aims at identifying the CHP potential and developing new mechanisms for CHP support.

RES

The share of RES and waste in Poland's total primary energy supply (TPES) has increased steadily over the last years, from 5.1% in 2003 to 10.8% (10.64 Mtoe) in 2012. In 2012, 92.9% of the total RES supply came from biomass and waste and smaller amounts came from hydropower (2.0%), wind power (4.7%) geothermal and solar power contributions being negligible.

The latest achievements of RES expansion have been by 2012:

- the RES capacity grew by 1334 MW (growth of 43 % as compared to 2011);
- the installed wind capacity reached 2497 MW,
- biomass power plants 821 MW,
- biogas plants 131 MW,
- hydro energy - 966 MW

Biomass is used in two processes: incineration in plants designed for biomass only and co-firing biomass with coal. Utility power plants burn yearly some 6.1 million t of biomass (2011).

Agro-fuel plantations and the market develop slowly (due to lack of long-term contracts with farmers and support for bio energy crops) but it does not cause difficulties with obtaining the required amounts of biomass in future. Nevertheless incineration of significant quantities in large installations is questionable due to transport costs.

Energy from waste starts to develop, there are several projects planned to be realized in next 3 years.

The Polish government has taken commendable steps towards reaching the country's RES targets: 15% of gross final energy consumption until 2020.

The share of RES in TPES is expected to double by year 2020 to the level of 13.8%. The greatest absolute growth is expected in biomass, increasing its contribution by 6.4 Mtoe between 2009 and 2020.

2.9.3 Planning

Local communities are required by law to develop local energy plans that would identify least-cost options of providing energy services to households, including heat, electricity and gas supply. They are required to pay special attention to CHP and utilisation of waste heat. This obligation has not been properly enforced, and only a small number of municipalities have developed such plans. App. 40-50% of the municipalities do not have any such plans and the plans that exist are of various quality. Even if the plan exists it does not have the status of the local law, so the investor is not obliged to obey it.

There are also other challenges faced by municipal energy planning as follows:

› There are problems related to network built in the past on the land that is not owned by DH company. The problems relate to the access right and claims for compensations by the current land owners.

› Since 2008 under new law (Civil Code) the servitude of transmission can be established – so far the practice concerning fees for this does not exist.

› The problems are caused also by the big amount of lots through which the network goes; the question of perpetual usufruct is not solved. Most of the networks were built before 1990 when the ownership rights were not taken into account. Now the majority of network needs to have their legal status sorted out.

› Investment barriers related to network planning: long bureaucratic procedures, right for the owners of land to protest, lack of current maps, difficulties in establishing who owns the land (last one can be as much as 80%)

› Urban planning regulation so far is not favourable for the DH development. According to Act- Energy Law – there is an obligation to connect the facility (building) if the heat demand is above than 50 kW to district heating network.

2.9.4 Legal and Regulatory Framework

Building Regulation

Poland introduced new, more stringent, building codes in 2008. Since January 2009, new buildings are obliged to fulfil technical requirements whereby installations for water heating and space heating, cooling and ventilation should be designed and installed in such a manner that the quantity of electricity and heat consumed will be at rationally low levels. However, enforcement of buildings' energy performance standards is often weak.

Moreover, new buildings represent only a small share of the total building stock, so their contribution to the overall EE improvement is still limited. By law, the building codes must also be applied when buildings are refurbished but this requirement is not always implemented in practice. According to the Action Plan for the Years 2009-2012 of the *EPP 2030*, minimum standards for EE of buildings are to be increased in 2010/11.

Furthermore, with the objective of complying with the EU directive, as of January 2009, all buildings that are newly constructed, that undergo major refurbishment, that are sold or rented out must have an energy performance certificate. However, these certificates have not proven yet to be a significant factor in decision making about buying or renting housing. Quality and reliability of information contained in the certificates should be improved, and public awareness about their use should be increased. New public buildings will have to meet this requirement by the end of 2018.

Regulation has been amended in 2013 which partially implement the provisions of Directive 2010/31/EU on the energy performance of buildings, introducing as from 1 January 2014 more stringent requirements for new buildings. The main aim of the changes is reduction of the amount of energy required to cover the energy demand of buildings. Provisions of the new version of the technical conditions requirement regulation came into force from 1 January 2014. At the same time, the Regulation provides that the requirements for PEF, demand for non-renewable primary energy and the U coefficient (heat transfer coefficient) will consistently increase with the beginning of years 2017 and 2021.

In 2009 coal was still the dominant fuel in buildings, accounting for 26% of final energy consumption, mainly for water and space heating. Gas and DH accounted for about 16.5% each, electricity for 20%, oil and renewables (mainly biomass) and waste for 10% each.

The National Centre for Research and Development (NCBiR) implements a strategic project "Integrated System for Reducing Energy Consumption in the Maintenance of Buildings" with a budget of PLN 30 million (EUR 6.9 million) over 2010-2013. NCBiR manages ten other EE projects within the existing funding tools.

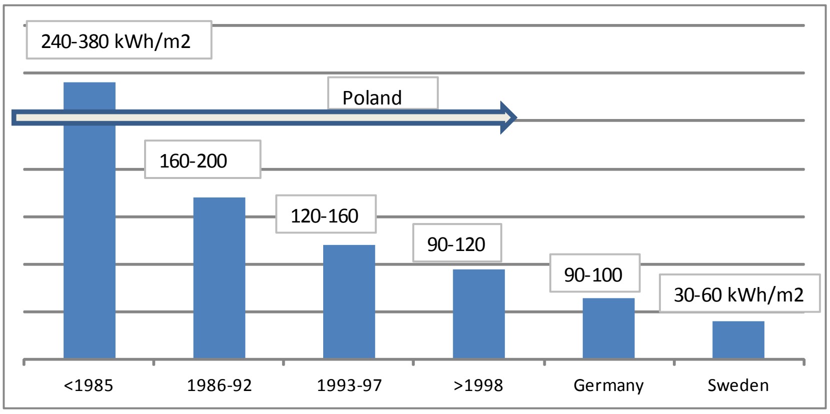

Figure 1-8Specific heat energy consumption in residential buildings in Poland, Germany and Sweden (kWh/m²) Source: Energy Policies in IEA countries, Poland 2011 Review, IEA.

Price regulation

End-user electricity prices are not regulated except for household tariffs which are still subject to approval by the President of Energy Regulatory Office (URE). The government plans to completely phase out the electricity price regulation.

Regarding the end-user price regulation in gas and DH sectors, URE still approves tariffs for all consumer groups. URE also regulates transmission and distribution of electricity, DH and gas.

As regards heat sector, URE approves DH tariffs according to the “cost-plus” methodology, i.e. the tariff covers all justified costs. According to Polish tariff regulation not only the justified costs but also justified return on capital employed in the heat supply activity may be included into planned revenues of the heat company. In April 2013 URE published *Model for rules and methods of including the return on capital (costs of capital) in the heat tariffs for the years 2013-2015*. The Model was implemented in 2013 and is monitored on regular basis. In case of any improprieties it will be subject to amendments.

Competition on Heat and Power Sector

The Polish electricity market was fully opened to competition on 1 July 2007, in accordance with the EU directives.

The significant development of competition in electricity market could be observed in the last few years. In 2012 the number of commercial transactions carried out through the power exchange constituted as much as 61.8% share of the volume of electricity sold by the generation companies. The significance of bilateral contracts has diminished (they constituted in 2012 almost 33% of all forms of wholesale trade, whereas in 2010 this index amounted to 89.8%).

There are also intensive works ongoing aimed at creating competitive gas market as well as promoting competition in the heating market. The *EPP 2030 introduced* a number of short-term measures to enhance competition in the electricity and gas markets.

Feed-in-tariffs for CHP and RES

Poland's current RES policy is based on the system of certificates of origin which is more market oriented than FITs. Consequently, investors' calculations of future profitability and payback period are less certain.

Nevertheless, there are other privileges for CHP and biomass. The DH system operators are legally obliged to buy heat from renewable energy installations and CHP connected to their DH network in an amount not exceeding the demand of customers connected to this network.

Emission Trading Scheme

Poland is an active member of the ETS of EU.

To fasten development of the RES expansion, the Polish government introduced the system of tradable Renewable Energy Certificates ("Green Certificates"). In 2012, energy companies that sell electricity to the end-users were required to redeem certificates representing 10.4% of the total volume of electricity they purchased in a given year (or pay substitution fee). There is a penalty fee for failing to purchase and redeem the required amount of certificates that effectively serves as the upper ceiling for their price.

The green certificate share is steadily growing, and projected to reach 20 % in 2021.

To stabilise the certificate market, Polish authorities are establishing a price floor equivalent to 75 percent of the substitution fee. The system is being expanded to include certificates with different colours symbolising other desirable ecological activities such as cogeneration at small plants.

Carbon Tax

Carbon tax is not used in Poland

Investment Grants

The Polish Government supports the production of energy from renewable sources by:

- Investment incentives for producers of RES (system of differently coloured certificates);
- Obligating default suppliers of electricity to purchase electricity from renewable sources;
- Priority access to the transmission grid for producers of RES;

- Exemption of electricity generated from RES from the excise tax;

- Decreasing by 50% the fee for connecting small installations (<5 MW) to the grid. These type of installations are also exempt from the licence fee and the annual fee paid by licence holders;

- Co-funding investments in clean energy under the National Fund for Environmental Protection and Water Management (NFOŚiGW).

1.9.1 R&D

Stimulating technology uptake and innovation, including in the energy field, is one of the government objectives that is described in the National Development Strategy 2007-2015 and the National Strategic Reference Framework 2007-2013.

In 2011 National Research Programme was approved by Polish Government. The Program defines national priority directions of research and is one of the main instruments facilitating the implementation of science policy.

Programme identifies following 7 national priority research areas:

1) Energy
2) Health – new drugs
3) ICT
4) New materials
5) Environment and agriculture
6) Society in sustainable socio-economic development,
7) Safety and defence

The main focus of this Programme in energy area is energy efficiency, renewable energy and CO_2 emissions reduction. It covers new energy sources (including shale gas and nuclear energy) as well as the traditional energy economy based on coal, gas and renewable sources. Also included are materials science, electricity distribution and the modernisation of the national electricity grid. Due to Poland's important domestic resources of hard coal and lignite, low-emission coal technologies including gasification are strongly supported.

Priority research areas are implemented by strategic research and development projects that are managed by two executive agencies: the National Centre for Research and Development (industrial research) and National Centre for Research (basic research).

For example Ministry of Science and Higher Education finances large research project "Advanced technologies for energy generation". The project is concentrated on innovative usage of coal and renewable energy and refers to the European Union 3x20% targets. The support for this project is near PLN 300 million and the total budget is PLN 360 million for 2010-2015.

Polish partners are active in many European initiatives and projects in the field of energy innovation. In Poland is located KIC *InnoEnergy Poland Plus* which is one of six European Knowledge Nodes created by the Knowledge and Innovation Community *InnoEnergy*.

The *EPP 2030* identifies "diversification of technologies" as a tool for enhancing energy security. It highlights the need to deploy modern technologies in the electricity sector and to enhance innovation efforts in most other sectors – from natural gas and DH to EE.

R&D organizations dealing with DH, CHP and RES comprise the Silesian University of Technology (*Politechnika Śląska*, Gliwice), AGH University of Science and Technology (Krakow), the Czestochowa University of Technology; Gdańsk Technical University, Krakow University of Technology, Technical University of Łódź; Warsaw University of Technology, Wrocław University of Technology, Poznań University of Technology, the Polish Academy of Sciences, Institute of Chemical Coal Processing (Zabrze) and the Institute of Power Engineering (Warsaw).

2.9.5 Heat Customers

All DH customers are metered on the building level.

The customer basis in terms of heated floor area continues expand, but the heat sales have fallen year by year due to thermo-renovation of existing buildings, and the new buildings being energy efficient.

2.9.6 Ownership

The Ministry of Treasury plans to privatise – fully or partially – a number of electricity companies, while retaining controlling shares in PGE.

Most of over 460 licensed DH companies are under municipal ownership but some of them, for instance, such as in Warsaw, Lodz and Poznan (Dalkia), Gdansk (Stadtwerke Leipzig GmbH), Czestochowa and Wroclaw (Fortum), Opole (E.ON) and Katowice (Tauron Group) are run by private or foreign operators.

Municipalities as owners of many DH companies are in bad financial condition and are not willing to participate in commercial bank loans desired by their DH companies. The creditworthiness of many DH companies is low in order not to be able to borrow alone. Therefore, DH rehabilitation precedes slower that desired.

2.9.7 Best Practices

MPEC Krakow, the municipality owned DH company in Cracow, offers an excellent example of rehabilitation of the DH system as well as organizing competition between the two main heat sources, CHP Krakow and CHP Skawina.

1.10 Russia

1.10.1 National Energy Policy

The new Energy Strategy of Russia until year 2030 endorsed by the Russian Federation Government (Ordinance #1715-r) in November 13, 2009 sets the strategic goals of developing DH supply in particular as follows:

› To achieve a high level of comfort in residential, public and industrial premises, including a quantitative and qualitative rise in the bunch of heat supply services (heating, cold supply, ventilation, conditioning, hot water supply) matching the high level of leading European countries at affordable costs;

› To ensure a drastic rise in the technical standard of heat supply systems based on innovative, highly efficient technologies and equipment;

› To slash non-production losses of heat and fuel;

› To ensure the manageability, reliability and efficiency of heat supply;

› To reduce the negative impacts on the environment.

Energy conservation in heat supply will be pursued in the following key directions:

› In heat production, efforts will be taken to raise the efficiency of boiler units, central heating and other plants based on modern fuel burning technologies, CHP, boost thermal capacity utilization ratio, develop distributed heat generation systems involving renewable sources of energy in heat supply, enhance technical standard, automation of small heat sources, fit them out with heat metering and regulation systems;

› In heat transmission systems, efforts will focus on reducing heat losses and leaks of water as a result of remodeling heat supply networks based on prefabricated pipelines and automatic control systems;

› In heat consumer systems, emphasis will be put on heat metering and controlling, erecting energy efficient buildings.

These efforts are expected to result in reduction in DH network heat losses from 19% to 8 - 10 % by the end of 2030, which will ensure the saving of no less than 40 million tons of reference fuel.

The projected development of heat supply will call for pushing through measures such as forming a competitive heat market, supporting efforts to create advanced Russian equipment manufacturing, updating management of these systems, and lending support on the part of the state and regional government parts in order to provide necessary investments in the DH sector.

In the first stage in the Strategy implementation it is essential to draft and begin consistently enacting a set of program measures to drastically upgrade heat supply by means of:

- Creating favourable conditions for attracting private investments in heat supply, including efforts to employ a method of economically warranted return on the invested capital;
- Optimizing a system of tariffs (transition to obligatory application of two-tier tariffs, application of long-term tariffs under bilateral contracts) by meeting the interests of both producers and consumers of heat;
- Drafting mandatory requirements to the equipment being produced and used as well as to raising the EE of buildings;
- Employing in a reasonable manner instruments of state support and using this practice also within the framework of private-public partnership (PPP).

The second stage in implementing this Strategy is expected to show large-scale remodelling and re-equipment of key facilities, including economically justified replacement of DH networks and network equipment in regions. De-centralized (individual) heat supply systems, including those using renewable sources of heat, may see large-scale development at the new technological level. A heat market will be created, and the relations between its actors will be streamlined.

At the third stage the DH supply is expected to reach high levels of energy, economic and ecological efficiency. The DH sector is expected to ensure a high level of heat comfort for the population matching the development level of countries with similar natural-climatic conditions (Canada, Scandinavian countries).

In technical terms, the Strategy promotes modern DH and CHP development by nominating:

- Mini size CHP plants of module type;
- New heat generation and distribution systems to reduce energy losses;
- Modularized combined gas and steam cycle CHP plants with electric capacity of 100 MW to 170 MW and electric efficiency factor of 53% to 55%;
- Condensing heat recovery boilers fuelled by gas;
- Production of equipment and automatic systems for control and management of heat consumption
- Low-temperature DH systems with demand driven control properties and decentralization of peak-load heat production capacities;

› Substations both for DH and DC for large social and industrial heating and cooling customers;

› Automatic monitoring systems for large DH systems;

› Upgrading technologies for industrial production of preinsulated pipelines and closing valves with automatic drives.

According to the Strategy, the role of heat only boilers (HoBs) will decline due to expansion of CHP systems (gas turbines with waste heat recovery boiler). By year 2030, the share of heat produced at the existing HoBs plants will shrink from 43% (2005) to 35%. This cap will be filled by gas turbine driven CHP units and autonomous plants.

The following key tasks need to be tackled to achieve the strategic goals of the sector development:

› To develop heat supply of Russia and its regions based on modern economically and ecologically efficient CHP plants of a wide range of capacity;

› To spread the CHP applications in forms of steam-turbine, gas-turbine, gas-piston and diesel plants to medium and small DH systems;

› To ensure optimal combination of centralized and de-centralized heat supply with heat zoning;

› To tap to the maximum extent the potential of geothermal energy industry to provide heat supply to isolated regions rich in geothermal sources (the Kamchatka Peninsula, Sakhalin Island, Kuril Islands);

› To develop thermal power centralized-distributed generation systems with various types of sources located in areas of heat consumption;

› To upgrade CHP plants operating modes with a view to scaling down the condensation cycle and to increase operation in CHP mode;

› To modify the structure of heat supply systems to include rational combination of redundancy, automatic control systems and measuring instruments as part of automatic monitoring over normal and emergency operation modes;

› To remodel CHP plants, boilers, DH networks, pursue thermo-hydraulic adjustment of regimes, boost the quality of construction-and-installation and repair work, execute on-line monitoring measures, supply consumers with both stationary and mobile heat supply plants as reserve and (or) back-up sources of heat supply;

- To work out regulatory-legal base ensuring effective interaction of heat producers, organizations involved in its transmission and distribution, as well as consumers in commercial market conditions.

