MARCH 2014
BASREC

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

BASREC – BEST PRACTICES SURVEY

SUMMARY

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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 Summary and Conclusions

1.1 Background

Achieving the EU 2020 and 2050 energy and climate goals requires strong and focussed energy development strategies. EE and integration of RES into the markets for electricity and heating are important steps in the entire development process.

The Northern European energy systems have a solid foundation for meeting the challenges of the future, and the Baltic Sea Region has a unique opportunity to become a frontrunner in the development process. The region is endowed with vast natural resources in terms of biomass, wind and hydro power potential and there is a long tradition for electricity cooperation between the Nordic countries ensuring optimal utilisation of the resource potentials possible in short medium and long term.

To ensure efficient utilisation throughout the development process however, the interaction between the electricity and heat market are of upmost importance. It is recognised that CHP and DH has a key role to play in helping Europe reach its EE target of 20% in 2020. DH is an important infrastructure for phasing out the direct use of fossil fuels for heating purposes in the short term. A common recognition of this importance at regional level would support national strategies and create a sound basis for the necessary investments in the heat supply structure to ensure the overall efficiency of the integrated energy structure up to 2020 and between 2020 and 2050. After 2050 new technologies might be ready to take over.

Strengthening CC and reduction of costs of fossil fuels are some of the new challenges that DH, CHP and RES are facing now. To meet the new challenges, the BASREC countries shall continue pioneering work in the global context.

In the Communiqué adopted at the BASREC Meeting of Energy Ministers in Berlin 14–15 May 2012 the Parties confirmed that their co-operation in the upcoming co-operation period 2012-2015 will concentrate on certain energy topics in order to meet global energy policy challenges. Two of these topics are:

- Increased use of renewable resources available in the region, including integration of fluctuating wind power into the electricity system, and
- Rehabilitation and development of DHC and CHP.

On 25 October 2012, the EU adopted the Directive 2012/27/EU on EE. This Directive establishes a common framework of measures for the promotion of EE within the Union in order to ensure the achievement of the Union's 2020 20 % headline target on EE and to pave the way for further EE improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national EE targets for 2020.

By 31 December 2015, Member States shall carry out and notify to the Commission a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient DHC. If they have already carried out an equivalent assessment, they shall notify it to the Commission. The comprehensive assessment shall take full account of the analysis of the national potentials for high-efficiency cogeneration carried out under Directive 2004/8/EC.

Member States shall adopt policies which encourage the due taking into account at local and regional levels of the potential of using efficient heating and cooling systems, in particular those using high-efficiency cogeneration. Account shall be taken of the potential for developing local and regional heat markets. For the purpose of the assessment, Member States shall carry out a cost-benefit analysis covering their territory based on climate conditions, economic feasibility and technical suitability in accordance with Annex IX of the Directive. The cost-benefit analysis shall be capable of facilitating the identification of the most resource-and cost-efficient solutions to meeting heating and cooling needs.

The substance of DHC, CHP and RES is wide. Demands for development vary due to diversity of substance, stage of progress, differences in municipality size, geography and national interests.

Under consideration of both the EU requirements and the specific goals and objectives in the Baltic Region identification of new actions and cooperation issues are prioritized by BASREC in connection with the development. As basis for decisions it is important to establish a consistent overview of:

- Energy policy of BASREC member states regarding DHC, CHP and RES relative to objectives and targets set by the EU; and,

- Studies recently completed about DH rehabilitation and development, DC expansion, CHP growth and RES expansion in the member states, IEA and Intelligent Energy Europe.

The report at hand aims at identifying new ways of strengthened pioneering in research of DH, CHP and RES with links to other research underway and planned elsewhere.

1.2 Objectives and approach

The general aim of the "State of the Art" project is to help the GSEO when considering BASREC's role in "Rehabilitation and development of DHC systems" and "Increased use of RES available in the region" as stated in the Communiqué.

For the GSEO it is important to find suitable project(s) and possible cooperation forms with other organizations to avoid duplication and to save in expenses.

