CODE2

Cogeneration Observatory and Dissemination Europe

D5.1 Final Cogeneration Roadmap

Member State: ***Estonia***

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Version 1.0

Leading CODE2 Partner: ***Jozef Stefan Institute***

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Introduction and Summary

The CODE2 project[1]

This roadmap has been developed in the frame of the CODE2 project, which is co-funded by the European Commission (Intelligent Energy Europe – IEE) and will launch and structure an important market consultation for developing 27 National Cogeneration Roadmaps and one European Cogeneration Roadmap. These roadmaps are built on the experience of the previous CODE project (www.code-project.eu) and in close interaction with the policy-makers, industry and civil society through research and workshops.

The project aims to provide a better understanding of key markets, policy interactions around cogeneration and acceleration of cogeneration penetration into industry. By adding a bio-energy CHP and micro-CHP analysis to the Member State projections for cogeneration to 2020, the project consortium is proposing a concrete route to realise the Europe's cogeneration potential.

Draft roadmap methodology

This roadmap for CHP in Estonia is written by the CODE2 partner Jozef Stefan institute based on a range of studies and consultations (see Annex 7). It has been developed through a process of discussion and exchanges with experts[2].

Acknowledgement

Jozef Stefan Institute and the CODE2 team would like to thank all experts involved for their contributions to develop this roadmap, which has been valuable regardless of whether critical or affirmative. It has to be stressed that the statements and proposals in this paper do not necessarily reflect those of the consulted experts.

[1] For more details and other outcomes of the CODE2 project see: http://www.code2-project.eu/.

[2] Discussions with policy authorities and experts took place on the several CA-EED meetings and later on in 2014 with more experts phone conversation and mail exchanges of information.

Summary

Estonian minimum energy dependency based on the prevailing use of domestic oil shale (60% in primary energy and 90% in electricity generation) and 30% of electricity export has an important influence on the past and current CHP development with 10% share in growing electricity generation. Long cogeneration tradition in district heating and industry, rather broad awareness on cogeneration advantages and incentive support framework enables further CHP development, especially by using renewable and domestic energy sources, like wood biomass, oil shale, peat and waste. Current unfavourable energy market conditions with low electricity and growing natural gas prices and risky natural gas supply from Russia are not providing a proper incentive for natural gas CHP investments. Sustainable CHP electricity generation is in line with the key national energy policy goals to increase energy efficiency and use of domestic primary energy sources and could contribute to a long-term goal of Estonia, to become a net exporter of energy.

The CHP roadmap path would deliver up to 1,4 TWh/a of primary energy saving (PES) and 1 Million tonnes of CO_2 reductions are achievable till 2030. CHP could contribute more than 20% of the national indicative primary energy saving target (5,6 TWh) till 2020 and result in huge benefits for the national economy. Preserving a stable long term support framework for cogeneration and subsidies for the energy retrofit of district heating systems and switch from fossil fuel heat to renewable CHP are key necessary support measures. Profound implementation of EED could significantly contribute to a proper future CHP role in the sustainable energy supply of Estonia and the roadmap implementation. Diversification of natural gas supply by new transmission lines and regional LNG terminals is a prerequisite for the exploitation of the natural gas CHP potential linked to the current more than 40% share of natural gas for heating. New market instruments for a faster integration of CHP units into grid ancillary services would have positive economic benefits for flexible CHP plants in current very unfavourable energy market conditions.

1. Where are we now? Background and situation of cogeneration in Estonia

1.1 Current status: Summary of currently installed cogeneration in Estonia

Positive trends of CHP electricity generation in Estonia are driven by a growing use of renewable energy sources beside traditional prevailing use of domestic oil shale resources. Close to 0,5 GWe of installed CHP capacity with 95% share of steam turbines, generated 1,2 TWh of electricity and 3,4 TWh of heat in 2013 whereas the share of CHP electricity generation in the growing total electricity generation varies for around 10%.