The share of heat-only-boilers is expected to drop from 49% to 40% by the end of 2030.There are a few nuclear power plants operating in CHP mode in Russia. According to the current strategy, no more CHP type nuclear capacity will be erected.[7]In addition to the latest Strategy, during 2007 – 2008 the Ministry of Energy has developed “roadmaps” of heat supply business development in Russia. Major provisions and objectives of these roadmaps are contained herein in order to demonstrate general direction of heat supply business development, which will be observed by federal energy authorities, as follows:

- Transformation of heat supply into an effective business sector in the Russian economy. Establishment of heat supply processes’ management system, including scientific research, design, technology and equipment, development and operation of DH market;

- Creation of long-term municipal energy plans and heat supply schemes including determination of economic heat transmission distance, heat supply centralization degree, back-up capacity reservation as well as possible fuel switching in the DH systems;

- Development of appropriate heat market models, change of institutional framework of contract relations between market actors with strong involvement of municipal governments;

- Change of planning (zoning and indicative planning) and tariff formation approaches, introduction of municipal standards of heat supply services and follow-up of their functioning, change of heat supply investment support systems;

- Defining the residential organizations as DH customers. Separation of two types of heat supply services – provision with heat resources and provision of heat comfort: temperature, humidity, continuous running of warm water, etc.;

- Creation of funding for modernization investments in heat supply systems and in enhancement of buildings’ EE;

- Transition, where practical, to consumption based billing and adjustment of heat consumption standards for those customers, who do not have heat meters;

- Corporatization of municipal DH enterprises and actively attracting private heat supply companies, having maintenance companies as operators of rural heat supply systems;

- Transition to economically differentiated tariffs on heat nodes with consequently removed of cross-subsidies;

[7]Ms. Marina Velikanova, Feb. 17, 2011

- Transition from "costs plus" tariffs to stable boundary tariff levels corrected on the basis of established "price formula" and formation of heat "tariff menu" for final consumers;

- Development of the "Menu of Technical and Management Solutions" on modernization and reforming of heat supply systems; and,

- Creation of intellectual heat supply systems through the development of:

  - automation of heat generation, transmission and distribution processes in accordance with customer's requirements, securing of reliability and service quality;

  - remote control and management of municipal buildings; and,

  - database of the entire heat supply business.

There are estimates that the development of the DH systems will require US$ 70 billion during 2003-2030, equal to US$ 2.6 billion a year and such funds will be collected from the budgets of the oblasts and municipalities, heat sales to customers and from investors (Energy Charter, 2004). It has been estimated by the officials that the investment value will reach the level of RUR 10,500 billion by year 2020, equivalent to US$ 370 billion[8].

1.10.2 Current Energy System

Currently, statistical data on a number of sectors, such as buildings, heating, and transport is virtually nonexistent. Therefore, estimates had to be used.

District Heating

DH covers 70-80% of the housing stock in Russia. In Russia alone, there are some 50,000 DH systems (Bashmakov, 2004). Some 60% of the Russian population have DHW supply from DH. In Russia's centralized heating systems, about 55% of the heat supply is produced by heat-only boiler plants and 44% is produced by CHP.

The high market share equals to a population of almost 100 million heated by DH systems in Russia.

The bulk of DH service comprises two products, SH and DHW, both of which are distributed with four-pipe networks from the group substations to apartments. DHW is heated either at the heat source (open systems) or at the group substations (closed systems), the latter one being the governing one.

[8] On measures to implement the Law on Energy Conservation and on enhancing energy efficiency,Moscow,Dec. 3, 2009,Deputy Director O.P. Tokarev, Department of state energy policy and energy efficiency.

Typically, DH is distributed by means of 4-pipe systems, group substation with and without heat exchangers for SH and in most cases with DHW through heat exchangers. The hydroelevators (jet pumps) are common in mixing the primary side supply water with the secondary side return at the constant mixing ration in order to provide secondary side supply water meeting the heating norms.

Heat metering depends on the type of customers. Often heat metering exists at commercial and industrial customers in large and medium cities, but not in small towns. According to the Ministry of Energy, 29% of buildings have heat meters (with a larger share in government buildings). However, unofficial estimates at times indicate lower numbers (Ministry of Energy 2012). For example, estimates by the Russian Center for Energy Efficiency (CENEf) made several years ago found that only 10 percent of residential buildings had meters. The difference may partially reflect the push to install meters in recent years, and significant regional differences in metering rates prevail. Nonetheless, the Law on Energy Efficiency No. 261 of November 2009 and its regulations require residents to install meters, and metering is likely to further increase in the future. Residential customers are mainly metered in Moscow but rarely elsewhere in the country. However, heat metering is expanding due to the new Heat Law. In Khanty –Mansisk, for instance, all new buildings will be equipped with heat metering both on building and apartment level. In practice it means that there are two heat meters in each building entrance, one for room space heating (SH) and the other one for domestic hot water (DHW). The same approach with two meters is used in apartment entrances as well. In old buildings, on the other hand, customers have started to install heat meters individually as a way to reduce their heating costs.

The market of the DH systems is declining. The outdated DH systems require major rehabilitation in order to become competitive in case the heating market fully opens for competition.

The results of the previous energy strategy until year 2020 have been unsatisfactory. Over the past period the technical situation in the DH sector has worsened despite of the adoption of a whole array of progressive decisions that, however, were not backed up by appropriate organizational and financial measures. For instance, during the past period the wear-out indicators (fully amortized) of key heat supply facilities rose from 65% to 70%, the length of the DH networks shrank by 7% equivalent to some 14,000 km, losses in DH networks increased from 14 % to 20%, and electricity consumption of DH pumping increased to 10 kWh/GJ.

The core problems are:

› The unsatisfactory technical condition of DH systems, which is characterized by the high wear-out rate of key facilities, particularly heat supply networks and boilers, the inadequate reliability of operation, large energy losses and polluting impact on the environment;

› The need to make heavy investments to ensure reliable heat supply and concurrently curb a rise in the cost of services;

› The need for the entire heat supply system to undergo institutional restructuring to get out of the economic crisis and operate successfully in market conditions.

In 2007, the DH/CHP systems in Russia comprised 500 CHP plants and 65,000 boiler houses connected to the end users by means of 200,000 km of DH networks. The heat deliveries were approximately 6,100 PJ (1,700 TWh), some 30% of which were produced by CHP, 45% by heat-only-boilers and the balance of 25% by industrial and other sources[9]The housing statistics was not available. Therefore, the heated area had to be estimated by using 229 kWh/m^2, based on the CENEf study and what was typical in Poland in early 90'ies as well as well 20% of produced heat lost in the network. The estimate yields the magnitude of 5.9 billion m^2 heated floor area connected to the DH systems.

Most of Russia's boilers fall short of the best international energy intensities. One may use as the international benchmark of 95% efficiency for gas-and liquid-fuel boilers and 85% efficiency for coal-fired boilers. These efficiencies are consistent with the efficiency of boilers operating in Western Europe. Official reports on Russian boiler efficiency show the efficiency of DH boilers at 80.3%, and small boilers at 81.6%.[76] Russia's boilers are likely less efficient than official statistics suggest. Energy audits conducted by Russia's Center for Energy Efficiency (CENEf) cast doubt on the accuracy of the official figures[10].

District Cooling

For the time being, there are no DC systems in Russia.

Electricity

Russia's CHP plants operate at a level of EE well below that of most technologies used internationally. In condensing mode, the gas-fired and liquid/solid fuel fired CHPs abroad typically operate at 51% and 46-48% efficiency levels, respectively. On the other hand, Russia's gas-fired and liquid/solid fuel fired CHPs currently operate at 39%and 36% efficiency levels, respectively. Therefore, efficiency advantages of Russian CHPs over international modern condensing plants are minimal[11].

RES

Russia plans to develop it RES share from the current 1% of the primary energy consumption to 4% by year 2020.

1.10.3 Planning

Traditionally, integrated resource planning has worked rather well in Soviet Union and resulted in comprehensive and integral DH and CHP systems. In the soviet era,

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[9] IEA: CHP/DH Country Profile: Russia, The International DHC/CHP Collaborative.
[10] CENEf/WB/IFC, 2008
[11] CENEf/WB/IFC 2008

however, the economy was neglected, and therefore, construction of the DH and CHP system has used excess materials and operation excess fuel consumptions. Updated IRP based on real economic facts would result in optimal refurbishment programs.

There has been little combined energy and urban planning so far, and therefore, sometimes DH has expanded to areas which may not have been economic in the long term. As a result of financial problems of the companies, the total network length has shortened in the past decade. Customers have been likely switched to gas heating in low heat load density areas and the outdated DH networks sections of poor quality have become idle. The new Strategy emphasizes zoning of the areas for centralized and decentralized energy systems. The new Federal Law "On Heat Supply" lays emphasis on heat supply schemes development for the settlements, and gives priority to the CHP heat. All heat supply schemes are to be approved by the Regional governments or Ministry of Energy (for settlements with population exceeding 0.5 million). Heat schemes development as a part of integrated resource planning should be aimed at energy savings and energy improvement.

1.10.4 Legal and Regulatory Framework

Building Regulation

The average space and water heating intensities in Russian buildings are much higher than what could be achieved. The Russian average heating energy intensity for multi-family, high rise buildings is 229 kWh/m^2/year. The heating energy intensity for new, multi-family high rise buildings in Russia is 77 kWh/m^2/year of heat.[52] Rehabilitating existing housing stock can yield energy intensities of some 150 kWh/m^2/year.[12]

The greatest potential to improve the efficiency of final energy consumption lies in Russia's residential, commercial, and public buildings, where EE investments could save up to 68.6 mtoe per year. Energy use in buildings (144.5 mtoe) has been directly responsible for more than one-third of energy end-use in Russia. Two-thirds of the potential energy savings in this sector can be achieved through the reduction of DH use for existing space heating and hot water customers.

Price regulation

The tariffs are below the real costs, but still there is a large affordability problem in paying the heat bills. The regulator hesitates to raise the tariffs in order to avoid larger social problems to emerge. On the other hand, though, higher prices would make the rehabilitation investments profitable, that would reduce the need of price increases.

Under the current regulatory framework, the following approaches for tariff setting can be applied:

[12] CENEF/WB/IFC 2008

- Cost regulation (cost of service regulation): Under this scheme the tariff will be approved each year in accordance with the (justified) costs of heat supply. Cost increases due to investment measures will only be considered if they have been approved in advance. The regulatory period for this approach is one year. Another tariff check can be requested if a cost item (such as fuel) has increased by at least 15%, but cost increases lower than that will not be considered.

- Indexation method: A baseline tariff is approved for a period of three years. During this period cost items can be increased according to the respective input prices. As under the cost of service regulation, additional cost caused by a non approved investment program will not be considered.

- Investment cost method: A surcharge on the baseline tariff, which is determined according to method a) or b), can be approved to cover the additional costs caused by the investment program. The regulatory period is 3-5 years with annual adjustments.

- Method of comparison of analogs: a method applied to a setting long-term parameters of regulation, based on comparison of indicators of activity of the organization which are carrying out adjustable activity with the similar indicators of other organizations comparable to it on economic and technical characteristics (has never been used in Russia yet).

- The first method is a typical cost of service approach, which does not provide any reasonable incentives to improve the efficiency and performance of the DH system.

The first method is a typical cost of service approach, which does not provide any reasonable incentives to improve the efficiency and performance of the DH system.

The second and third method can be seen as examples for an incentive regulation. They allow the investor to retain profits for cost saving measures for a period of up to three years.

The third method is definitively the preferred one for investors. As it is only a surcharge, it has to be combined with one of the other two methods. However, the surcharge will allow the investors a reasonable payback of their investments within a certain period of time.

Besides justified costs, the tariff may also include a profit. For the profit margin, the DH company may suggest a proportional surcharge upon the expenses. The regulator then may decide whatever profit can be justified, based on the real expenses and the previous year performance of the DH company. Basically, there is also a risk that the regulator will reduce the tariff if the costs due to reduced employment and losses have dropped much and are not sufficiently compensated by the repair fund and depreciations.

Based on the latest heat tariff booklet[13] there is an energy based heat tariff in terms of RUR[14]/GJ of sold heat energy. The tariff, however, has been traditionally used on normative basis: the produced heat energy has been allocated to the heated floor area connected to the system and the number of registered people living in apartments, without heat metering. Based on the already installed heat meters, however, the heating service provider is forced to apply the heat energy fee directly in metered consumption based billing.

An important aspect of incentivizing efficiency is the tariff structure. The Russian Law on Heat Supply provides for three types of tariffs (Russian Federation 2010):

› Cost-plus, based on reimbursing suppliers for the cost of running heat systems with a fixed percentage of profit built in, which operators must use to pay for upgrades (capital depreciation and maintenance are not fully covered in the allowable tariff-basis costs).

› Return on investment, which allows operating expenses and longer-term (3-5 years) investments to be included in the rate basis. Payback and return on invested capital within a specified period are also included.

› Tariff indexation, similar to a price cap, when prices are set to cover the costs of the preceding year multiplied by an index set by the central government that reflects change in specific conditions, such as rising fuel cost or deviation of the fuel cost from the expected.

A fourth tariff type, benchmarking, was recently introduced in the law. It allows prices to be compared to peer suppliers of heat, and in theory, should promote efficiency. However, the supporting regulation has not been developed for this tariff to be effectively used.

Tariff structures also affect end-users' motivation to save. If customers receive satisfactory service, they know are paying a reasonable price for what they consume, and feel a degree of control over their bills. Therefore, they are more likely to pay their bills, consume rationally, and not seek alternative heat supply options. Similarly, consumers will be more motivated, if their bills are based on their actual consumption, rather than estimates, fixed fees, or norms of consumption. Among the positive developments in Russia is the new legislation that requires consumer bills to be more transparent and detailed.

The commercial interface with customers is cumbersome at the moment. Expanding heat metering combined with consumption based billing and one-tier tariff effectively motivate customers to save energy, thus reducing heat sales. Moreover, the current tariff may be based on underestimated network losses, and after metering completed, the company has to pay for the excess heat losses, thus also reducing the income from heat sales. In both ways the revenues of DH services will fall faster than the costs, which will lead the DH company to serious

[13]Analiztarifnovoregulirivaniateploenergetyki v. 2007 poystanovleniotarifovna 2008, issued by administration of Khanti-MansiskAutonomusOkrug in year 2008.
[14]RUR – Russian Ruble

financial problems. Such an experience has been demonstrated by some DH companies in Poland about ten years ago. The only remedy was to introduce a two-tier heat tariff and set the level to cover the real costs. The commercial interface also requires effective collection practices to be adopted.

Regional Energy Committee sets the final tariff (as well as general price caps for heat from CHP). The regulator tries to keep the heat tariffs at low level in order to protect the customers, the voters, and to follow political decisions of Federal Government.

Competition on Heat and Power Sector

On the power sector, competitive market conditions prevail.

On the heating sector, on the other hand, there is already some little competition since DH has lost customers, probably prosperous ones, to gas heating. In general, however, but DH is in the monopolistic position in the urban areas where DH exists already. The same monopoly applies on new urban areas to be built.

Green certificate

There is no national green certificate system in Russia.

Emission Trading Scheme

There is no national emission trading in Russia.

Carbon Tax

There is no carbon related tax in Russia but only VAT is applied to energy products.

Investment Grants

There is FIT neither for CHP nor RES in Russia.

The existing legislation has made possible to invest in electricity and heat generation, but the effect of such investments has been very low, especially on the housing and communal sectors.

The Federal and local project beneficiary budgets to support the US$ 270 billion investments in EE by year 2020 amount to US$30 billion US$34 billion equivalent, respectively. The balance of US$206 billion is expected from other sources: mainly from investors and international financing institutions[15].

1.10.5 Ownership

In Russia, the boiler houses and DH networks and usually the DH substations, as electricity distribution networks and all other infrastructure, are basically under municipal ownership.

[15] O.P. Tokarev on Dec. 3. 2009 in Moscow.

A problem is the divided corporate responsibility between heat transmission and distribution, which hampers holistic optimization of the integral DH/CHP systems. In the distribution side in particular, there prevails poor heating specific know-how, because the staff has to take care of all facilities related to buildings and courtyards, heating as one of many.

The DH companies are operation and maintenance organization whereas investment decisions and financing is carried out by the municipality, the owner. Billing and collection is often carried out by the municipality together with other utility bills, and sometimes by an intermediate billing company, but not by the DH company.

The border of responsibility in heat supply between the DH company is usually the outlet valves of the group substations (Ufa and Taganrog, for instance), but sometimes the DH company owns the secondary networks until the building entrance (Bashkirenergo, for instance).

The indoor piping is sometimes owned by the customer but usually maintained by the municipal service company regardless the ownership.

There are private companies involved in DH (and CHP) rehabilitation and operation. Such companies are Bashkirenergo, the Finnish Fortum (TGK-1[16] partly and TGK-10 wholly) and the French Dalkia, for instance. The latter one has a joint venture with TGK-4. In all TGK systems there is DH production and transmission included.

There is no third party access in energy production. However, the Energy Strategy until year 2030 suggest legislative support to the transparent and non-discriminatory arrangement of access for all market participants to energy infrastructure (trunk pipelines, electricity and heat supply networks) and tightening anti-monopoly legislation to preclude cartel collusions and technological monopolies.

The investor has no rights on heat tariffs and a little influence on the collection rate, which makes it difficult to invest in DH. The situation should improve as the new heat laws are going to be promulgated.

Synergy allocations

The CHP plants (energo's) do not have heat sales directly to end-users but to heat distribution companies (teplosets). Teploset has the option to use the heat-only-boiler or to buy heat from energo. In such a case the CHP heat shall be cheaper than the total costs of the heat-only-boiler.

[16] TGK – Territorial power generation company

1.10.6 R&D

Below, some key research projects carried out in the research organisations in St Petersburg area are summarised[17].

1. Development of heating supply systems within in St. Petersburg

The objective of the project is to carry out development of heating supply systems in St. Petersburg, collect the required start-up data, arrange for public hearings and approve heating supply systems of St. Petersburg in compliance with current legislation and regulations of St. Petersburg and the Russian Federation.

The study shall involve study of heating supply system within the administrative boundaries of St. Petersburg, including all sources of heat supply both operating and under design, of heat transmission and distribution networks, pumping stations, central heating units. The study covers 14 (at least) CHP sources, 726 (at least) boilers, trunk and heat distribution network with the length of 7 800 km (at least) of single-tube lines, including central heating stations and pumping stations.

The work shall be carried out in six stages from the data collections up to public presentation of the results.

The project will be carried out during 2013 - 2015. By November 2013, the research organization was not selected yet.

2. Internal corrosion in outdoor heating supply systems and ways to reduce it

The research project is being carried out in terms of the Comprehensive Program "Science. Industry. Innovation" in St. Petersburg for 2012-2015", as approved by the Decree number 835 of the Government of St. Petersburg on June 28, 2011 and the Resolution № 883 of the Government of St. Petersburg on June 30, 2010 "On awards of the Government of St. Petersburg to the winners in the competition on business ideas, scientific and technical development and research projects, under the motto "Young, Bold, Forward-Looking."