As basis for ensuring a sustainable development the long term targets of the proposed project are to:

- minimize the carbon footprint and PEF; and,
- increase the rates of CHP, DH, DC and RES and improve the overall efficiency of CHP, DH, DC

The immediate goals of the project are:

- To make a survey of the state of the art on DH, DC, CHP generation and use of Renewable/Local Energy Sources in BASREC countries; and,
- Based on the survey to propose project(s) by which to fulfill the assignments set out in the Communiqué in an efficient way and benefiting the majority of the BASREC countries.

A comparable and consistent overview of the present structure of DH, CHP, DC and use of RES has been established for the 11 BASREC countries.

The capital cities in the countries are all active players in establishing and implementing sustainable energy development schemes. Therefore it has been chosen to "tell the energy story" of the capital cities for each country along with other selected best practices in the individual countries. Although some of the best practices may not be directly replicable due to different circumstances prevailing in the countries the cases serve as inspiration and gives ideas to be exchanged among the countries on how system performance could be improved.

A short summary of ongoing both national and international research and development programs on DHC and CHP with RES is included to set the framework for decisions related to new needs and activities.

1.3 Conclusions and Recommendations

The BASREC countries comprise a large variety of sizes, affiliations and energy systems ranging from small Iceland with 100% renewable to huge Russia with some 1%. Most BASREC countries are models to other parts of the world in terms of successful implementation of DHC and CHP as such and particularly linked with RES.

The lessons learned from the areas with more successful implementation of DHC and CHP are primarily that energy planning is the most essential parameter. In general, a wide focus on energy planning as basis for ensuring development and implementation of policy goals at both national and local level is very important for the development.

Energy planning with focus on *gross energy savings*, meaning the reduction in total primary energy source (TPES), needs to be emphasized to optimize system performance and cost on a national and international level. In this respect CHP can play a major role. Some BASREC countries have a widely developed district heating system, and much fossil fuel in the electricity mix, meaning that there is a large amount of waste heat that can be utilized in DH at a low cost, reducing operation at inefficient heat- and power plants. This is one example of energy planning leading to reduced costs and TPES savings.

It is essential to estimate the *spill over/repercussions* of an energy scheme, prior to implementation. The effects of implementing one scheme in country A, will impact the energy system of the neighbouring country B. This again will lead to a response which might have a negative impact on country A. The energy planning over borders and cooperation when developing national energy plans is important to avoid that energy measures *backfire.*

As some countries in the region have stated that independence from foreign energy supply is top priority, there is a risk that environmental considerations are not adequately cared for. Biomass (and waste) heating/CHP could be promoted as an ideal alternative and a measure to achieve the desired energy independence.

When implementing measures to improve national energy systems, the procedure to have the measures implemented at municipal level can be troublesome. The lessons learned from well-developed energy systems are valuable and should be shared with decision makers of less developed systems.

In the market where it is desired to increase the share of DH/CHP/RES, the conditions for such establishments have to be in order. A competitive market with relatively low entry barriers is not always granted.

In the report at hand, the authors would like to pinpoint three best practices to address the issues mentioned above. The selected three best practices are:

- **District cooling** shall be developed as a complementary product to CHP and DH in locations where sea or lake water can be used as a natural cooling source. Thus, the PEF of cooling can be substantially reduced as has been done in Stockholm, Helsinki and Copenhagen, for instance, as presented in Chapter 4.1.

- **Integral urban and energy planning** has become an important issue while planning urban structures to favour EE and RES development, and with DHC and CHP in particular. Examples of integral urban and energy planning are the cities of Växjö, Sweden, and Porvoo, Finland, for instance, as described in Chapter 4.2

- **"Planning and pooled operation of several energy production plants in integrated urban CHP/DH systems based on RES (biomass/geothermal/solar)** is important to optimise the use of different types of renewable sources in different heat and electricity markets. Flexibility and links between the electricity systems and the heat market are

required to ensure that valuable energy is not wasted. The Copenhagen system is illustrating best practices in this respect.

All eleven BASREC countries have good examples on how the technologies have been implemented at city level. While having such a strong background, high requirements are set to the volume and substance of the related research activities in the BASREC countries.