The objectives of the Project are to study the heat losses of DH pipelines from the heat source to the consumer and determine the ways of reducing losses.

Under the research project the study of the coefficient of thermal conductivity of modern thermal insulation is being carried out now, evidence from liquid ceramic thermal insulation RE-THERM. To study the coefficient of thermal conductivity of the thermal insulation material, analytical and experimental methods are used.

The analytical method involves gathering and compiling technical characteristics of different types of insulation, and their comparison analysis.

For the comparative analysis of the thermal characteristics of various thermal insulation materials, the most widely used insulation materials were selected: poly urethane foam, poly mineral foam and liquid ceramic insulation.

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[17] A.E. Erastov appointed by Nuorkivi Consulting, November 2013

Experimental method involves determining the coefficient of thermal conductivity λ in the pilot facility, by the "pipe method". During the experiment the temperature at the tube surface and the surface of thermal insulation are measured in different thermal conditions of the pipeline. The dependency of λ values of on the temperature of the wall is identified.

Temperature at the non-insulated pipe wall is measured by chromel-copel thermocouples, while the temperature at the pipe surface is measured by a contact thermometer and an optical pyrometer.

The obtained values of the coefficient of thermal conductivity enable us to determine the scope of liquid ceramic thermal insulation applications and to develop practical recommendations for the application of this type of insulation in design and reconstruction of heating supply systems for Project and Service Companies, as well as to develop recommendations for reducing heat loss in the coolant in the heating supply systems.

The novelty of the project is a developed option to reduce heat losses in heating supply systems by using new modern liquid ceramic thermal insulation.

The project has started in 2012 and is ongoing at St. Petersburg State University of Architecture and Civil Engineering.

3 Creating an intelligent system for monitoring and management of energy consumption with predictable metrology resource in buildings and facilities

The study was conducted in terms of the federal target-oriented program "Research and development in priority directions of scientific-technological complex of Russia for 2007-2013". The objective of the project was to develop scientific and technological solutions in order to create high-tech intelligent automated systems that ensure maximum efficiency of heating supply systems and to increase comfort level of various buildings and facilities in terms of reduced power consumption.

The research developed the principle of priori data application, which meant to create models of the premises and to set control algorithms based on such models; created a model of an intelligent system for monitoring and management of energy consumption including load forecast; developed software systems, drawing sketch of the design documentation for the model of the system; developed programs and methods of experimental testing of software for monitoring and energy management of energy consumption in buildings and facilities. Experimental studies of the model were conducted.

The model was designed and made. The model consists of hardware and software parts. The hardware of the system model includes measurement channels of standardized electrical signals and information- processing sub-system for the software part of the system. Experimental tests of the model were made. The model software was debugged. The program documentation was developed.

The study was done by 2012 in the "Saint Petersburg Electro-technical University "LETI" named after V.I. Ulyanov (Lenin)" (SPbGETU).

4. Increase in technical and economic characteristics of combined cycle gas turbine power plants by means of recovering low-grade heat in heat pumps

The objectives of the project was to research and develop low-grade heat utilization schemes in heat pumps (HP) that allow an increase technical and economic performance of the combined cycle CHP plant.

In order to achieve this goal the following objectives were set:

- A comparative analysis of the low-grade heat sources (LGHS) in the CHP plant was performed.
- Schemes allowing to recover heat from the most relevant LGHS by means of HP were developed and tested.
- Analytical dependencies that allow defining the boundary conditions for the HP application in the CHP with HP were developed.
- Mathematical models of the CHP with HP for various solutions were developed, that enabled to investigate changes in characteristics of their heat efficiency through the use of HP, and recommendations for the optimal recovery of low-grade heat were offered.

Thermodynamic analysis of power plants, mathematical modeling and technical and economic calculations were used.

The research was completed n 2012 in the "Saint -Petersburg State Polytechnic University" (FGBOU VPO "SPbGPU")..

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1.11 Sweden

1.11.1 National Energy Policy

Sweden's energy policy is stipulated by two government Bills (2008/09:162 and 163) from year 2009. The bill on I**ntegrated climate and energy policy** (*En integrerad energi- och klimatpolitik)* sets ambitious targets to support and even exceed the 20/20/20 objectives of the EU, as sustainable policy measures for the environment, competitiveness and long-term stability. The targets are allocated to short and medium as well as long term priorities as follows:

The short- to medium-term targets for 2020 are as follows:

› 40% reduction in greenhouse gases (GHGs) or about 20 million tonnes of carbon dioxide equivalent (Mt CO2-eq), compared to 1990, to be achieved outside the European Union Emissions Trading Scheme (EU-ETS) with two-thirds in Sweden and one-third by investments in other EU countries or the use of flexible mechanisms;

› at least 50% share of RES in the gross final energy consumption;

- at least 10% share of RES in the transport sector; and
- 20% more efficient use of energy compared to 2008.

The long-term priorities are:

- by 2020, Sweden aims to phase out fossil fuels in heating;
- by 2030, Sweden should have a vehicle stock that is independent of fossil fuels;
- Sweden is committed to develop a third pillar in electricity supply, next to hydro and nuclear power, with increased co-generation, wind and other renewable power production to reduce vulnerability and increase security of electricity supply; and
- by 2050, the vision is that Sweden will have a sustainable and resource-efficient energy supply with zero net emissions of GHGs.

Sweden considers natural gas as a transition fuel in industry and CHP. With a view to implement the priority of a fossil-fuel independent future by 2030, a committee has been created by the government to present concrete proposals on how Sweden can reach the 2030 decarbonisation goal.

The Environmental Agency of Sweden, supported by the Swedish Energy Agency and other national authorities, presented a proposal for a Climate Roadmap in December 2012. The roadmap identifies scenarios for achieving the long-term 2050 priority and is to be adopted in the course of 2013. The long term priorities comprise:

- by 2020, Sweden aims to phase out fossil fuels in heating;
- by 2030, Sweden should have a vehicle stock that is independent of fossil fuels;
- Sweden is committed to develop a third pillar in electricity supply, next to hydro and nuclear power, with increased co-generation, wind and other renewable power production to reduce vulnerability and increase security of electricity supply; and
- by 2050, the vision is that Sweden will have a sustainable and resource-efficient
- energy supply with zero net emissions of GHGs.

Sweden is well on track to meet its 2020 targets for the reduction of greenhouse gases (GHGs): average 2008-11 emissions are below 1990 levels and Sweden's target under the Kyoto Protocol and the EU burden-sharing target.

In 2009, Sweden decided to annul the nuclear phase-out and to allow for the replacement of its nuclear reactors at the three existing sites at the end of their operational lifetime.

Commendably, Sweden has opened the door to an additional option to shape the transition to a low-carbon economy. Nuclear power currently supplies about 41% of domestic electricity production. Greater certainty is however needed as to if, when and how nuclear capacity can be replaced by other production modes by 2030.

Sweden has strengthened the demonstration and market deployment of energy technologies, such as smart grids and second-generation bio fuels, fostered by a special demonstration funding, a soft loan programme and the new CleanTech Strategy, which are promoting innovative enterprises, innovation clusters and supporting technology incubators with the aim to facilitate the development and deployment of clean technologies.

The Swedish EE model relies on the voluntary measures and commitment of local and regional authorities, such as the work of the 14 regional energy agencies, the local energy and climate advisors, and the co-operation with industry, services and academia in research, development and demonstration (RD&D).

Sweden is the IEA member country with the lowest share of fossil fuels in its energy mix (without nuclear). The average share in IEA member countries was 81% in 2011. Sweden's share of coal accounted for 4.1% and natural gas for 2.4%, compared to the IEA average of 20% and 25% respectively. Oil accounts for the lion share of the fossil fuels supplied to Sweden, amounting to 25.3% of TPES and 78.2% of all fossil fuels.

1.11.2 Current Energy System

District Heating

DH emerged in Sweden in the 1950s. Since the 1970s, there has been a major transition towards the use of renewable fuels leading to considerable emissions reductions. In 2011, DH supply accounted for around 54 TWh, produced mostly from wood fuel and other bio fuels (39.2%), waste (18.2%), mainly renewable organic waste, peat (3.8%) and waste heat (6.1%). Oil, natural gas and coal have minor shares.

The supply of waste has increased over the past decade, and in some Swedish cities, heat from waste incineration forms the basis of DH.

At present, there are 200 DH companies active in the market. The Swedish DH network accounts for 23 000 km.

District Cooling

DC has been introduced in the 1990s and is mainly used for air conditioning in offices, shops and industrial processes. In 2010, 31 companies provided DC on a commercial basis with supplies of 871 GWh.

Electricity

Sweden's electricity supply is almost carbon-free already, as it is dominated by hydro and nuclear energy. Compared to the other IEA member countries, Sweden has the second lowest share of fossil fuels in the electricity mix, after Switzerland. Amongst the Nordic countries, Iceland, of course has even lower a carbon dependence than Sweden. In 2011, total electricity generation in Sweden amounted to 150.5 TWh, which is an increase of 1.3% from 148.5 TWh in 2010.

Electricity from solid bio fuels and wastes accounted for 12.8 TWh or 8.5% of the country's total electricity generation in 2011. Growth in wind power generation has been significant since 2009, accounting for 6.1 TWh or 4% of electricity supply in 2011, an increase from 3.5 TWh in 2010 and 1.4 TWh in 2007.

RES

Sweden converted the EU Renewable Energy Directive 2009/28/EC to two main legal acts adopted by the Swedish Parliament in 2009, the government bill *Genomförande av direktiv om förnybar energi* (Implementation of the Directive on Renewable Energy) and the government bill *Hållbarhetskriterier för biodrivmedel och flytande biobränslen*(Sustainability criteria for biofuels and bioliquids).

Under the EU directive, Sweden agreed to a binding overall target for a share of RES of the gross final energy consumption of 49% to be achieved by 2020 as the EU target is 20% for the all member countries on average. The Swedish figure is the highest target in the EU and can be explained by the fact that Sweden has the highest share of RES among the EU member states, having amounted to 40% of gross final consumption in 2005.

In 2011, 35% of total energy was supplied by RES sources, well beyond the IEA average of 8%. This growth from 28% in 2006 was mainly the result of increased use of solid biofuels and onshore wind power in recent years. In gross final energy consumption, Sweden reached a share of 48% of RES in the gross energy production.

In 2012, bio fuels and waste accounted for around 64.2% of RES supply. This is largely the result of increased use of bio fuels in electricity and heat production as well as in the pulp and paper industry. The use of bio fuels in the DH sector, for instance, has increased more than fivefold since 1990.

Sweden is already well ahead of the indicative trend set for Sweden in the Directive, reaching a share of renewables of 47.8% in 2010 and 48% in 2011, and is up well on track to achieve at least 50% by 2020. The share of renewables in the electricity sector was around 56% in 2010, and for heating and cooling around 65% in 2010. For the period up to 2020, Sweden's RES development forecast lies above the indicative trend set in the Directive.

1.11.3 Legal and Regulatory Framework

Building Regulation

Sweden's environmental quality objectives call for the reduction of energy consumption in the building sector by 20% in 2020 and 50% in 2050. The majority of the multi-storey buildings were built in the 1960s and 1970s. Approximately half of the non-residential building stock in Sweden is owned by the public sector. As the construction rate of new buildings is low, the contribution of new building construction to the EE target is rather negligible.

In 2012, Sweden adopted an upgraded building code to require new residential, public and commercial buildings and buildings undergoing deep renovations to consume no more than 90 kWh/m² in the southern climate zone and 130 kWh per m² in the northern climate zone. Residential and commercial buildings when heated with electricity must not consume more than 55 kWh/ m² in the southern climate zone and 95 kWh /m² in the northern climate zone.

Sweden promotes awareness of EE in the buildings sector, *e.g.* through the website www.energiaktiv.se, to educate the public on how to improve EE in buildings. In line with EBPD, an energy performance certificate (EPC) is required for large buildings with public functions or whenever a building is sold, rented or constructed.

Demonstration projects for low-energy and zero-energy buildings are under way. In 2010, Sweden launched the five-year financial support programme (LÅGAN) for the construction of buildings with very low energy consumption (at least 50% lower than current regulations require). LÅGAN is a co-operative effort between the Swedish Energy Agency, the Swedish Construction Federation, the Region of Västra Götaland, Formas, the National Board of Housing, Building and Planning, private-sector clients, contractors and consultants. The total budget for LÅGAN amounts to EUR 6.9 million, with the Swedish Energy Agency providing EUR 2.4 million and the other partners financing the balance.

Price regulation

There is no national price regulation in Sweden. Therefore, there are significant differences in the price of DH. The price in the most expensive municipality is more than twice the price in the cheapest. These price differences are due to the factors such as various ownership structures in the DH companies, different profitability requirements, fuel allocation to power and hear in CHP systems as well as climatic conditions surrounding the DH systems.

The 2008 DH Act introduced negotiated pricing, information and reporting obligations, with the Energy Markets Inspectorate acting as supervising authority and a DH Board charged with mediating prices and access to the distribution network. However, the sector fails to deliver the adequate choice for the consumer and competition on the heat production side. Between 2006 and 2011, DH prices increased by 18%, while switching DH suppliers remains very limited in practice, as the customers' choice depends on where they live.

Competition on Heat and Power Sector

The government considers energy markets with effective competition, efficient use of resources and efficient pricing as the fundamental basis for its integrated climate and energy policy.

In the power sector, given the joint- and cross-ownership of generation assets, competition issues are a continuous concern of the Swedish authorities. In several investigations the Swedish Competition Authority highlighted the risk of collusion due to structural ties between producers. This particularly concerns nuclear generation. Investigations were not conclusive, but a code of conduct and an independent surveillance group were set up by the government in 2010 to monitor the nuclear power companies. This group of independent observers attends board meetings.

As of 1 January 2011, following the amendment of the Competition Act, the Swedish Competition Authority has the power to examine and intervene against distortions of competition which might occur when a State, municipality or county council carries out sales activities on competitive markets.

The electricity market reform in 1996 required, however, DH to be operated on a commercial and competitive basis. The reform initiated a change where many municipality-owned companies passed into private ownership. Between 1990 and 2004, around 70 municipal energy companies with DH operations were sold to private companies but since then privatisation has halted.

The current regulations stipulating DH operations mean that only the owners of a DH network have the right to access the network. As a consequence, the possibility of introducing third-party access (TPA) has been investigated. The TPA investigation (SOU 2011:44) proposed to open up the DH networks for access to competing producers and suppliers. Where competition arises, a distinction between the various operations of distribution, production and supply should be made. A reason behind legislated third-party access is to help open up the DH market to have more waste heat supply from industry. The TPA investigation however found that it was unclear how DH prices would be affected if the legislative proposal was adopted. The cost of realising these objectives relative to the energy and environmental goals has not been investigated.

In March 2012 the Swedish government rejected the proposed TPA legislation and instead proposed four measures to strengthen the position of consumer and industrial waste heat suppliers in the DH market given the difficulty of achieving effective competition in this market. The four measures are:

› the introduction of a price-change test to protect customers from unreasonable price hikes;

› the regulated access for residual heat suppliers and other heat producers;

› the accounting for residual heat potential in the design of new DH production; and

› the equal treatment of customers in the same customer group.

These regulations should protect consumers from unfair rate hikes and lead to greater efficiency and in the long run benefit customers. The new rules have not yet entered into force, as legislation is being prepared by the Energy Markets Inspectorate and the Swedish Energy Agency.

Green certificate

Sweden is another part of a Norwegian-Swedish electricity certificate market, which will contribute to increased production of RES. Sweden and Norway have set a goal to increase power generation from RES sources by 26.4 TWh by 2020.

Sweden and Norway signed a legally binding treaty (29 June 2011) on a common market for electricity certificates which started on 1 January 2012 and will last until the year 2036. The Swedish Parliament approved the agreement on 30 November 2011 and the Norwegian Parliament, Stortinget, on 12 December 2011. On 20 December 2011.

Emission Trading Scheme

As a member state of the EU, Sweden is covered under the regime of the EU-ETS cap-and trade system which was set up in 2003 for the implementation of the Kyoto Protocol by Directive 2003/87/EC and started in 2005.

Sweden increased the budget for purchasing emissions reductions from CDM/JI projects – a cost-effective way of reducing emissions.

Carbon Tax

Commendably, the country has been making the polluters pay by means of a CO2 tax and energy tax for decades.

In 1991, the carbon dioxide taxation was introduced in addition to the already existing energy tax on fossil fuels. Sweden has the world's highest CO2 tax imposed on the non-trading (non EU-ETS) sectors and households/services. There are certain tax breaks to Sweden's domestic industries. High energy taxes on fuel and electricity as well as high CO2 taxes on fossil fuels effectively steer demand through environmental signals, putting an implicit price on carbon, while at the same time providing state revenue.

Heat production in CHP (within the EU-ETS) saw the introduction of a 30% energy tax and 7% CO2 tax, while other heat plants are taxed with a 100% energy tax and a 94% CO2 tax. In the 2013 Budget Bill the government proposed to abolish the CO2 tax for CHP heat production.

Investment Grants

Besides the certificate system, Sweden currently provides investment subsidies to solar PV and innovative biogas, which are still in the early phase of their development in Sweden. Investment subsidies are granted for innovative biogas projects, mostly for the production of biogas which could be fed into to the gas grid or used for transport. The government proposed to Parliament to prolong the support for solar PV and biogas until the end of 2016. The government has also assigned a public investigation to propose how a system for net metering for household's micro generation (solar PV systems and wind generators for households) can be introduced.

Until 2009, the climate investment programmes (LIP and KLIMP) granted subsidies to municipalities for ecologically sustainable and environment friendly CHP projects. Around 260 projects were supported in the DH sector. Support continued under the programme "Sustainable Cities" until the end of 2012.

Between 2006 and 2010 investment grants for conversion from oil or direct electric heating to DH, ground source heat pumps or small-scale bio fuel installations could be obtained. The grants for conversions from direct electric heating totalled around SEK 455 million for the whole period, of which 75% was allocated to DH conversions. Around SEK 450 million was paid to conversions from oil heating (2006/07), and around 20% went to DH installations.

1.11.4 Ownership

In Sweden, electricity generation assets are owned by four large companies: Vattenfall AB, E.ON Sverige AB, Fortum Power and Heat AB, StatkraftSverige AB. The State owns through Vattenfall approximately 40% of the country's total power generating capacity, non-Swedish owners account for 40%, Swedish municipalities for around 12% and others for roughly 8%.

The three largest electricity generators, Vattenfall, Fortum and E.ON Sverige together accounted for 80% of domestic electricity generation in 2011, a slight decrease from 86% in 2008. The decrease of their market share is to some extent the result of new generation by new market players, in wind (*e.g.* Norwegian Statkraft) and bio fuels.

Municipal DH companies currently provide 63% of the delivery of DH in Sweden, while private and state-owned DH companies account for 37%.

Synergy allocations

The CHP cost allocation can be freely chosen by the companies provide the allocation does not cross-subsidize either product[18]

1.11.1 R&D

Research and innovation for a sustainable energy system

In October 2012 the government presented the Research and Innovation Bill (2012/13:30), proposing increased funding for research and innovation, including

[18] Sources: Energy Policies of IEA Countries – Sweden, 2013 Review, IEA

for energy research, demonstration and deployment (RD&D). The bill addresses the use of the additional resources, as described in the Research and Innovation Bill and proposed in the draft Budget Bill for 2013.

DH research based on governmental financing has been running since 1980's, and in the first years already under the national energy research program. During the period of 1995-2005 both the energy authorities and the Swedish DH association operated the research under Hot water Program. The Program towards technical distribution issues which comprise both university and practice driven parts. In the course of the years, research facilities have been built in several technical universities such as of Chalmers (distribution), Lund (substations) and Luleå (measurements), for instance.

Between 2002 and 2006 the two institutions mentioned above financed the program "Low-density DHV (Värmegles Fjärrvärme) which aimed at increasing the feasibility of connecting small houses to DH. Since year 2006 another DH research program started with the title "Looking ahead" (Fjärrsyn). The first period ended at 2009 and the second one has is just ended in July 2013.

Fjärrsyn is a multi-disciplinary research, development and innovation program with the fundamental objective to realize research and development activities within district heating and cooling, and areas that have strong impact on their development.

Fjärrsyn has worked on strengthened communications and sharing the research results with various interest groups. Therefore, the results of the research are rather well known in the industry. During 2013-2017, communication of the research activities is funded by a separate budget.

Fjärrsyn 2013-2017 is organized in three main research and innovation areas:

- System development
- Effects of and adaptation to new policy and surrounding world changes
- Collaboration for sustainable development

In the evaluation of the last program period it was concluded that Fjärrsyn contributed to an enhanced collaboration between researchers and users and with it a better relevance in the research. Fjärrsyn has also contributed to creating a common national image of what district heating is and what needs to be developed.

The initiatives for communication in the program have brought the program to where its activities and results are well known in the sector, but a difficulty that was pointed out in the evaluation was how to get research results put into use. Improvement proposals from the evaluation of the last program period have been incorporated into this existing program description, for example clearer goals and initiatives for increased implementation of results. The special efforts for communication from the earlier program are maintained but handled outside the frame of this program description.

There are also other DHC related programs under Swedish funding, namely:

- Co-operation program between fuel based electricity and heat production (CHP)

- International research co-operation in DH, IEA-DHC
- Program Energy Systems at Lindkoping university
- Waste Refinery
- More effective forest fuel system - ESS (*effektivare skogsbränslesystem*)
- Fuel program "Sustainability" Bränsleprogrammet Hållbarhet
- Research and innovation for energy efficient building and living - EFFSYS

2 Research Projects and Development

In here six project ideas are outlined which are aimed at studying the combined DHC, CHP and RES development that is currently hampered by various barriers on the way towards the carbon neutral future, as targeted by most BASREC countries already.

The project ideas can be possibly combined with the ongoing calls of the IEA and IEE, for instance. In such away the limited research resources of the BASREC community can be combined with a larger research program, and thus producing results for both BASREC and international audiences. Moreover, some of the suggested project ideas can be merged to a larger and more concise project.

2.1 Uniform CHP statistics

2.1.1 Challenge to Research

Statistics of CHP still lack consistency. Most often, the CHP share in electricity production is reported only based on the installed capacity and not based on annual electricity production in CHP mode. For some time already, the unclear CHP issue has been intensively discussed at EU level, and in the Energy Efficiency directive a set of definition and standards has been agreed upon.

2.1.2 Possible Approach

It is recommended to establish a BASREC overview of CHP both in the heat and in the electricity market, which is harmonized with the definitions given in the Energy Efficiency directive. This overview would emphasize the strong role of the BASREC countries in the overall European DH/CHP/DHC and RES development as well as provide clear and explicit concept of CHP. Further it will be important for the internal cooperation and development among the BASREC countries.

2.1.3 Expected Outcome

The overview would give an explicit definition to CHP. Based on the overview, measures to promote real CHP and not a mixture of CHP and power-alone applications would become uniform.

2.2 CHP coordinated with individual RES sources

2.2.1 Challenge to Research

Both CHP and RES are warmly welcome to be promoted due to their merits in high EE and low emissions, but how to integrate them optimally is not that simple. For instance, RES based heating systems installed in the DH area where CHP supply already exists or potentially will come, would reduce the heat demand of DH, and the potential of CHP. Analysis and consecutive guidelines to deal with the conflict are needed. For the instructions, it is important to have a realistic view of carbon neutral heating and power in the future.

2.2.2 Possible Approach

The impacts of RES based heating on CHP, and further to primary energy consumption, depends on the overall power market in the region. Therefore, the impacts should be calculated in a region specific way, for instance as follows:

- In Nordpool, the marginal power generation is based on hydropower most of the year, but in winter times on coal condensing power.
- In southern BASREC countries, coal condensing may be the dominant way of producing the marginal power but there are times when solar and wind power have become increasingly important
- In the eastern BASREC countries, coal and natural gas are the fuels to generate incremental power almost all year round.

2.2.3 Expected Outcome

Tee report will offer instructions how to coordinate RES based heating and CHP in the various power market conditions in order to be optimally combined, and having the primary energy consumption reduced.

2.3 Benefits of CHP – Past and Future

2.3.1 Challenge to Research

The materialized energy savings of CHP with and without CHP since 2000 will be estimated. In Finland, for instance, such benefits in one year (2011) have been about 700 kg of hard coal consumption equivalent and 1600 kg of CO2 emissions per capita lower than without CHP. In other countries this has not been analyzed yet.

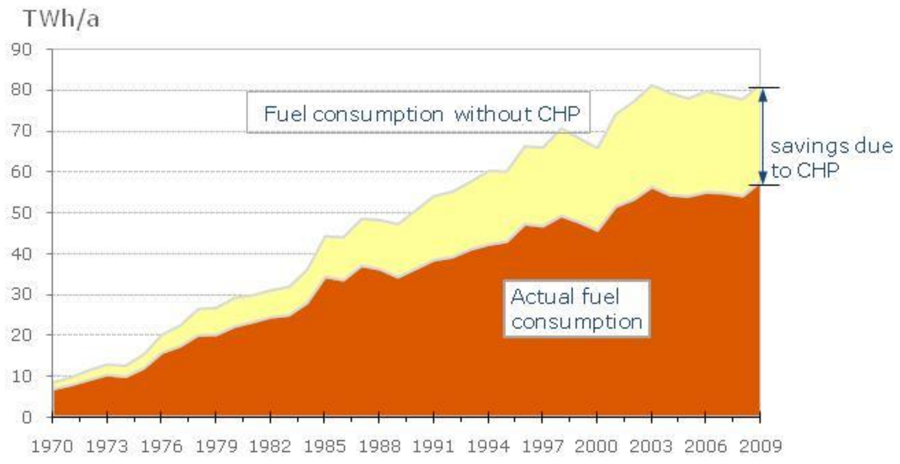


Figure 3-1. Annual fuel consumption with and without CHP in Finland as an example.

2.3.2 Possible Approach

Using the same approach to all BASREC countries, the benefits from year 2000 to the present year will be calculated. Additionally, an estimate for 10 years to come will be estimated based on the existing policies and plans for the countries to implement.

2.3.3 Expected Outcome

The BASREC level benefits of CHP will be used for marketing CHP and DHC in the BASREC countries and elsewhere.

2.4 District Cooling Expansion

2.4.1 Challenge to Research

DC would be a good complementary product to CHP and DH, but slowly develops in most BASREC countries. The investments are high and the customers still not aware of the financial benefits.

2.4.2 Possible Approach

Various methodologies for DC being available in the BASREC countries and in various regions will be reviewed and described. DC has different success factors in the locations whether near the seaside, lake and riversides, geothermal area, etc. Moreover, the potential for DC development in the next 10 years will be elaborated, and a list of measures will be suggested to support the development. Benefits to traditional cooling modes will be assessed.

2.4.3 Expected Outcome

The report will be used for marketing DC amongst the policy makers and energy companies in BASREC region.

2.5 Hiding Heating with Electricity

2.5.1 Challenge to Research

There exists electric heating in the households and commercial buildings in a substantial scale, but such electric heating is hiding behind the statistics. Such hiding electric heating materializes in dish washers, laundry machines, heat pumps and in floor heating of sanitary rooms. In commercial buildings, electric heating is used in also dish washing and laundry machines, lighting, heating outdoor entrances, etc.

Such hidden electric heating reduces the potential for CHP as it reduces the thermal heat to be used for DH supply. Thus, the overall primary energy factor remains high as electricity is "wasted" to heating applications in which less valuable energy in thermodynamic terms means could be used instead.

On the way towards carbon neutral communities, the volume of the hidden electric heating should be evaluated in quantitative terms

2.5.2 Possible Approach

The hiding electric heating will be estimated based on the available case studies, expert interviews to be carried out and statistics.

The influence of the hidden electricity heating to primary energy consumption depends on the composition of the electricity sectors as and should be quantified in three country categories:

- those having quite much of carbon free or neutral components in the energy balance already in terms of nuclear, hydro and biomass (Finland, Latvia, Norway, Sweden)
- those having much fossil but also substantial amounts of solar and wind energy already (Denmark, Germany), and
- those mainly being on fossil fuels such as natural gas and coal but little RES (Estonia, Lithuania, Poland, Russia

Table below shows how the electric heating influences the primary energy consumption in CHP supplied are in one of the above mentioned country categories while using individual groundwater heat pump as an example. In the first row, all heat is produced by CHP with the overall primary energy factor of 1.58 (158% of the fuel). In the consecutive rows, the share of individual heat pumps is raised in 10 nit steps, thus substituting DH. Simultaneously, the CHP production of heat and electricity falls down, and the electricity has to be produced in power-only mode at the high primary energy factor, and consecutively with high fuel losses. Moreover, the electric energy needed by the heat pumps need to be generated in the power-only mode as well because the CHP potential has been lost. In the final stage on the last row, no more CHP exist and all electricity is based on power-only generation. Thus, the primary energy factor has increased from 1.58 to 2.06, equal to 30%

increase in this case. Similar calculations with other results should be carried out to various power markets and types of RES in the CHP environment.

Table

Electricity				Heat			Primary
Total	**CHP**	**Separate**	**Heat pump**	**Total**	**CHP**	**Heat pump**	**energy**
40	**40**	0	0	100	**100**	0	158
43	36	4	3	100	90	10	163
46	32	8	6	100	80	20	168
49	28	12	9	100	70	30	172
51	24	16	11	100	60	40	177
54	20	20	14	100	50	50	182
57	16	24	17	100	40	60	187
60	12	28	20	100	30	70	191
63	8	32	23	100	20	80	196
66	4	36	26	100	10	90	201
69	0	40	29	100	0	100	206

Explanations:

CHP: power to heat ratio=	0,4	
Heat pump: heat/power=	3,5	
Boiler efficiency of the CHP plant	90 %	
CHP electrcity used for internal process in CHP =	6 %	of CHP electricity generation
Separate electricity generation: efficiency =	33 %	

Possibilities to convert the hidden electricity to DH and other RES should be elaborated.

In Finland, for instance, a residential building is under construction in which some household appliances such as dish and laundry washing will be heated with DH instead of electricity.

2.5.3 Expected Outcome

The report shall provide quantitative information and guidelines about how address the hidden electricity heating in the BASREC countries in order to reduce primary energy consumption on the way to towards the carbon neutral future.

2.6 Competitiveness of RES

2.6.1 Challenge to Research

Due to expanding shale oil and gas use, mainly in the USA, the prices of fossil fuels have been declining globally. Therefore, use of fossil fuels, mainly coal, has increased all over the EU and the BASREC, which is contrary to fighting Climate Chance. Most BASREC countries already use carbon taxes (Scandinavia), price premiums (Germany), FITs, investment subsidies (all), for example, to support RES development, but increasing such measures even further would harm the economic competitiveness of Europe.

On the other hand, expanding use of RES has reduced the unit costs of RES investments already, which helps with competitiveness in the future, but not right now.

2.6.2 Possible Approach

As an idea for approach, expert interviews could be carried out amongst the researchers, policy makers, businessmen and non-governmental organizations to find out other possible instruments to support RES development than listed above and without compromising the European competitiveness.

2.6.3 Expected Outcome

The report could provide a set of measures that could be used for RES development other than those traditional ones listed above. The report could also assess the impact of the various measures currently being in use in the BASREC countries to draw lesion learned to the others.

2.7 CHP and RES in the Electricity Market

2.7.1 Challenge to Research

The electricity markets in Northern Europe – to a wide extent are integrated. RES policy in one country and electricity trade thus highly influences the marked conditions for electricity in general, and for CHP produced electricity in particular, in all the interconnected countries.

2.7.2 Possible Approach

These aspects could be further analyzed and discussed among the BASREC countries in the context of evaluating the future development of CHP/DHC/RES. Interviews and document reviews can be used as tools.

2.7.3 Expected Outcome

The study will result in recommendations about how to improve commissioning of CHP and RES in the energy market on a strong and sustainable basis.

3 Best Practice Cases - DHC/RES Schemes

3.1 BASREC Capitals

3.1.1 Riga, Latvia

The district heating network in Riga covers 76% of the city's heat demand and more than 90% of heat energy is produced by CHP plants. All 8000 district heating costumers in Riga have an automatic building heat substation that controls and reports on heat consumption.

The first bio fuel fired unit in the district heating system of Riga was installed in 1996 at the plant “Daugavgriva. A 7.5 MW pre-furnace was added to the existing stream boiler. In 2010 the heat capacity for bio fuel was increased by 14 MW when the base load heat plant Vecmilgravis was upgraded. In addition two new bio fuel projects are underway. In Ziepniekkalns, a 22MW heat and 4MW electricity CHP plant with a heat utilization of 97% is planned, alongside a modernization of the heat plant Zasulauks of 20MW. Together these projects are estimated to deliver just less than 6% of the heat production.

The World Bank supported The Riga District Heating Rehabilitation Project of $140 million which aimed to optimize the operational performance of the DH system, increase the efficiency of heat supply, and improve reliability of service delivery. The project was successful in contributing to reducing the grid losses by 30% and to improve connection to the most efficient CHP plants.

Ownership

The Joint Stock Company Rigas Siltums manages and distributes 76% of the thermal energy in the city of Riga. 77% of the thermal energy is used for heating of residential houses and for preparation of domestic hot water. Total length of city's heating network is about 900 km, 72% of which are owned by the JSC Rigas Siltums.

3.1.2 Reykjavik, Iceland

The main use of geothermal water in Iceland is for heating houses. The District Heating Utility in Reykjavík is the largest geothermal DH service in the world. The harnessed power of the geothermal areas is about 780 MW thermal. Annually, 60 million cubic meters of hot water flow through the Utility's distribution system.

The water from the low temperature fields is used directly for heating and as tap water. Due to high content of gases and minerals at the high temperature area, water and steam are used to heat fresh water. Today geothermal energy is used to heat the entire city and five neighbouring communities. From 1998 electricity has been co-generated from geothermal steam at Nesjavellir. About 70% of the energy used for DH comes from low-temperature geothermal fields the other from high-temperature geothermal resources. The use of geothermal energy for heating in Reykjavik has massively reduced the City's dependence on fossil fuels, making it one of the cleanest cities in the world.

The CO2 emission has been reduced from 1944 to 2006 by up to 110,000,000 tones, delivering savings of up to 4 million tons CO2 every year. The cost of the geothermal energy is low comparing to other alternatives. The use of geothermal for heating houses in Iceland has therefore contributed to Iceland's transformation from one of the poorest nations to one that enjoys a very high standard of living.

The geothermal DH system in Reykjavík which delivers 80°C water includes:

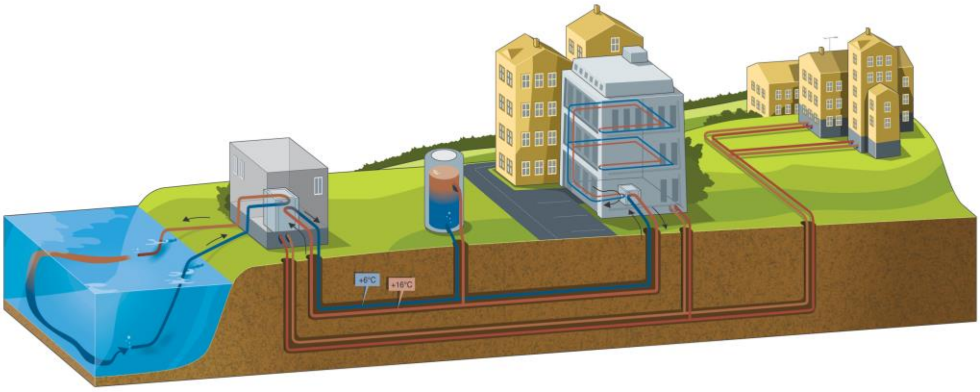
- 830 MW installed power from:
  - four low temperature geothermal fields: Reykir, Reykjahlið, Laugarnes and Elliðaár
  - Cogeneration at the Nesjavellir high temperature geothermal area, located about 30 km east of the city.
  - High temperature area, Hellisheiði.
- A total of 51 boreholes
- The 27 km long Nesjavellir pipeline and other major transmission pipelines such as the Reykir pipelines
- A distribution network in Reykjavík, Kópavogur and Garðabær with a total trench length of 2,984 km.
- Peak flow 5 m^3/s

The oldest part of the network in Reykjavík, which is over 40 years old, has been refurbished.

3.1.3 Stockholm, Sweden

The energy system of Stockholm with comprehensive and sophisticated DHC and CHP is driven by the Finnish Fortum. The Stockholm speciality is district cooling, which is the largest of its kind in the world in terms of both the length of the network and the number of customers. Based on the statistics of 2012, the connected cooling load was about 330 MW consisting of some 135 customers and some 620 buildings. The average customer size was about 500 kW ranging from 8 to 7 000 kW.