The role of BASREC can be to support the institutional development of DHC, CHP and related RES. New project ideas are suggested in Chapter 3 with links to existing research and development organizations. Preliminarily the following research ideas have been identified:

Uniform CHP Statistics

Statistics of CHP still lack consistency. The CHP share in electricity production most often is reported only based on installed capacity and not based on annual electricity production in CHP mode. For some time already, the issue has been intensively discussed at EU level, and in the Energy Efficiency directive a set of definition and standards has been agreed upon. It is recommended to establish a BASREC overview of CHP both in the heat and in the electricity marked which is harmonized with the definitions used in the Energy Efficiency directive. This approach will also set focus on the strong role of the BASREC countries in the overall European DH/CHP/DHC and RES development. Further it will be important for the internal cooperation and development among the BASREC countries.

CHP with Individual RES Applications

Both CHP and RES are good to be promoted but how to integrate them is not that simple. Individual RES installed in the DH area with CHP supply reduces 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.

CHP and RES in the Electricity Market

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. These aspects could be further analyzed and discussed among the BASREC countries in the context of evaluating the future development of CHP/DHC/RES.

Hiding Heating with Electricity

There is substantial electric heating in households and commercial buildings that is hiding behind the energy statistics. Such hiding heating used in dish washing, laundry washing, floor heating of sanitary rooms, heat pumps, entrance of doors, etc. Converting such electric heating to DH and other RES would reduce primary energy consumption.

Benefits of CHP

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

District Cooling

Review of various methodologies for DC being available in BASREC countries and various regions such as locations near the sea side, lake and river side, geothermal area, etc.) as well as the potential for DC development in the next 10 years will be elaborated. Benefits to traditional cooling modes will be assessed.

A consistent approach to analyzing the benefits of DC in respect of energy savings, CO2 reductions and cost allocation is an important aspect in the future development which needs to be elaborated. Examples from different ongoing DC projects in the BASREC countries should be evaluated and discussed in order to establish a common platform for further development.

The report will be used for marketing DC in BASREC region.

1.4 Country overview – Summary

A comprehensive country survey is found in the report appendix. The main findings is presented here.

The main regulatory features of the countries are summarised in Table below. The features are just typical as many practices may prevail in a country. Heat metering, for instance, exists in Russia, but with a minority of consumers being metered. Therefore, it is marked with "N".

		DE	DK	ES	FI	IS	LV	LT	NO	PL	RU	SE
1	Building regulations with EE	y	y	y	y	y	y	y	y	y	n	y
2	DH prices regulated	N	Y	Y	N	N	Y	Y	Y	Y	Y	N
	DH market stable/expanding/shrinking	E	S	S	S	S	S	S	E	S	S	S
3	Heat market competition	Y	N	Y	Y	N	Y	Y	Y	Y	N	Y
4	Main competitor	Gas		Gas	HP	El	Gas	Gas	El	Gas		HP
5	FIT/Premium scheme for CHP	Y	N	N	N	N	N	N	N	N	N	N
6	FIT/Premium for Biomass	Y	Y	Y	Y	N	Y	N	N	N	N	N
7	Emission trading scheme	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
8	Carbon tax in use	N	Y	Y	Y	Y	N	*	Y	N	N	Y
9	Investment grants for DH/CHP	Y	N	Y	N	N	N	N	N	N	N	N
12	DH customer rights (Weak/Strong)	S	S	S	S	S	S	S	S	S	W	S
13	DH service quality (Good/Poor)	G	G	G	G	G	G	G	G	G	P	G
14	Billing based on metered consumption	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
15	Municipal role (Weak/Strong)	S	S	S	S	S	S	S	S	S	W	S
16	Private sector involvement in DH/CHP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y/N	Y
17	Integrated resource planning	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
18	Heat planning and zoning	N	Y	N	N	N	Y	Y	N	Y	Y	N
19	Technical standards up-to-date	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
20	Refurbishing strategy in use	n.a.	n.a.	Y	n.a.	n.a.	Y	Y	n.a.	Y	N	n.a.
21	DHW supplied with DH	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Clarifications: N=no, Y=yes, EL=Electricity, W=Weak, S=Strong, HP= Heat pump

**only for transport sector*

Table 1: Summary of regulatory features among the countries.