Distinct Cooling in Stockholm functions in the four steps as follows:



1. Cold seawater is "borrowed" to cool the District Cooling network closed loop water system. The sea water is then returned back to the lake or sea;

2. The low temperature water in the DC system is transferred to the building's closed loop distribution system via a heat exchanger. The distribution system cools the ventilation supply air and the building itself;

3. The waste heat energy in the District Cooling system returning from the buildings is recycled to the District Heating system; and,

4. During nights and times when the need for cooling is less, cold water is stored in a water tank or rock cavern.

The DC facilities of Fortum in Stockholm comprise

- Free cooling from sea water at about 100 MW capacity as base load in summertime
- Waste cooling from heat pumps

- Peak load from chillers
- Heat pumps running also in chiller mode
- Base load with waste cooling wintertime (Heat Pumps using DC as heat source)
- Rock storage of 60 MW storing cold water from excess capacity night time
- Cold storage aquifer (10 MW) in the form of ground water in gravel ridge
- Waste cooling from heat pumps (waste water heat pumps) at 40 MW capacity
- Peak load from chillers used summertime

In year 2010, the COP (coefficient of performance) of DC was 6.9 and some 57% of the DC was based on free (sea water) or waste sources (heat pumps).

The benefits to the customer compared to the traditional cooling are as follows:

- Capital and other resources are freed as the supplier takes
- The risks associated with owning, operating and maintaining chillers are eliminated
- Energy costs and maintenance costs are stable
- High flexibility in delivery with good adaptability to changing needs
- Great opportunity to influence costs through efficiency
- High availability through simple and proven technology
- Floor and roof surfaces can be released to other purposes, even for a greenhouse on the roof
- The environmental profile is improved as the associated emissions and primary energy factor are reduced.

3.1.4 Helsinki, Finland

District heating and CHP

Helsingin Energia is a local municipal energy company owned by the City of Helsinki. It operates as an independent economic unit, in the form of a commercial enterprise. Helsingin Energia covers more than 90% of the heat demand of the capital city with DH. Its net turnover in 2009 was 723 M€ and operating profit 247 M€. Helsingin Energia has more than 13 000 paying customers in Helsinki district. For a comparison, average price for DH in Finland in 2009 was 5.62 snt /kWh.

At the moment, DH covers 93% of Helsinki's total heating energy demand. This means that there is more than 1230 km of DH pipelines beneath the Helsinki district. The heat sales in 2010 were 7360 GWh (26469 TJ).

The EU has classified Helsingin Energia's efficient DHC system as Best Available Technology.

DH production is mainly based on four large CHP plants located in three different areas: Vuosaari, Hanasaari and Salmisaari. Natural gas represents 60 % of DH production. The other fuels are coal 35%, heat pumps 3% and oil 2%.

In the city of Helsinki, DHC and electricity are produced in CHP processes on a large scale. The emissions have decreased and the air quality in Helsinki has improved considerably since 1990s – despite the fact that energy production has increased by more than 60%!

The main indicators of DH in Helsinki are:

- DH covers 93% of the total heating energy demand in Helsinki
- More than 90% of DH energy is produced by CHP
- The annual EE of CHP exceeds 90%, which is one of highest in the world. If electricity and heat were to be produced separately, the fuel costs and emissions would be at least 40% higher.
- Despite of low prices of DH, Helsinki Energy is highly profitable.
- In year 2010, the heat sales specific CO_2 emissions were only 113 g/kWh.
- For example, data server centres are connected to the DHC system to create world's most eco-efficient computer halls.

Today, Helsingin Energia uses the light district heat as a heating solution for low-energy houses built in the outskirts of the DH network. The building automation of these houses supports the concept of lower temperature of the circulating water in the smart DH system.

Green future

The city council has set the goal by year 2020 to have the share of RES in heat and power production at least 20% of all heat and power production of Helsingin Energia. Also Helsingin Energia is expected to reduce green house gases by 20% from the level of year 1990.

On Dec. 8, 2010 the City Council approved the development program of Helsingin Energia towards carbon neutral future by year 2050. The program implementation requires a strong investment program that may temporarily weaken the currently strong financial position of Helsingin Energia.

District Cooling

Despite the northern location, there is an extensive and constantly growing DC system in Helsinki. Helsingin Energia delivers DC to their customers by means of water at +8^{o}C temperature and the customers return the water back to the utility at

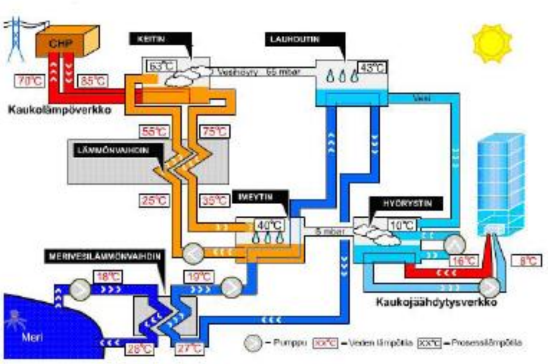
+16°C temperature. The temperature difference is used for cooling the customer building.

The DC development in Helsinki started in 2001 and the DC supply has been constantly growing on fully commercial basis to close 200 MW by 2013.

The cooling system consists of three different technologies and locations as follows:

› First, sea water is used for cooling when the water temperature is low enough as a means of free cooling. A heat exchanger of platinum material is used to transfer the cooling to the DC circulation.

› Second, in Ruoholahti suburb, DC services are provided by means of absorption chillers of 35 MW in total. The chillers are driven by DH instead of electric power. The chillers are used in summer time because the sea water temperature is not cold enough to cool down the buildings connected to the chilling system In winter, on the other hand, chillers are not needed but the sea water with low temperature is sufficient to provide natural cooling to the buildings. In order to increase flexibility in DC services, there is a storage tank of 1000 m^3 capacity to be charged/discharged according to the actual needs. Typically the tank is charged in the night time, when the cooling demand is low but discharged in day time to reduce the operation of the absorption



chillers.

Figure 3-1 Absorption cooling in summer

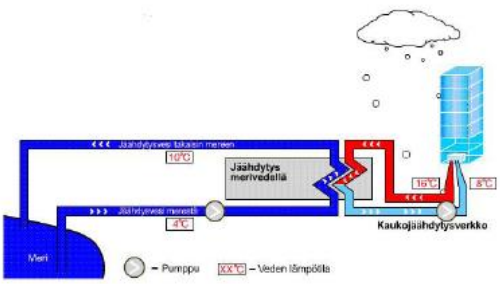


Figure 3-2 Natural sea water cooling in winter

Third, there is a compressor driven heat pump plant under the Katri Vala park that provides DH in winter and DC in summer time.

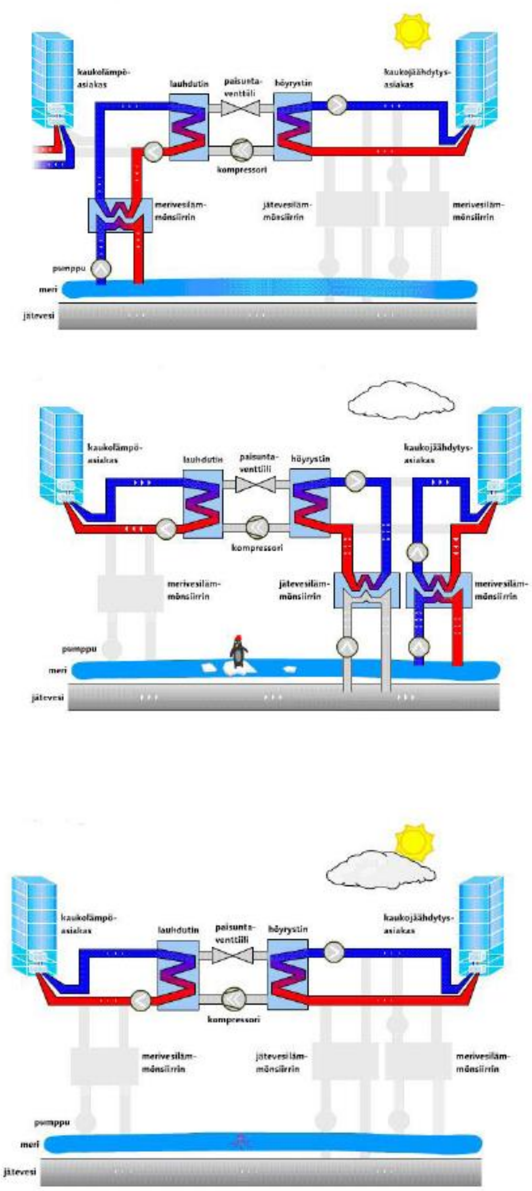


Figure 3-3Heat pump both in spring and autumn

In summer the source of cooling is the sea water but in winter the source of heating is the waste water tunnel of Helsinki. In spring and autumn the same machinery can be used both for heating and cooling simultaneously. Both the sea water and the waste water are RES to be used for cooling and heating, respectively.

Moreover, in case the customers have compressor driven heating, the return water of the DC system can be used for cooling of the compressor released condensing water.

In the annual energy balance, the DC systems of Helsinki use 60% of RES in terms of low temperature of the sea water and the waste heat of the power plants. The waste heat cannot be fully sold to the DH customers in the summer time but can be used as the driving energy of the absorption chillers.

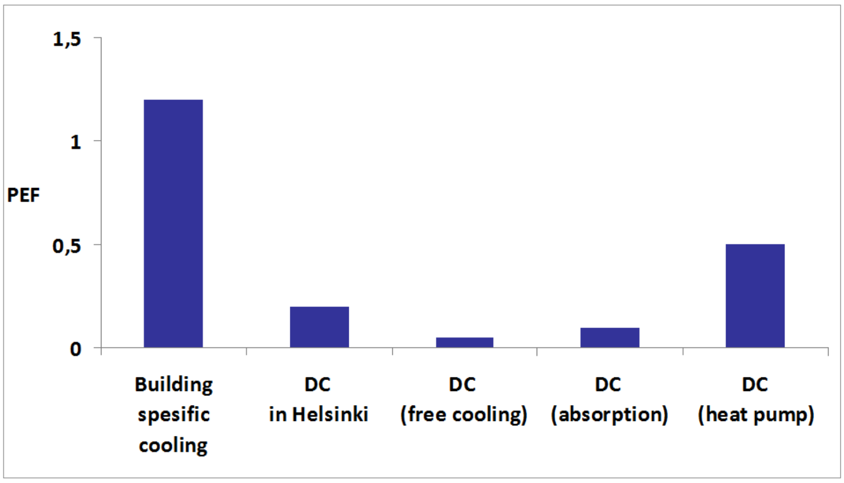


Figure 3-4. PEF of various cooling options in Helsinki (source: Helsingin Energia)

The primary energy factor of the DC options of Helsinki is presented in the picture above.

The same phenomenon as is with the PEF applies to CO2 emissions of the cooling methods as well.

In the annual terms, the heat pump plant system in Helsinki

› Replaces heat only production (400 GWh fossil yearly, equal to 30 million litres of oil)

› Remarkable primary energy and CO2 savings (nearly 100 000 tons CO2 yearly, equal to 500 million kilometres by a car)

› Competitive costs compared to alternative solutions

› Could be replicated in most cities in Europe.

3.1.5 Tallinn, Estonia

Tallinna Küte supplies with heat about 2/3 of Tallinn city and Maardu town to 3 644 buildings in total. In 2012 the heat sales were 1 707 GWh. With our heating network are connected 4 065 heat substations (91% are fully automated), some 3 873 of which equipped with heat meters. The other 1/3 of Tallinn uses either local heating possibilities (wood, electric and gas boilers; heat pumps) or the service of the other DH company Adven Eesti.

[19]OÜ UTILITAS group as the owner of TallinnaKüte is the largest DH operator in Estonia. The group's core business segments are production of electricity and heat and provision of DH services. The group includes heat and power producer OÜ Tallinna Elektrijaam, DH companies AS Tallinna Küte, AS Eraküte and AS RaplaKüte and technical services provider OÜ Väo Hake. OÜ Utilitas holds 100% in all group companies, with the exception of AS RaplaKüte, where the group holds 76.7%.

Tallinna Küte produces about 50% of heat in its own boiler plants and purchases the rest from the other heat producers.

Tallinna Küte operates the network of 422 km length as well as 3large and 19 small boiler plants, manly based on natural gas fuel:

- 416 MW Mustamäe
- 295 MW Kadaka
- 238 MW Ülemiste (in reserve)
- 19 local boiler plants with the capacity ranging from 0.17 to 16 MW

Breakdown of DH production in Tallinn:

	2013	**2014**
TallinnaKüte boiler plants	42%	34%
CHP TallinnaElektrijaam	24%	24%
CHP IRU plant	24%	24%
CHP IRU waste power unit	9%	17%
Adven boiler plant	1%	1%

The CHP plant **Tallinna Elektrijaam** uses renewable fuel. Output of the CHP plant amounts to 25 MWel / 49 MWth + scrubber 18 MWth (max) .The fuel comprises a mix of wood and peat. The woodchip consumption is up to 270 000 sm3/year.

Electricity and productions are up to180 GWh and 480 GWh per year, respectively. The overall efficiency is up to 90 % but with flue gas condensing over 100%. Produced heat is sold all year around to Tallinna Küte and the electricity to the power grid. Tallinna Elektrijaam CHP-plant also belongs to the holding company OÜ Utilitas.

The CHP plant **IRU** fires not only natural gas but it has a waste-to-energy power unit commissioned in June 2013 incinerating mixed municipal waste. The power and heat capacities are 17 MW and 50 MW, respectively.

[19] Source: www. helen.fi

3.1.6 Berlin, Germany

Vattenfall Europe Wärme AG is the largest DH company in the westen Europe supplying 1 million apartments through the DH network of almost 1 800 km long. The number of consumer substations amounts to some 18 000. The DH production capacity amounts to some 5 580 MW and produces 9 440 GWh heat annually, which is about 27% of all heat supplied in Berlin.

In the Climate Protection Agreement (Klimaschutzvereinbarung) with the Berlin authorities since year 2009, Vattenfall is committed to reduce the CO2 emission by half by year 2020 (2020: 6.4 Mt/a, 1990: 13.3 Mt/a).

All 18 power plants in Berlin are CHP, be means of which about 530 Million Liter of heating oil equivalent has been saved. Therefore, the primary energy factor of 0.56 has been determined by the Dresden University of Technology.

In 1991 the city hall Charlottenburg was connected as the first customers served by the power plant Charlottenburg. At present, the office of Bundes Councellor, hotel Adlon, TV tower, Olympic stadion and the Berlin Zoo are some of the distinguished heat customers of DH in Berlin.

Figure 3-5 District cooling station at Posdamer Platz, Berlin..

Moreover, Vattenfall is operating the largest district cooling (DC) network in Germany for the new city centre of Berlin around Potsdamer Platz and Leipziger Platz. The smart thing about the system is that a large amount of the cooling energy is generated by absorption refrigeration machines from environmentally-friendly DH, which is produced by the CHP plant Mitte. Compressor chillers refrigerating machines meet the remaining demand for cooling. The Vattenfall central cooling station in Stresemannstraße supplies approximately 10 000 offices and about 1 000 apartments with district cooling. It cools the Sony Center, for example, as well as the Potsdamer Platz Arcades, the headquarters of Deutsche Bahn AG, the Bundesrat parliament building, the Federal Environment Ministry (BMU) and the Berlin House of Representatives.

3.1.7 St Petersburg, Russia

Of course, St Petersburg is not the capital of Russia, but as the second largest city in Russia with high population of 4.6 million and being on the coast of the Baltic Sea was chosen to introduction instead of Moscow.

The main features of the DH system are in brief:

- St Petersburg is divided into 8 urban (city) and 7 suburban heat districts.
- Total heat load in St Petersburg is about 24 000 MW.
- Heat demand calculation norm is 128 kWh/m² of heated residential floor (Regional construction norm 30-305-2002 St-Petersburg)
- Total installed capacity of heat sources is 34 400 MW, including installed capacity of TGK-1, Corp. 13 700 MW, but the available capacities are a little lower 29 300 MW in total, including available capacity of TGK-1 with 11 500 MW.

There are three major CHP producers of heat energy in the city, namely

- Territorial Generating Company 1 (TGK-1) as the largest one in which the gigantic Gazprom is the majority shareholder (51.8%) and the Finnish Fortum as minority owner (25.66%). In 2010, the turnover of TGK-1 was about €1.3 billion equivalent. The installed capacity of the 9 CHP plants (and three hydro power plants) of the Nevsky branch of TGK-1 amounts to 13 800 MW and 3 400 for heat and power, respectively. Heat production of TGK-1 amounted to 26 200 GWh in 2010. The major heat transmission pipelines (around 500 km in total) mostly belong to TGK-1.
- Industrial central heating and power plants (3 plants) with installed capacity 1 900 MW with the connected customer heat load of 1390 MW.
    - Izhora-Energosbyt, Corp. (selling of heating energy, heating energy producer is ZAO "UK "GSR ENERGO") .Izhore-Energosbyt Corporation runs a natural gas fuelled CHP plant. In 2009 heat and power production amounted to 1600 GWh and 100 GWh, respectively. The latter value indicates that most of heat production is from boilers as the electric energy is only 6% of the heat production.
    - Obuzhovenergo, Ltd. Co.
    - "I.I. Polzunov Scientific and Development Association on Research and Design of Power Equipment", Corp.
- North-west CHP Plant Corporation, 100% owned by the national power company RAO UES, runs a modern gas fuelled CHP of 1800 MW electric capacity. In 2009, the energy production amounted to 1 060 GWh and 6 100 GWh of heat and power, respectively. The high power value indicates that there has been lack of heat load compared to the capacity.

Heat only boilers and networks are operated by other three companies, namely

- GUPTEK (TEC SPb) under the City Committee of State Property with the heat sales of 12 900 GWh in 2009. Natural gas has been the sole fuel in all 278 boiler plants of GUPTEK. The ownership rights of the local pipelines belong to the city but they are utilized and maintained by State Enterprise GUPTEK.

- PeterburgTeploEnergo owned by Gazprom with the heat sales of about 3 000 GWh in 2010. Natural gas has been the sole fuel in all 108 boiler plants of PTE. The Company established in 2004 works in the following districts of St Petersburg:

  - Petrogradsky district (reconstruction has been done, it was the first, pilot district)

  - Kurortny District

  - Petrodvorets District – reconstruction has been finished in 2011. New capacity is 400 MW.