Based on the country assessment and the detailed country reports included under chapter 2 of the present report, some comparative key figures are given below. The country specific data presented here is based on IEA (2013) and Euroheat&Power (EHP Survey - 2011) statistics publications. Exceptionally, the values of Russia, if not available in any statistics mentioned above, have been estimated by the consultants.'

The key figures will be further discussed as basis for identifying similarities and differences between the 11 countries. This discussion again will form the background documentation both for new BASREC initiatives of common relevance and for exchange of experiences between the countries.

The key figures further can be used as basis for a common reporting and follow up on development of the sector in the BASREC countries both internally and towards EU.

Electric power

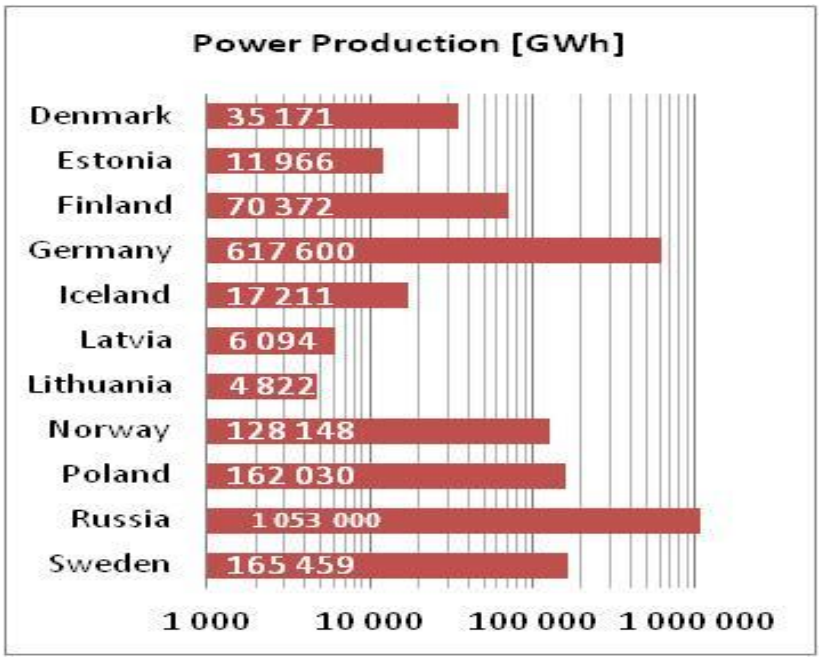


Figure 1-1 Domestic power production in 2011[GWh]-IEA

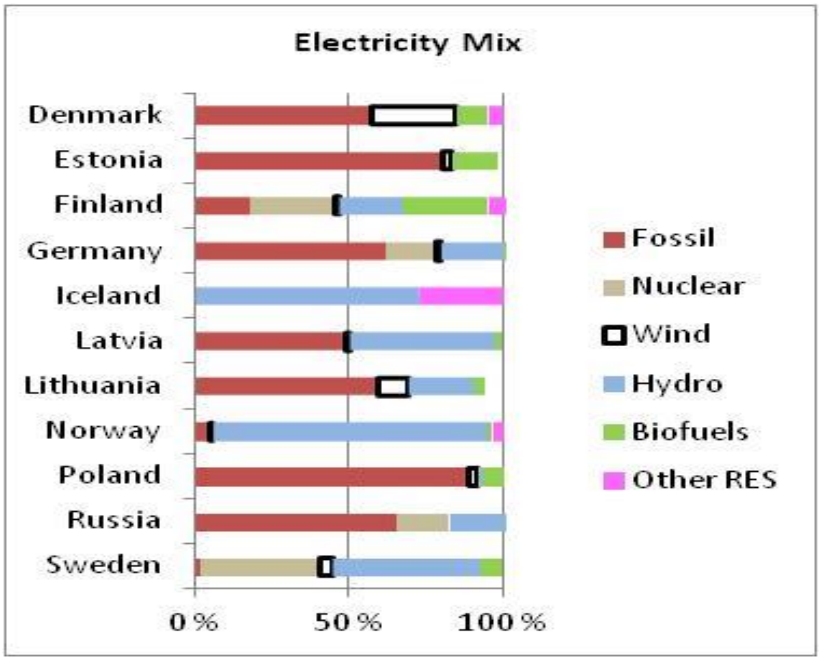


Figure 1-2 Fuel sources for domestic electricity production 2011- IEA

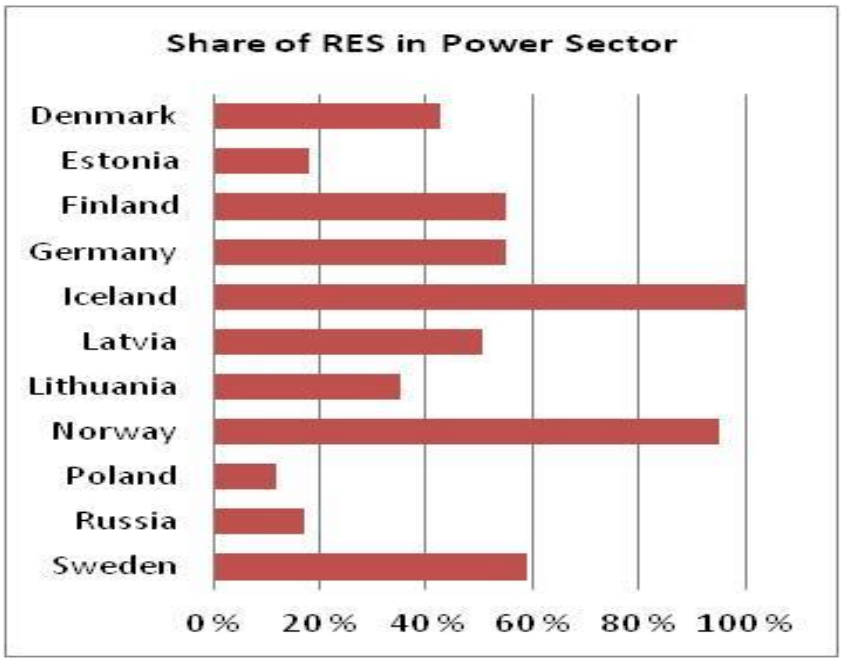


Figure 1-3 The share of RES in the power sector 2011 – IEA

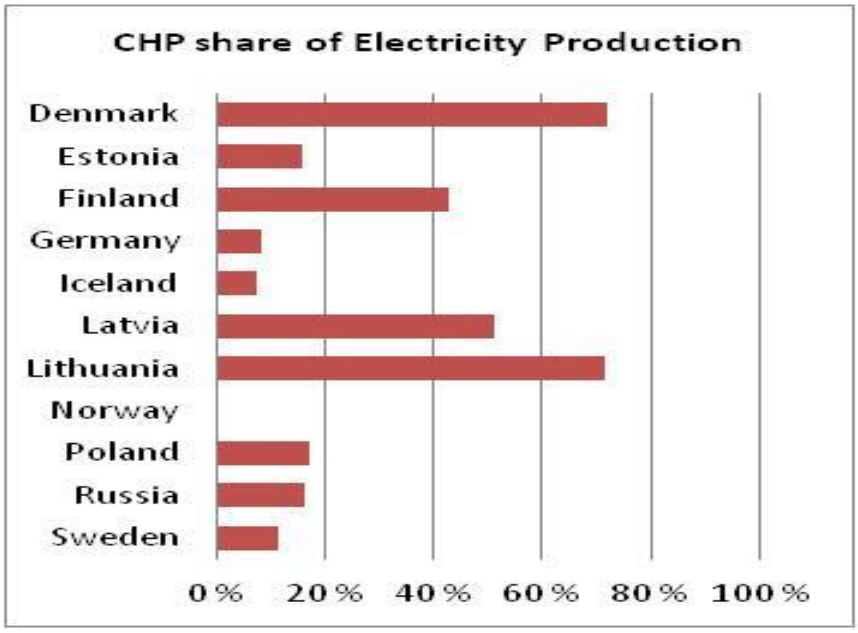


Figure 1-4 Share of power from CHP plants based on various sources (various sources 2009-2011).

Combined Heat and Power

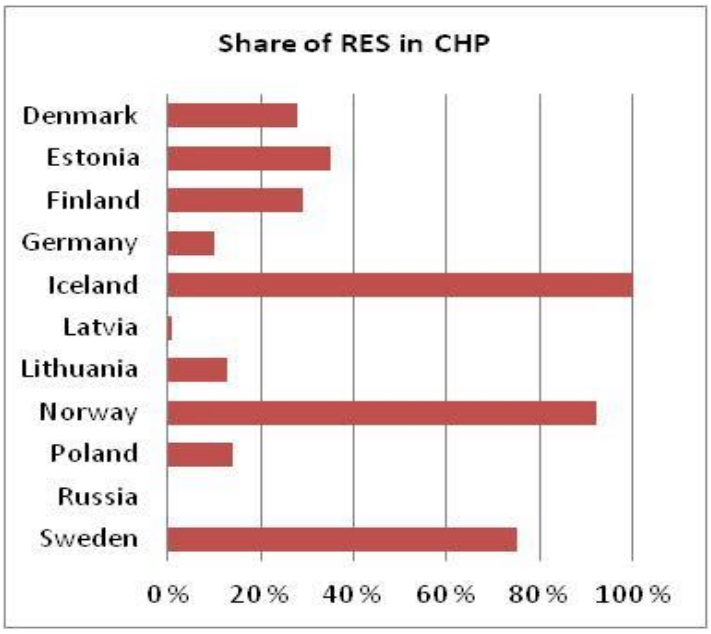


Figure 1-5 Share of RES in CHP plants – EHP2011

District Heating

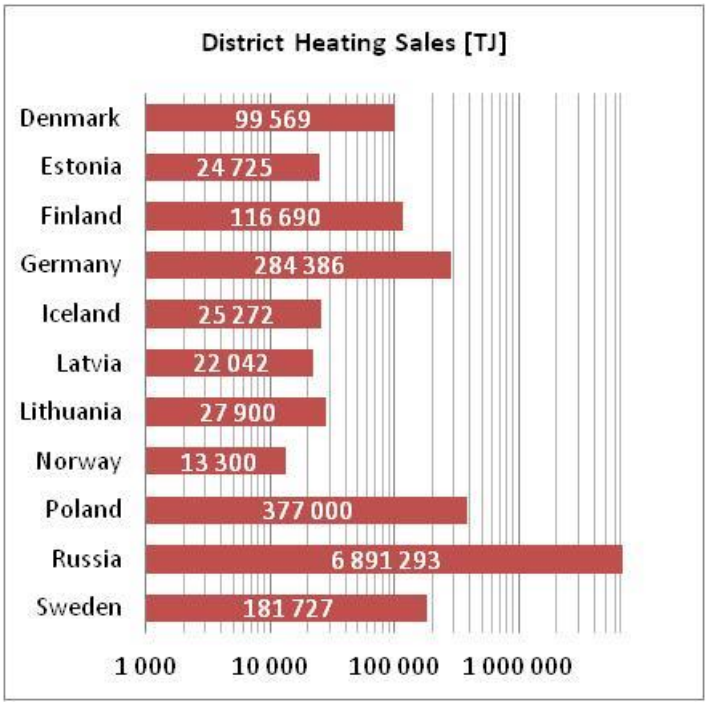


Figure 1-6 The size of DH sector. Total amount of heat sold to customers (Note: logarithmic scale) [TJ]-EHP2011and Polish energy authorities.