  - Admiralteysky and Central District – since 2010. Old 28 boiler houses will be closed and 16 new heat generating centres will be built. The main fuel is gas. Back-up fuel is mazut and diesel fuel.

- Lenteplosnab Corporation under private ownership with the heat sales of about 2300 GWh in 2009. Its 47 boiler plants with 970 MW capacities and 540 MW connected load are fuelled by coal, natural gas and diesel oil.

The current situation with lump sum tariffs does not stimulate heat supplying companies to cut their costs and introduce EE projects.

Nevertheless, the DH system rehabilitation is underway but still a lot of work needs to be done. There is an estimate of the city administration from year 2012 according to which some RUR 100 billion (€ 2.5 billion) and 10 years are needed to complete the system modernization. This would require some 1000km of replaced networks, for instance. Financing is still open as the subsidized customer tariffs do not gain financial resources to the companies to invest.

The development of the DH system is based on the following documents:

- “Program on complex development of communal infrastructure system in St Petersburg in the field of heat supply, water supply, water disposal and sewage water treatment up to 2015” has been adopted in 2008. This Program was created with taking into account Master Plan of St Petersburg Development.

- “Industrial scheme of heat supply system of St-Petersburg up to 2015 with perspective up to 2025”.

› On the base of this Program “Investment program of modernization of communal infrastructure systems” has been made. Program is financed from City budget.

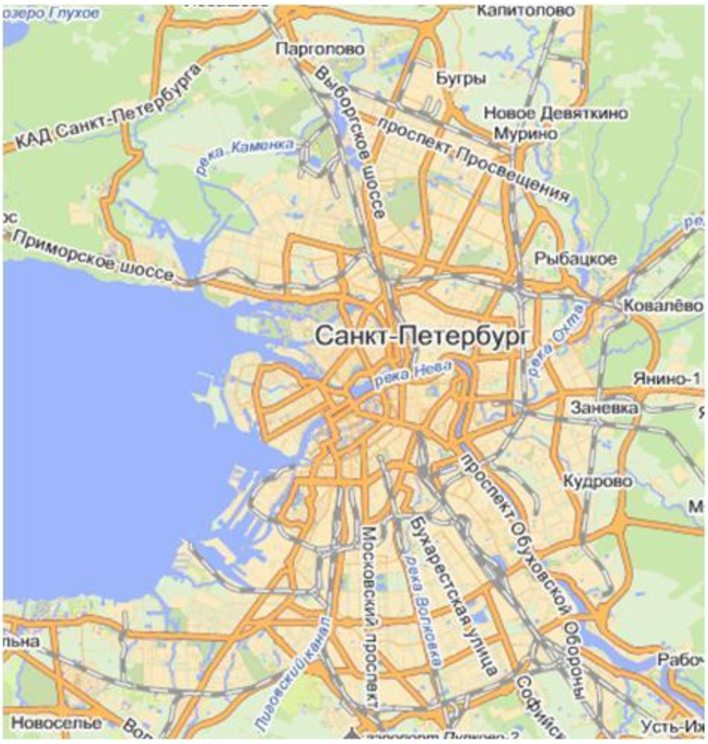


Figure 3-6 DH supplied area in St Petersburg.

In addition to the above listed companies, a number of departmental boiler facilities, covering heat demand of housing and public utility system, operate in the region: 800 boiler houses with heat capacity 4 200 MW.

Total length of the heat supply network is 7 920 km in one-tube mode, almost 4 000 km in route length with diameters ranging from DN 57 up to DN1400 mm. St-Petersburg city owns 5400 km of tubes and TGC-1 771 km of tubes.

3.1.8 Warsaw, Poland

Warsaw Dalkia operates the largest in the European Union DH system, delivering heat and hot water to 80% of the buildings in Warsaw. From October 2011 SPEC Warszawa became a part of an international group Dalkia, a European leader in energy services.

In the late 1980’s, Warsaw DH system was on the verge of technical disaster. The DH pipelines were corroding at a dangerously high rate. There were periods when the water losses of the treated hot water exceeded 2000 tons per hour, which was more than4.5% of the water flow rate. The number of network failures exceeded 4 000 a year. The poor technical performance of DH caused serious problems to the city and its inhabitants.

With the World Bank support during 1992-1999, USD 278 million was used to rehabilitate the DH system of Warsaw. The rehabilitation program yielded considerable benefits to DH customers and to SPEC since 1992 as follows:

The network damages were reduced 76%, from 2.00 to 0.49 damages/km;

Water loss in the system dropped 65%, corresponding to a decrease in the replacement of system water from 22 times to 7.6 times a year (network volume 470,000 m^3).

Emissions of various types from local heat-only-boilers (HOBs) dropped 80%, thanks to successful boiler elimination and coal-to-gas conversion program;

DH costs have decreased in real terms and its competitiveness with individual gas heating has improved.

During the past decade, the DH system rehabilitation has continued, and the competitiveness of DH to gas heating improved. Therefore, new customers have been connected and the network length extended from 1400 in to 1700 km in a decade by 2013.

Dalkia Warsaw has focused on technical innovations. On the basis of the former Centre for Research and Development of Heat Engineering was established modern international centre for research and innovation in heat - Heat Tech Center. HTC is one of the five development centres worldwide of technical ideas, conducting research on improving the efficiency of urban energy systems and industrial applications.

Delivered energy (GWh)	36 PJ of heat (2010)
Market share (% of total heat market in location)	80%
Revenue (in EUR)	368 M EUR

Figure 3-7Dalkia 85%, Warsaw City 15% in 2011

Dalkia Warsaw is a company with over 60 years of experience in the distribution of heat and hot water. The company operates the largest in the European Union heating network, which consists of: 1740 km DH, 10 480 chambers and manholes, and 15 464 substations equipped with automatic weather. The staff amounts to 1 100.

Dalkia Warsaw launched a study to assess the effectiveness of the DH network. Conducted from April to November of the current year of the active control is prevention, to detection and elimination of potential water leaks in the network.

Dalkia Warsaw' policy and measures to locate the leakage of water from the DH network can be divided into two groups:

› year-round activities do not result in the necessity of stopping the supply of heat to the public,

› actions involving suspension of heat supply to consumers. Caring for Customers, Dalkia Warsaw activities such results only for the period from April to November, when outdoor temperatures above 0 ° C.

All activities are subject to the provisions safety.

The purpose of these actions is to locate and remove the water leaks in DH in their early stages, when spills and their negative effects on the population are minimal.

The benefits of early detection of water leaks are:

› No flooding of basements, streets, sidewalks,

› No structural damage such as collapse of roads and pavements,

› shorter interruption of heat supply to customers,

› Smaller number of buildings without heat supply.

3.1.9 Oslo, Norway

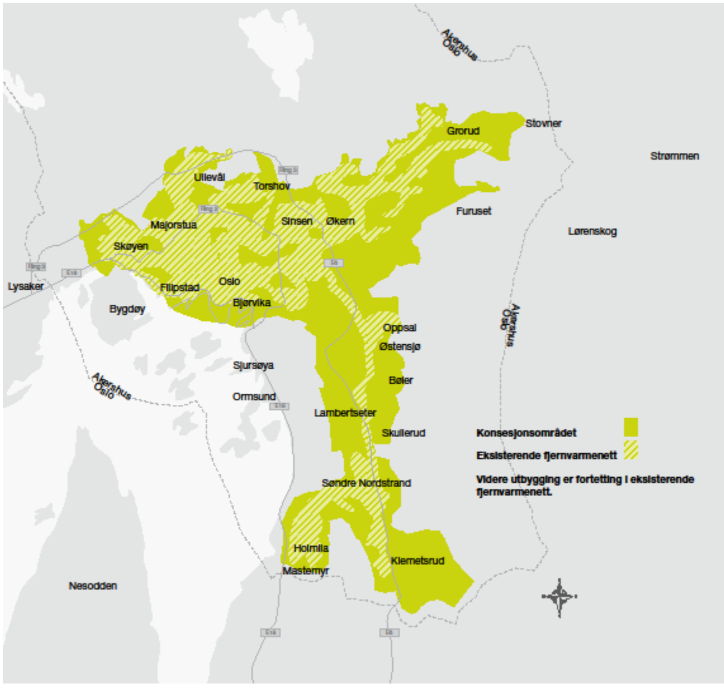


Figure 3-8The concession for DH in Oslo (green area) and the existing DH network (striped area). Source: www.hafslund.no/privat/artikler/les_artikkel.asp?artikkelid=1668

Hafslund Heat has expanded the production capacity at Haraldrud heating plant. The new wood powder plant has an installed effect of 56 MW. A 20 MW oil boiler heating system have been replaced by a new 56 MW wood powder boiler which is the first of its kind in Norway. The boiler will essentially be fuelled with wood powder, but can also use bio - and mineral oils. The chimney is also replaced to manage a higher capacity and to improve flue gas cleaning. The project has a budget of approximately 217 million.

The feasibility of expanding the district heating sector in Oslo has been discussed, and several research projects have come to completely opposite conclusions. SINTEF has found that district heating in Norway makes a large contribution to the flexibility of the energy system, and that it is an important peace in securing supply, especially in the case of two consecutive dry years (low hydropower capacities), as district heating and electricity to some extend is substitutes. Xrgia on the other hand has found no certain indication that means for reducing power consumption is an alternative to increased production capacity.

3.1.10 Copenhagen, Denmark

In the City of Copenhagen, 98% of the heat demand is covered by DH. In 2011, 42% of DH in Copenhagen was CO_2 neutral. The CO_2 emission factor for district heating in Copenhagen was in 2012 108 g/kWh.

The hot water system consists of a transmission network and a distribution grid. The transmission grid delivers heat from the heat plants out to exchange- and pumping stations. In these stations, the pressure of the water is lowered and the hot water is pumped into the distribution grid that distributes DH to the consumers.

Copenhagen is supplied with heat from four cogeneration plants, and four waste incineration plants placed in the city.

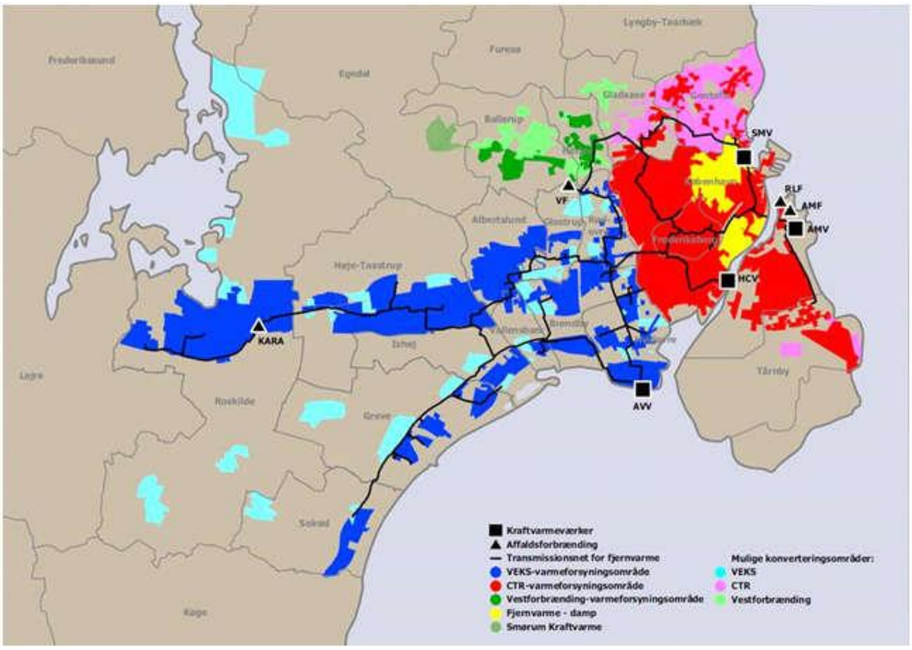


Figure 3.9 Copenhagen District Heating grid. Source: HOFOR

The Greater Copenhagen Utility (HOFOR) owns and operates a DH steam system, which today extends over approximately 110 km. To reduce heat losses in the system, the entire steam system will be refitted and incorporated to part of one large water system by 2025. To save even more heat, a part of the DH system has been converted to a low-temperature DH system. This restructuring has reduced heat loss in the water system and provided a more efficient operation of the production facilities.

DH in Copenhagen is produced in many different plants. To balance produced heat to the at all-time current demand, HOFOR and the other DH suppliers in the Copenhagen coordinate the production planning through Varmelast.dk optimized to minimal cost.

HOFOR can also deliver 30 MW of cooling to 30 DC consumers. The DC network in Copenhagen is expected to deliver cooling for approximately 1400 full load hours per year. The supplier of DC in Copenhagen, HOFOR, states that there is achieved a reduction of up to 70% cooling related CO_2 emissions and likewise, electricity savings of up to 80% by switching to DC. The CO_2 emission factor for district heating was 100 g/kWh in 2012.

HOFOR has set an ambitious goal to make the entire heat sector CO_2 neutral as early as 2025. To reach this target, Municipality of Copenhagen wishes to establish an energy system with multiple energy sources to form a flexible electricity and heat supply, to counteract the fluctuating electricity production from RES like wind and solar. In 2025, Copenhagen will be supplied with CO_2-neutral heating, primarily based on biomass and geothermal energy. Amagerværket and Avedøreværket will be converted to biomass, and there will be established new biomass fired cogeneration capacity in Copenhagen. Today, there is a geothermal demonstration plant at Amager Power Station, which forms a dataset on a number of operational experience that can be used in the future decision making processes.

3.2 Other Best practices

3.2.1 Integrated energy and urban planning – Porvoo, Finland

In very few planning schools in the world, the urban and regional planners are educated with understanding on energy, and on RES and EE in particular. Based on the survey made in year 2009, only one such planning school was identified in North America (Canada) and three in Europe, namely in Germany (Stuttgart), Denmark (Arhus) and Finland (Oulu). Later on, a few other planning schools have adopted energy issues to their urban planning curricula.

AESOP – the Association of European Schools of Planning is the largest global association in the area of urban planning – not only European anymore. In the annual conferences of AESOP there are about 700 participants from both Europe and elsewhere. More than 1 000 papers have been submitted for review every year.

In the last three annual conferences (2012 Ankara, 2011 Perth, and 2010 Helsinki) there has been only a session or two with only some 20-40 participants to learn of how energy should be adopted as a new element to urban planning. The international urban planning audience has not yet recognized energy and emissions as a new element in urban planning, but traditional topics dominate discussion.

Therefore, there is rather no research available on combined energy and urban planning as the subject is new to the research community. Otherwise, any training is based on the results of the relative research. In this case, however, training had to start from the scratch as research material was not available.

Nevertheless, such combined skills of energy and urban planning have become vital while fighting the Climate Change: the urban planner is the first actor in the planning process, the plans of whom will either restrict or enable optimal RES and EE implementation later on.

The traditional way is that a municipality creates a general location plan in which the buildings can be easily built and connected to reads, and defines the physical dimensions of the buildings. The building code ensures the new buildings meet the EE norms. Thereafter, the energy and water utilities connect the buildings to their infrastructure in the best way still possible. In such away, however, it may be too late to optimize the RES and EE!

In the existing urban structures we have barriers to introduce RES and EE as well as DH to integrate them to customers.

Therefore, training of urban planners with energy skills has been carried out as pilot training in five countries such as Germany, Hungary, Spain, U.K. and in Finland, the latter country to cover the coordination responsibility of the project with the acronym UP-RES (Urban Planners with Renewable Energy Skills). Because the training topic was new, it was challenging to attract participants to the pilot training courses. Normal marketing of training was not adequate as most urban planners considered the energy and emission issues too mathematical and complicated, and they were afraid of that the energy issues would set new constraints to the already challenging and comprehensive urban planning task. Without strong financial support from the EU amounting to 70% of the total project costs, the pilot training would not have materialized.

In the new way, the energy experts and the urban planners start working together in the general plan stage already. The impacts of various plans will be quantified in terms of energy consumption, investment and operation costs as well as emissions. The particular plan will be chosen for implementation which offers the lowest lifecycle costs and emissions. In city of Porvoo case in Finland, for instance, the new urban plan that was based on maximizing the share biomass fuelled CHP and DH appeared to be the best choice from environmental point of view, and moreover, with the overall life-cycle costs much lower than the traditional plan would have caused. In other words, the new combined energy and urban planning was a win-win approach from both the reduced emission and the lowest cost point of view that was highly appreciated by the local decision makers.

In the Finnish city of Porvoo, a new management approach was adopted in planning of the new urban area, named Skaftkärr. In the very initial stage of planning both the urban and energy planners were invited to work together. As the reference for their co-planning, the Skaftkärr plan from year 2007 was adopted, but assuming that passive energy houses would be used apart to those assumed in the plan of 2007. The reference plan was a sub-urban plan traditionally dominated by small houses to be located so that personal cars would need to be used. As heating sources in the reference plan, a combination of DH, electricity and heat pumps was assumed.

Co-planning started with a few studies about how people live, move and what are their expectations. Co-operation among the urban and energy planners was not that simple in the beginning, but some time was needed for them to learn each others 'way of work and thinking. A year was mentioned as a period of time that was needed to harmonize their co-operation.

Finally, the co-planning methodology provided four options to the urban scheme to be applied in Skaftkärr. All four options had the primary energy consumption and the emissions 30-70% lower than the reference plan.

The four options generated by the co-planning were as follows:

- Option 1 (M1 in below Figure)
  - A dense new area that is supported by the existing city structure.
  - The passive energy buildings are connected to the DH.
  - Effective public and light transport routes are created to the city centre.

Compared to Reference case:

  - Primary energy consumption 40% lower
  - CO_2 emissions 34% lower

- Option 2 (M2)
  - Effective small-house characterized Option, where 50% of heat is based on DH and the balance of other 50% on ground water heat pumps.
  - Effective public and light transport routes are created to the city centre.

Compared to Reference case:

  - Primary energy consumption 36% lower
  - CO_2 emissions 31% lower

- Option 3 (M3)

- A loose land use Option, where heat and power are produced inside the buildings 100% based on RES.

- Passive energy houses.

- Traffic like in Reference Case based on private cars and a little public transport.

Compared to Reference case:

- Primary energy consumption 67% lower

- CO_2 emissions 48% lower

› Option 4 (M4)

- Community type land use Option, in which the focus was on reducing the need of transport and by locating working places and services in the area.

- Effective public and light transport routes are created to the city centre.

- Passive energy houses served 100% by solar heating. The area will supply solar heating to all citizens of Porvoo.