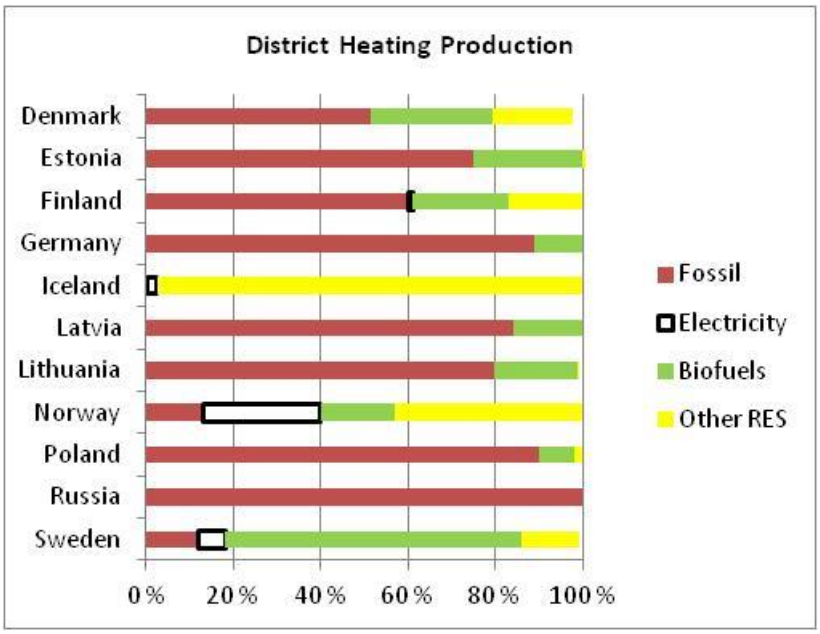
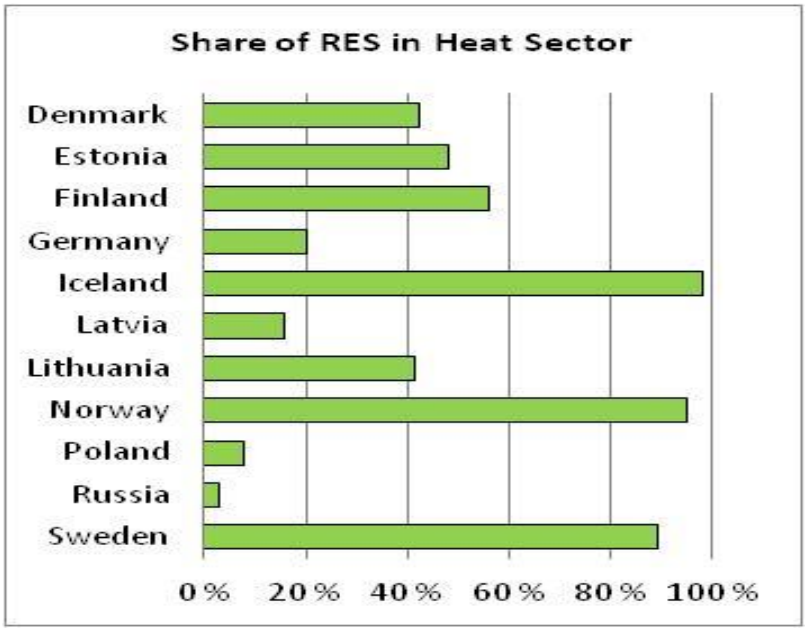


Figure 1-7 The composition of fuels to cover the total domestic heat demand- EHP2011