Compared to Reference case:

- Primary energy consumption 45% lower

- CO_2 emissions 62% lower

The life-cycle costs of the four options (M1 - M4) in terms of Euro per inhabitant during 30 years to come are presented in the next picture. In three of four options the life cycle costs were lower than in Option 3. In the latter one, the investment costs of RE as well as the individual heat pumps using the electricity produced in the building itself became extremely high.

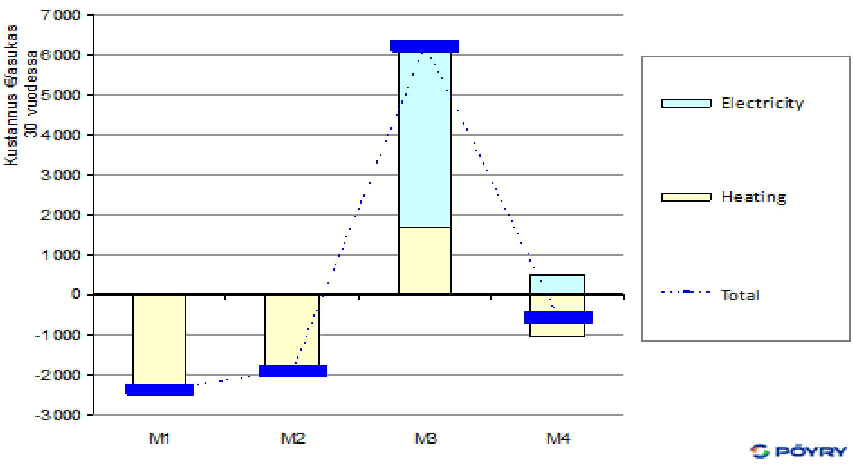


Fig. 4.9 The life-cycle costs of the different options (M1 - M4) in terms of Euro per inhabitant during 30 years

The final option selected for implementation was based on prioritizing light and public transport (biking highway, for instance), using DH in most buildings and enabling solar heating to be used later on. DH as the primary source in Porvoo is a special case as 92% of the heat energy in Porvoo is from the CHP plant, the fuel of which is 70% from biomass (wood chips).

The city management of Porvoo was happy with the results as well, as the infrastructure costs (streets, pipelines, etc.) were substantially reduced as well.

The new co-planning approach in Porvoo was supported and monitored by the Finnish Ministry of Environment and the Finnish Innovation Fund - Sitra. The co-planning approach is currently expanding to other cities in Finland, sooner or later maybe to other cities in Europe as well. Such expansion, however, will need training similar to that used in UP-RES pilot courses and adjusted to local conditions and country specific differences.

3.2.2 DH rehabilitation in Mytishi, Russia

The municipality of Mytishi is located in the northeast of the Moscow Oblast in the immediate proximity of Moscow. The total area occupied by the municipality is approximately 49.4 thousand hectares. The city population is 185 thousand people. Municipal property comprises 80% of the municipal housing stock area (2804.7 thousand sq. m) where 141 thousand people live.

The municipal heating system comprises 45 boiler plants with total installed capacity of 579.7 GCal/h, 64 Central Heating Substations (CHS) and 183.5 km of heating networks (in two-pipe length). The present main municipal heating system assets are operated and maintained by the Open Joint- Stock Company (OJSC)

”Mytishinskayateploset” consistent with the Agreement between the Regional Administration and OJSC ”Mytishinskayateploset”. OJSC ”Mytishinskayateploset” is an Open Joint- Stock Company where the company’s employees are shareholders.

The Mytishi region is characterized by a high share of industry, manufacturing more than 60% of the total amount of goods. The main region economic profiles are: machinery, instrument making, chemical, wood processing, textile and food-processing industries as well as production of construction and finishing materials.

In 1998 approximately 20-25% of heat generated at the boiler plants or purchased from the outside sources is lost in the aboveground networks. Such an amount of losses is stemming from the poor current condition of the heating as well as of the hot domestic water networks; the prevailing type of insulation is made of mineral wool. The region is characterized by the high level of underground water, and that is why lifetime of pipes with this type of insulation is shorter even than that stipulated by the established standards. The number of damages in the heating networks in 1977 has been accounted for 95 per 100 km of a heating pipeline. Separate heating network sections are dubbed by the citizens as”valleys of geysers” because of failures frequently occurring. Water leaks are resulting from failures as well. The total amount of water losses in 1997 due to leaks made up 34406 m^3.

DH system rehabilitation has taken place in a relatively small number of cities in Russia, one of them being Mytishi located in Moscow region with population of 160,000.

In 2000, the total network length was 182 km, some 95 km and 48 km of it being for distribution of space heating and DHW, respectively, and the balance of 49 km for heat transmission.

Altogether 236 compact building level substations were installed in Mytishi in the World Bank financed Municipal Heating Project to eliminate the group substation and DHW distribution networks and 60 km of new distribution networks were built. In addition, modern pumps were installed. The economic benefits of Mytishi component were consistent to those presented in Annex 1 for Polish projects and summarized in Table below.

Table 14.1: DH refurbishment experience from city of Mytishi, Russia.[20]

	Unit	Before 2002	After 2006	Change
Number of network damages	-	194	110	-43%
Make-up water consumption per heat energy ratio	m^3 /GJ	0.4	0.1	-67%
Fuel consumption heat energy ratio	Kg/GJ	45.9	40.4	-12%

[20]Implementation Completion and Results Report (IBRD-46010) on a Loan in the Amount of US$85 million to the Russian Federation for a Municipal Heating Project, Report No: ICR0000881, Dec. 10, 2008

Electricity consumption per heat energy ratio	kWh/GJ	10.0	4.8	-51%

3.2.3 DH rehabilitation in Chelyabinsk, Russia

Chelyabinsk – is the city in South-Urals region with a population more than 1.2 million. In the region the ambient temperature may drop as low as to -45°C.

OAO "Fortum" (formerly – OAO "TGK-10") is the power and heating company, which was acquired by Finnish power corporation Fortum in 2008. Together with its heat transmission and distribution subsidiary OAO "UTSK" Fortum is the main heat supplier with the market share more than 80%. OAO Fortum also operates in Ozersk - city north-west to Chelyabinsk (99% of market share).

Unlike the other TGKs, in OAO " TGK-10" heat production and heat transmission/distribution were legally separated in 2008 by foundation of subsidiary allied company OAO "UTSK" (Urals Heat Transmission Company).

Now structure of heat supply system of Chelyabinsk is following:

- OAO Fortum operates main heat sources in Chelyabinsk and Ozersk (1106 MW of power production capacity and 5558 MW of heat production capacity), all CHPs are powered mainly by natural gas.

  OAO Fortum sells all the heat generated to the OAO "UTSK" at CHPs collectors or to other heat distribution companies in Ozersk DHS.

- OAO "USTK" operates and maintains 369.3 km of heat pipes, with average diameter as of 500 mm and total volume as of 187.2 th.m^3, 8 high voltage pumping stations, 25 central heating substations (CTP). The newest pumping station was commissioned in September 2009.

  OAO "UTSK" also has its own production units (heat only boilers – two in Chelyabinsk, and one in Verhniy Ufaley town) with total heat production capacity of 1741.5 MW. OAO "UTSK" also buys heat from other heat producers (more than 30 small municipal and industrial HOBs), and pays transmissions fees to other small heat networks.

  OAO UTSK sells both purchased and generated heat to the final customers with different tariffs. Thus the problem of cross – subsidies between industrial and residential consumers still exists in Chelyabinsk.

  In 2011, UTSK has the one-tier tariff, which ranges from 633 RUR/Gcal (equal to 5.2 US$/GJ) for the residential consumption to 1035 RUR/Gcal (equal to 8.3 US$/GJ) for industrial consumption (all without VAT).

  Tariffs are approved by bodies of executive power in the area of state tariff regulation (Federal Tariff Service of Russian Federation and State Committee "United Tariffs Body of Chelyabinsk region).

The invoicing of residential heat consumption is carried out by GZNKP of Chelyabinsk (city united billing centre for utilities), together with all utility bills in the city.

Industrial heat sales are mostly covered by consumption based billing with heat metering. Although most of the residential consumers (served by housing maintenance companies – formerly "zekhs") rely on the traditional normative non-metered lump sum payments (RUR/Gcal or RUR/m^2). Fortum plans to have all customers with heat metering by year 2013.

The border of responsibility in heat supply between UTSK and consumers is usually at the building walls as UTSK owns the secondary networks.

High heat tariffs for industrial consumptions had forced many of them to disconnect from DH system and install their own hear sources. Therefore over the period of 1992-2002 more than 660 MW of heat load had been detached from Chelyabinsk DHS that reduced CHP efficiency and made heat relatively more expensive. Nevertheless regional authorities and Fortum have a scheme of cross-subsidy removal by year 2014. Reduction or complete removal of cross-subsidisation between groups of consumers will make CHP heat production more competitive compared with gas powered HOBs.

OAO Fortum and Chelyabinsk Region Authorities have agreed on extensive cooperation in the area of EE. The largest operation in the programme is the automation and upgrade of the Chelyabinsk DHS, which will reduce energy losses in the area by over 30% as well as significantly decrease fuel consumption and emissions.

The main idea of the project is to interconnect the three heat sources including one HOB into one integrated scheme that will allow producing heat in the most cost – optimal way (CHP) and delivering the heat to customer at any place of the city. New heat substations are to be installed as well. A project this size is unique in Russia and will be partly funded by rising heat tariffs. Once completed, consumers will be provided with uninterrupted and more affordable supply of district heat.

3.2.4 The Greenest City in Europe – Växjö, Sweden

Concept[21]
According to the Law on Communal Energy Planning (1977:439) each municipality is responsible for preparing an energy plan that covers production and distribution of energy in the municipality. The Plan shall promote energy economy, sufficiency and reliability of energy supplies, and even be approved by the city council.

[21] Source: www.vaxjo.se

Here the example from Växjö is presented, as Växjö is largely considered as one of the greenest cities in Europe.

The Energy Plan for Växjö municipality has been updated on Sep 11, 2011. The summary action plan of the Energy Plan comprises 38 individual measures with the appointed organization responsible for implementation of the measure. Such measures are, for instance,

	Description of task	Responsible
1	When constructing new buildings, 0.5% of the total investment costs shall be earmarked to RES production.	Technical office and VKAB
8	DC has to be built to cover more customers.	VKAB
9	Växjö Energy tests bio oil in one small-scale heating plant. Experiences if positive shall be used to extend operation security in the way to use more bio oil in the other heating systems as well as in Sandviksverket.	VKAB
12	In every building rehabilitation case, the municipal building companies shall prepare calculations in order to meet the below mentioned heat consumption indexes. By the year 2015, at least 50% of the rehabilitated residential Residential buildings: Buildings have to meet 75 kWh/m^2 a year, and regarding electricity heated building separately to meet 40 kWh/m^2 . Other buildings: 70 kWh/m^2 and regarding electricity heated building separately to meet 40 kWh/m^2 . In case such indexes cannot be reached, it shall motivate monitoring of each building object according to the energy plan.	VKAB
15	The municipal companies shall build only residential buildings that use energy less than 55 kWh/m^2 (and for electricity heating 30 kWh/m^2).	VKAB
16	The municipal companies shall build only buildings other than residential that use energy less than 50 kWh/m^2 (and for electricity heating 30 kWh/m^2).	VKAB

Lesson to learn

The municipality can set an action plan that stimulates the private and binds the municipal stakeholders in the city towards EE and RES use, as has being done by Växjö in Sweden.

3.2.5 DH expansion - Mannheim, Germany

Mannheim is a German city with the population of 300 000. MVV Energia AG, the city owned enterprise, plans to significantly develop DH in the city of Mannheim. The target is to raise the DH market share from the current 60% to 70% in a few years. This is equivalent to 4 000 buildings and 20 000 apartments being connected to the DH system. MVV Energie works together with the city authorities, and the city has approved the approach after an extensive analysis. As the driver to such co-operation was incorporation of the DH development of MVV to the climate protection programme of the city. IN such a way the DH based on CHP can contribute to the climate protection goal both on local, regional, federal and European levels. There is transition from network based decision to area based decisions. The heat load density of three existing DH networks will be increased, and new network branches built with the length of 30 km to various parts of Mannheim.

In order attract the customers to switch from the current, usually oil or gas heating, to DH, an incentive programme has been introduced by MVV Energie. The programme pays a bonus for every kW to be connected and a lump sum for every oil tank that would be removed. The programme is supported by a marketing and information campaign, informing the potential customers about the benefits of DH and CHP. The information will also stress how DH is important to improve overall EE, also meeting the legal EE criteria, and to use of RES in buildings. The DH and CHP programme helps the city of Mannheim to reach the climate protection goals.

DH currently reduces the CO2 emission in Mannheim by 300 000 tonnes annually. The development program would increase the reduction by some 17 600 tonnes per year. Likewise, the primary energy consumption related to DH has been about 1 955 TWh less per year than without DH, thanks to DH, and the programme adds more savings by 115 TWh per year.

On top of the climate protection benefits, there are also positive impacts on the society – especially in Mannheim region itself – contributing to local value creation. The investment volume amounts to € 50 million and most contractors are located in the Mannheim region. The DH development programme initiates further investments in renovation and retrofitting of heating systems, which account to another € 120 million. Accompanying rehabilitation measures in the buildings for improved thermal insulation and other measures add up to an additional € 30 million. The overall effect of the programme translates to 4 000 man-years. More than 50% of the employment increase will affect Mannheim region, the local economy.

3.2.6 Renewable district heating sector – Hillerød, Denmark

The SORCER project has ensured a significant growth in the share of the RES used for heat production in Hillerød/Ullerødbyen. It has increased from ~5% in 2006 to ~35% in 2013.

Table 14Overview of the various heat producers astablished partially under the SORCER project.

	Solar Heating	Solar Heating	Biomass boiler	Two stage gasification
Address of building	Månepletvej,	Kirsebæralle	Krakasvej	Krakasvej

Construction year	2009	2012	2010	2012
Gross area [m²]	3,000	788		
Installed capacity [kW]			7,400 heat	500 El 1.000 heat
Estimated annual production[MWh]	1,334	380	60,000	585 El 990 heat
Estimated electricity consumption MWh/year]			943	
Total plant costs [EUR]	1 M	315.000	1.8 M	1.34 M
Annual CO_2-savings [tonnes][22]	241	69	11,200	286

Solar heating

The plant has proven that it is possible to do a fairly simple set-up of the system based on existing technology. The solar heating plants are used to strengthen the DH grid locally in order to reduce the need for extra heating pipes.

The following experiences have been gained for the solar heat plant:

- The plant is located in a place which is highly visible close to a heavily trafficked intersection
  - This makes for an excellent display for citizens
    - A display on the building for technical installations placed next to the thermal plant shows the daily production and equivalent savings in oil.
  - Land area which normally would be vacant is utilized
- System performance within 2-3% of the expected production.

Biomass boiler

The following experiences have been gained for the biomass boiler:

- The biomass boiler uses wood chips and delivers heat to the low-temperature DH network in Ullerød and surrounding areas
- The biomass boiler has a capacity of 5,500 kW – or 7,400 kW including an absorption heater placed on the exhaust

[22] 183 g CO_2/kWh, emission factor for district heating 2012, 302 g CO_2/kWh, emission factor for electricity 2012

- The boiler runs in 1-2.5 tonnes of wood chips per hour, consuming approximately 60 tonnes each day
- The thermal efficiency reaches 105% based on lower heating value
- Production as expected and operating at close to the maximum capacity as a base load plant

Gasification process based on wood chips

The gratifier delivers 500-600 kW of heat to the DH network in Ullerød and some additional buildings in the surroundings. Production of electricity can reach 300-400 kW with an electrical efficiency of 38% and there has been an average production of 1.51 MWh electricity per day.

Due to various problems in the start-up phase as well as troubles later in the operation process, the gasifier has not been running stably.

Geothermal

The Hillerød utility company is investigating the opportunity for a geothermal heating plant in the local area. The results of the seismic studies will form the basis for selecting the optimal placements of wells and produce a drill profile with projected depths of the subsurface layers. The optimal locations of the wells are expected to be identified in the mid-summer 2014. The drillings carried out in this case in 2015.

CHP

Hillerød CHP plant has a capacity of 75 MW electricity. The annual electricity production is around 400 GWh, which corresponds to a consumption of 100,000 homes. Hillerød CHP plant produces about 416 GWh of heat, based on a heat capacity of 78 MJ/s. It is sufficient to meet the heat demand of approximately 40,000 homes. Each ear, the plant burns about 82 million m^3 of natural gas to utilization of 88%. The plant is equipped with a heat accumulator that can hold 16,000 m^3 water.

Photovoltaic

The plan in the SORCER project was to install 8 kWp of PV in Hillerød. Now 6-7 years later498 kWp of PV are installed on the roofs/ facades of many buildings in Hillerød Municipality. The PV plants produce an average of 954 full load hours each year.

3.2.7 CHP biomass – Klaipeda or Kaunas, Lithuania

Completed May 2013, Fortum's CHPP plant in Klaipeda is the first waste power plant in the Baltic States. Fuelled by municipal and industrial waste, and biomass, the plant can deliver 20MW electricity and 50 MW heat to the district heating network. Another 16 MW of heat during the period of maximum demand will be added in winter, as the flue gas condensers at the plant are capable of recovering 16MW of heat in addition to generating heat and electricity. It is estimated that the produced energy is expected to produce 140GWh of electricity and 400GWh of heat per year, displacing fossil fuelled technology and thereby reducing the local CO_2 emissions by 10-36,000 tonnes a year. The new power plant's boiler can incinerate 230 000 tonnes of waste and biomass annually, with an energy utilization close to 90%. The CHPP will be able to cover approximately 40% of the heat demand in Klaipeda.

It is expected that the power plant will operate as base load and run all year round with short stops for routine maintenance, and that the annual number of operating hours will make 8000.

Ownership

Plant construction started in March 2011 and took about 1.2 million hours or 750 man-years to complete. Occupational safety was a priority during the entire project and was at a good level with only two incidents causing lost workdays. Fortum's investment in the new power plant totalled LTL 435 million or approximately €130 million, which was financed by Nordic Investment Bank with €70 million loan. It was the largest foreign direct investment in Lithuania in 2012. Fortum is the owner and developer of the Klaipeda power plant and holds 95% share in the project, while Klaipedos Energija holds the remaining 5%. Klaipedos Energija will purchase the heat generated from the CHPP energy plant and sell heating energy to private as well as corporate consumers for the purposes of heating, hot water preparation, and steam for use in various industrial technologies.

The flue gas treatment and heat recovery system was supplied by Alstom. The flue gas treatment system included humidifiers, mixers, and waste treatment system. Fisia Babcock was the EPC contractor for the boilers. It was responsible for the design, development and erection of the boilers, as well as commissioning and trial operation. Honeywell provided the Experian Process Knowledge System (Human Machine Interface) and safety manager emergency shutdown for Klaipeda CHP plant.

Technical solution

The Klaipeda CHPP uses Alstom's NID flue gas cleaning equipment. The NID system is a semi-dry flue gas desulphurisation system that utilizes multi-pollutant control and zero-waste water discharge technology. The main concept behind semi-dry flue gas desulphurisation system is the reaction between sulphur dioxide and calcium hydroxide in humid conditions. The humidified mixture of hydrated lime (calcium hydroxide, $Ca(OH)_2$) and reaction product cools the inlet flue gas present in the NID system. The flue gas proceeds to the dust collector, where the gas particles are removed and processed back to the NID flue gas desulphurisation system. The fabric filter of Klaipeda CHPP has the advantage of lower particulate emissions and can absorb additional gas in the dust cake. Water is added to the ash, received from the fabric filter, to increase the moisture content in the humidifier.

The CHPP plant includes a safety manager emergency shutdown system, which reduce the human factor and thereby the chances of accidents and asset damages.

3.2.8 Small district cooling project – local areas, Norway

The DH network in Lillestrøm includes a 4.3 MW heat pump utilizing sewage. Also included in the local DH network is a boiler plant burning wood chips (20 MW) and renewable oil (50 MW), a 1.5 MW landfill gas boiler and 10.000m^2 of solar heating panels. The two wood chip boilers, which have a total capacity of 20 MW, are equipped with a flue gas condensation unit which combined with a heat pump brings the total efficiency to 118 %, based on the lower heating value of the wood. In addition a 3.5 MW cooling machine serves a 6 km long DC network.

Skøyen heating plant produces energy for 9,000 homes by using the heat from the sewers of Oslo. The plant consists of two heat pumps (18 MW and 9 MW) heating DH water to 90°C.

Solør Bioenergy's new cogeneration plant in Kirkenær is the country's first cogeneration plant based on bio energy. The energy produced by the creosote- and CCA-treated wood waste, which makes the plant the first to receive and burn treated wood waste in Norway. The facility includes a wood burning of 10 MW and an electrical generator of 1.8 MW.

Waste heat from the NPK plant in Porsgrunn Industrial Park covers nearly 90 per cent of the energy demand of the new DH network in Porsgrunn. The plant has an output of 23 GWh per year, supplying DH to a significant number of commercial and public buildings.

4 Interest groups

4.1 IEE - Intelligent Energy Europe

The largest financier of energy programs is the Intelligent Energy Europe that does not fund research, hardware The IEE programme is part of the EU's Competitiveness and Innovation Framework Programme. Managed by the European Commission and its Executive Agency for Competitiveness and Innovation (EACI), the IEE programme can already boast numerous success stories resulting in increased EE in buildings and industry, cleaner transport and greater use of wind, solar power and biomass, among many others.

Research, technology development, and hardware investments cannot be funded IEE. Neither will the IEE programme fund isolated, single actions at national or local level.

Recent project involving DHC, CHP and RES are listed below:

Cross-border markets for the European bioenergy industry (CROSSBORDERBIOENERGY)

Development of sustainable heat markets for biogas plants in Europe (BIOGASHEAT)

ECOHEAT4EU (ECOHEAT4EU)

Ecoheat4Cities (ECOHEAT4CITIES)

European heating and cooling market study (ECOHEATCOOL)

GIS-based decision support system aimed at a sustainable energetic exploitation of biomass at regional level (BIOENERGIS)

Geothermal DH in the city of Kecskemét (MLEI GEOKEC - CITY OF KECSKEMÉT

(HU))

Implementing Large Scale Solid Biomass Use in Eastern European District Heating Systems (Bioenergy To Business)

Improving the Social Dialogue for Energy Efficient Social Housing (ISEES)

Mobilising Local Energy Investments in Greater Cambridge and Greater Peterborough UK - Low Carbon Hub (L-CIF)

Mobilising local energy investment for a BiO and Waste district heating Network in Hengelo, the Netherlands (BOWEN)

Model cities promote green CHP - Pacemakers for renewable energies (CHP GOES GREEN)

New Business Opportunities for Solar District Heating and Cooling (SDHPLUS)

Promote Geothermal District Heating Systems in Europe (GEODH)

Promotion of Short Rotation Coppice for District Heating Systems in Eastern Europe (BIO-HEAT)

Solar District Heating in Europe (SDHTAKE-OFF)

Solrod Biogas Plant Investment Project (SOLROD)

Sustainable Energy Infrastructure for Greenport Venlo (ENERGY4FLEXIBILITY)

Woodheat Solutions (WHS)

A European Tracking System for Electricity (E-TRACK, Phase I and II)

Urban Planners with Renewable Energy Skills (UP-RES)

Cogeneration Observatory and Dissemination Europe, 1 and 2 (CODE and CODE2)

Enhancement of sustainable electricity supply through improvements of the regulatory framework of the distribution network for distributed generation (DG-GRID)

European Pellet Quality Certification (PELLCERT)

Market Access for Smaller Size Intelligent Electricity Generation (MASSIG)

New Business Opportunities for Solar District Heating and Cooling (SDHPLUS)

OPTimum Integration of POLYGENeration in the Food Industry (OPTIPOLYGEN)

Production of Electricity with RES & CHP for Homeowners (PERCH)

Promotion of Biogas for Electricity and Heat Production in EU Countries- Economic and Environmental Benefits of Biogas from Centralised Co-digestion (PROBIOGAS)

RES & micro CHP in RURAL LODGES (GREEN LODGES)

Reaching the Kyoto targets by means of a wide introduction of ground coupled heat pumps (GCHP) in the built environment (GROUND-REACH)

Renewable Electricity Supply interactions with conventional Power generation, Networks and Demand (RESPOND)

Strategic Initiative for Resource Efficient Biomass Policies (BIOMASSPOLICIES)

Development of sustainable heat markets for biogas plants in Europe (BIOGASHEAT)

Model cities promote green CHP - Pacemakers for renewable energies (CHP GOES GREEN)

Biomass role in achieving the Climate Change & Renewables EU policy Targets. Demand and Supply dynamics under the perspective of Stakeholders (BIOMASS FUTURES)

Deploying large-scale polygeneration in industry (D-PLOY)

Regional markets of RES-fuel cell systems for households (RES-FC MARKET)

Promotion of Biogas for Electricity and Heat Production in EU Countries- Economic and Environmental Benefits of Biogas from Centralised Co-digestion (PROBIOGAS)

4.2 Euroheat&Power

http://ec.europa.eu/competition/consultations/2013_state_aid_environment/euroheat_en.pdf

EHP unites the CHP and DHC sector throughout Europe and beyond, with members from over thirty countries: including most actors in the DH and cooling sector. EHP works for energy supply in balance with ecology, promoting the advantages of CHP/DHC in general, the use of renewable energies, and pursues international measures to enhance relevant innovation and development.

EHP states:"*Energy infrastructure planning must be driven by the objective of climate protection".*

Below some announcements/statements from EHP of relevance to the present project has been recited as basis for further discussion:

Long-term investment

EHP sees a problem in today's liberalized markets and states that they are too focused on short-term return on capital. Therefore, investors do not necessarily consider long-term commitments such as DH as attractive options.

To ensure an adequate return on investment in the DH infrastructure, legislation must provide for fair allocation of the gained value to all parties including to the investor and operator. These benefits include avoiding energy imports, price stability and environmental savings.

Assess potential

Directive 2012/27/EU on Energy Efficiency will request Member States to assess the potential for DHC and CHP, and to take measures to document the potential to achieve 2020 targets, and move closer to a low-carbon energy system. The Directive covers cost-benefits analyses, accounting for socio-economic and environmental benefits, which will evaluate the potential for alternative scenarios compared to conventional options. These analyses will underpin Member States' actions to realize the potential for CHP/DHC.

Simpler support scheme rules

Support schemes to DHC infrastructures need to be simplified, as it has so far been out of the scope of *Guidelines and Block Exemption Rules*. Such a situation has led to uncertainty for Government and operators. The clarification and simplification of rules can be done by including integrated projects such as efficient DHC projects in the *Guidelines and Block Exemption Rules*. Such a change will end the present situation, so that support to DHC infrastructure is systematically assessed on a case by case approach, and it will put investments into networks on equal par with CHP and the use of RES. In this way, support can be assessed on the basis of environmental benefits compared to a conventional investment and investments into energy production will be accompanied with investments on the DHC network.

Definitions

The definition of *"Efficient DHC"* will ensure that State Aid brings development of new networks/upgrade of existing networks towards 'Efficient DHC' status.

An *"Efficient DHC"* means a DHC system using at least

- 50% RES or
- 50% waste heat or
- 75% cogenerated heat or
- 50% of a combination of such energy and heat.

Economic instruments

Market based instruments, such as feed-in premiums for CHP, have proved successful at developing EE. These schemes have proved cost-effective in fostering a more efficient use of resources (conventional and renewables alike) while supporting installations that make energy systems more flexible and resilient.

Current economic circumstances are not favourable for CHP installations. On the electricity side, installations are hit by lower profitability because of changes associated to the growing share of intermittent power. On the heat side, the distortive effects stemming from emission trading are playing against efficient DH as the 20 MW threshold of the emission-trading scheme covers large DH installations but excludes the largest share of the heating market – block heating and individual boilers.

Future rules should therefore be designed with the aim to providing a clear framework supportive for CHP and DHC.

Need for further clarification

DC represents an efficient alternative to the use of electricity for the supply of cooling in urban areas. Due to the use of resources that otherwise would be wasted or difficult to use, DC systems reach efficiencies that are between 5 and 10 times higher than with traditional electricity-driven equipment. They can greatly contribute to avoiding electricity peak loads during summer which are increasingly occurring due to cooling demands in all European regions, in particular in Southern Europe. As a consequence, the need for investments in new power generation and network capacities as well as greenhouse gas emissions from power production, can be significantly reduced.

4.3 COGEN Europe

COGEN Europe is the European association for the promotion of cogeneration. COGEN Europe is a Belgian non-profit NGO established in 1993 and its membership includes more than 70 organizations involved in cogeneration in over 30 countries. COGEN Europe represents the interests of its members towards the European Parliament and European Commission.

Below some announcements/statements from COGEN Europe of relevance to the present project has been recited as basis for further discussion:

The central and most fundamental principle of cogeneration is that, in order to maximize the many benefits that arise from it, systems should be based on the heat demand of the application.

The Heat Coalition believes that the energy sector needs to focus both on technological innovation, as well as on societal, financial and organizational innovation in order to maximize success, especially when dealing with the development of emerging technologies, in both the heat and electricity sectors at local and regional levels. The main success factor for their implementation lies in tapping local/regional resources to its full potential.

Designing the future of European climate and energy policies requires a holistic approach by all levels of governance (i.e. European, national, local) involving all forms of energy supply and demand. For the successful development of a post-2020 energy policy framework, Europe needs to understand thermal energy flows within and across sectors.

Bottom-up assessment

A focus on CO_2 alone will fail in introducing a cost-effective implementation of energy efficient production and consumption. Decarbonizing the power and heat system requires a market-driven and cost-efficient approach, integrated solutions, partnerships and triggers which cannot be leveraged by a GHG-only approach. COGEN Europe recommends a bottom-up approach[23] to when setting 2030 climate and energy framework. A basis for this should be a thorough evaluation of the current and forecasted heating and cooling demand. This demand should be met by a proper individually and system considered solution.

Clarify the term "energy"

The Heat Coalition stresses the importance of making clear reference to *heating and cooling* when referring to "energy" and that thermal energy should be addressed with the same importance as electricity. This has not been done in the past and thus the sector's potential in energy savings and the use of RES remains untapped.

The PRIMES model neither takes into account current heating demand nor does it sufficiently reflect heat production in Europe. This result in an overestimation of "electrification" of heat is present in the Energy Roadmap 2050.

4.4 International Energy Agency - IEA

DHC Annexes

The Implementing Agreement of IEA for a Programme of Research, Development, and Demonstration on DHC, including the integration of CHP was established in

[23] The approach should maximize the different sectors' potential, where they contribute most efficiently to the targets in order to reduce costs and produce substantial side-benefits, including employment and local economic development.

1983. There have several 3 year lasting research annexes and the Annex XI for the year 2014-2017 is about to start in spring 2014 and the applications shall be submitted by January 2014.

The Implementing Agreement deals with the design, performance and operation of distribution systems and consumer installations. The Agreement is dedicated to helping to make DHC and CHP powerful tools for energy conservation and the reduction of environmental impacts of supplying heat.

The work programme is mostly conducted through cost-shared activities. In 2011 Annex IX was completed and the five projects carried out were titled as follows:

› The Potential for Increased Primary Energy Efficiency and Reduced CO2 Emissions by DHC, SP Technical Research Institute of Sweden

› District Heating for Energy Efficient Building Areas, VTT, Technical Research Centre of Finland/ Energy Systems

› Interaction Between District Energy and Future Buildings that have Storage and Intermittent Surplus Energy, Gagest Inc., Canada

› Distributed Solar Systems Interfaced To A District Heating System That Has Seasonal Storage, Gagest Inc, Canada

› Policies and Barriers for District Heating and Cooling outside EU Countries, Energy-AN Consulting, Finland

At the moment Annex X is running with the four projects about to be completed by 2014:

› Improved maintenance strategies for DH pipelines, SP Technical Research Institute of Sweden

› Economic and Design Optimization in Integrating Renewable Energy and Waste Heat with District Energy Systems, FVB Energy Inc., USA

› Towards Fourth Generation District Heating: Experiences with and Potential of Low Temperature District Heating, Technical University of Denmark (DTU)

› Development of an Universal Calculation Model and Calculation Tool for Primary Energy Factors and CO2 Equivalents in District Heating and Cooling including CHP, SINTEF Energy Research, Norway

New project application for 2014-2017

Annex XI seeks research within three (3) primary themes:

Theme 1: Cost Reduction in District Heating & Cooling

Background: Current practices often provide minimal profitability for district energy particularly within smaller systems (<20 MW) or areas of low line density (<1.5 MWh/meter and year). The design and construction of new, and refurbishment of old, district energy systems therefore necessitates both an optimized thermal performance as well as a minimized system cost. Research should focus on innovative methods, materials and practices in:

1.1. System Design – methods, practices or tools that reduce overall design time while maintaining a high degree of accuracy.

1.2. Component or system construction techniques – innovative materials or techniques that reduce the overall installation cost yet improve performance.

1.3. Operational philosophy or strategy – predictive techniques for optimizing energy production, dispatch and consumption.

1.4. Maintenance programs – techniques for monitoring or developing cost effective maintenance programs.

Theme 2: System Transformation from High to Low Temperature District Heating Operation

Background: The economic viability, efficiency and applicability of connecting existing buildings into existing DH systems are predicted to improve when the district heating system supply temperature is lowered. However, conversion of buildings internal heating systems can be required, typically an expensive undertaking. Research is therefore needed into methods and approaches to economically convert individual buildings, portions of or entire DH systems from a higher temperature (e.g. steam, hot oil, hot water) to a lower temperature (warm water, water at ambient temperature) heating supply. Sectors of interest include:

2.1. DH network system transformation techniques – economic techniques for conversion of distribution systems from high temperature to low temperature operation.

2.2. DH interconnections and building conversion – innovative options for economic conversion and connection of low energy buildings to low temperature DH systems.

2.3. DH system expansion techniques to include both low and high temperature supplies – methods of combining multiple energy sources at different temperatures to allow for system expansion or cost reductions

Theme 3: Resource Planning and Business Development

Background: Expanding existing or establishing new district energy systems as viable district energy1 (DE) businesses requires integration of the long term needs of the district energy system with those of the community. Business planning for district energy extends beyond efficient engineering to involve:

aspects of urban and resource planning, system modelling, financial instruments, socio-economic assessment, strategic decision making and program development and capacity building at the urban scale. Research is needed into demonstrated.

1 District energy has the same meaning as DHC and may include CHP generation techniques and practices that support the development of business models and the long term growth of district energy.

3.1. Methods for integrating district energy with urban planning – decision making strategies for aligning community needs with the benefits of district energy.

3.2. Governance structures and strategic decision making processes for urban and rural district energy development – case studies from alternate approaches to system ownership and operation.

3.3. Smart energy (thermal & electrical) system integration and operation – methods, tools and strategies that improve overall community energy efficiency and community resource efficiency.

3.4. Quantification of socio-economic and environmental benefits – techniques and demonstrated methods for quantifying or monetizing the socio-economic benefits and other externalities associated with district energy.

New: Task-shared Annex

A new Task-shared Annex started recently in IEA DHC history. The Task-shared Annex allows member countries and sponsors to link national research to benefit from international developments.

The first IEA DHC Annex TS1 aims to identify holistic and innovative approaches to communal low temperature heat supply. It is strongly targeted at DH technologies and the economic boundary conditions of this field of technology. The Annex TS1 is a framework that promotes the discussion of future heating networks with an international group of experts. The goal is to obtain a common development direction for the wide application of low temperature DH systems in the near future. The gathered research which is to collected within this Annex should contribute to establishing DH as a significant factor for the development of 100% RES based communal energy systems in international research communities and in practice.

4.5 Nordic Council of Ministers – St Petersburg Office

The purpose of the project is to promote RES and EE in Northwest Russia based on the Nordic experience in coordination with the Nordic Environment Finance Corporation (NEFCO) and United Nations Economic Commission for Europe (UNECE).

The goals of the Project are:

- To present Nordic strategies for sustainable use of RES and to prepare background materials for updating regional Plans on EE in Northwest (NW) Russia. Nordic policy on use of RES is learnt and evaluated. Background materials for updating regional Plans on EE are prepared;

- To create a platform uniting Nordic and Russian stakeholders for facilitating green growth in energy sector;

- To increase use of local energy sources especially in the remote off-grid territories of the Barents region of Russia;

- To present new environmental technologies in RES sector to municipal and private companies working in NW Russia and Nordic countries and to introduce funding opportunities for modernization of infrastructure;

- To develop pilot projects on use of local energy sources in the regions of NW Russia based on received knowledge; and,

- To provide Russian research institutes with an opportunity to present their ideas and innovations to regional governments and energy companies.

The project duration is January 2013 - June 2014.