F igure 1-8 The share of RES to cover the total domestic heat demand- IEA 2013

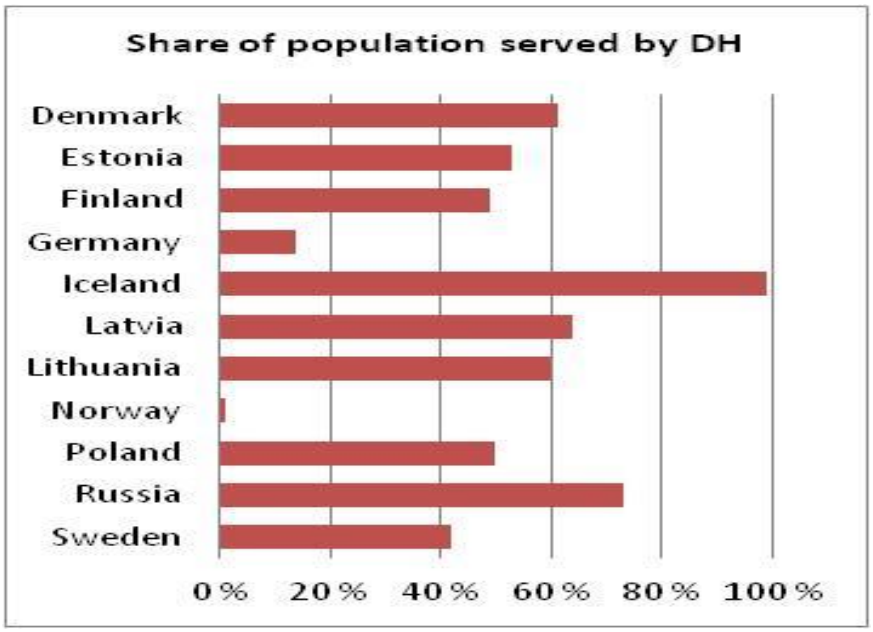


Figure 1-9 The share of population served by DH- IEA 2013

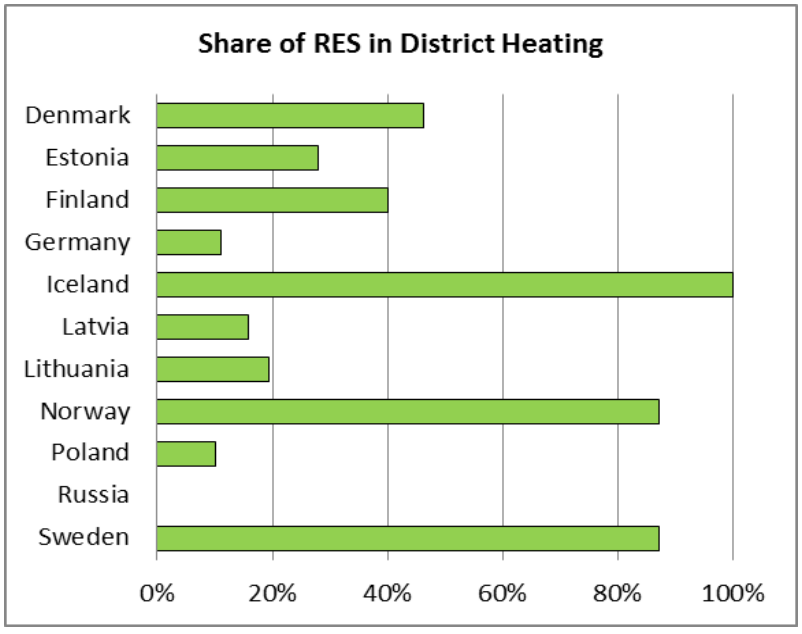


Figure 1-10 The share of RES in the production of DH- IEA 2013

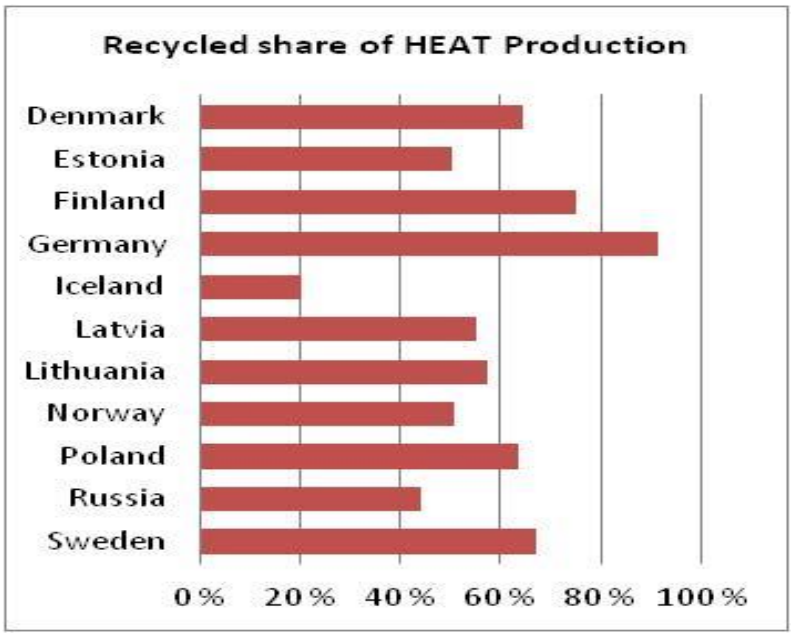


Figure 1-11 The share of recycled heat out of DH production-EHP 2011