Estonian minimum energy dependency is based on a prevailing use of domestic oil shale (60% in primary energy and 90% in electricity generation) and 30% of electricity export has an important influence on the past and current CHP development focused mainly on the supply of heat to district heating systems.

The lowest energy dependency in EU28[3] with prevailing 60% of domestic oil shale and 14% of renewable energy sources (RES) in primary energy consumption is an important energy specifics of Estonia (Figure 1) influencing also electricity generation where more than 90% of the around 11 TWh total net electricity generation (2,8 GWe of installed capacity[4]) is produced from oil shale, followed by growing generation from RES (mainly biomass and wind) in 2013[5] with more than 30% of the net export of electricity.

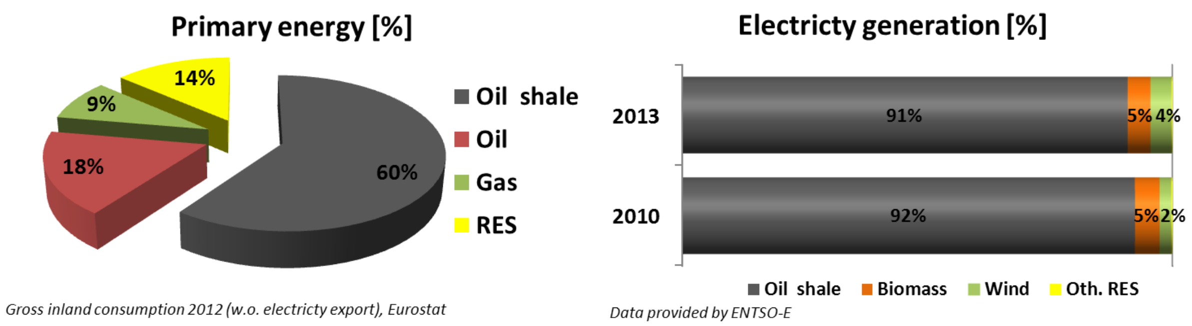

Figure 1: Structure of primary energy and electricity generation in Estonia

Following national CHP statistical data[6], the share of cogeneration in growing total gross electricity production in Estonia[7] oscillates around 10% (Table 1) with a growing trend of CHP electricity and heat generation (1,2 TWh and 3,4 TWh in 2013).

The total installed capacity of high-efficiency cogeneration in Estonia is growing and reached 0,46 GW in 2013 with more than 95% share of steam backpressure and condensing turbine in the

[3] Between 12- 24% in the period 2007-2012, the lowest in EU28 after negative dependency of Denmark, Eurostat, 2011.

[4] EUROSTAT Energy, transport and environment indicators, pocketbooks, EU, 2013

[5] Shares of other fuels (natural gas, coal and peat) are less than 1%.

[6] Data fits to Eurostat data: Combined Heat and Power (CHP) data, 11 June 2013 (minor deviations in 2011).

[7] Total gross electricity generation has grown for more than 35% in the period from 2006 to 2013.

minor share of internal combustion engines[8]. More than 75% of all installed CHP capacities are installed in district heating systems and more than 16% in industry.

Considering used fuel for cogeneration, renewable energy sources present 37% and the natural gas 17% of total all used fuels besides the prevailing 45% share of oil shale. The statistical data about the installed capacity, gross electricity and heat production from high-efficiency cogeneration in Estonia[9] are shown in the Table 1and Figure 2.

Table 1: National statistics on cogeneration in Estonia 2008 – 2013

CHP	Installed electrical capacity [GW]	Total heat supplied [TWh]	Total electricity generated TWh]	Total % of gross electricity production
2008	1,61	2,54	0,92	8,65%
2009	0,42	3,20	0,81	9,19%
2010	0,45	3,42	1,34	10,30%
2011	0,44	2,98	1,13	10,35%
2012	0,47	3,08	1,17	9,74%
2013	0,46	3,40	1,24	9,30%

Source: Statistics Estonia 2013.

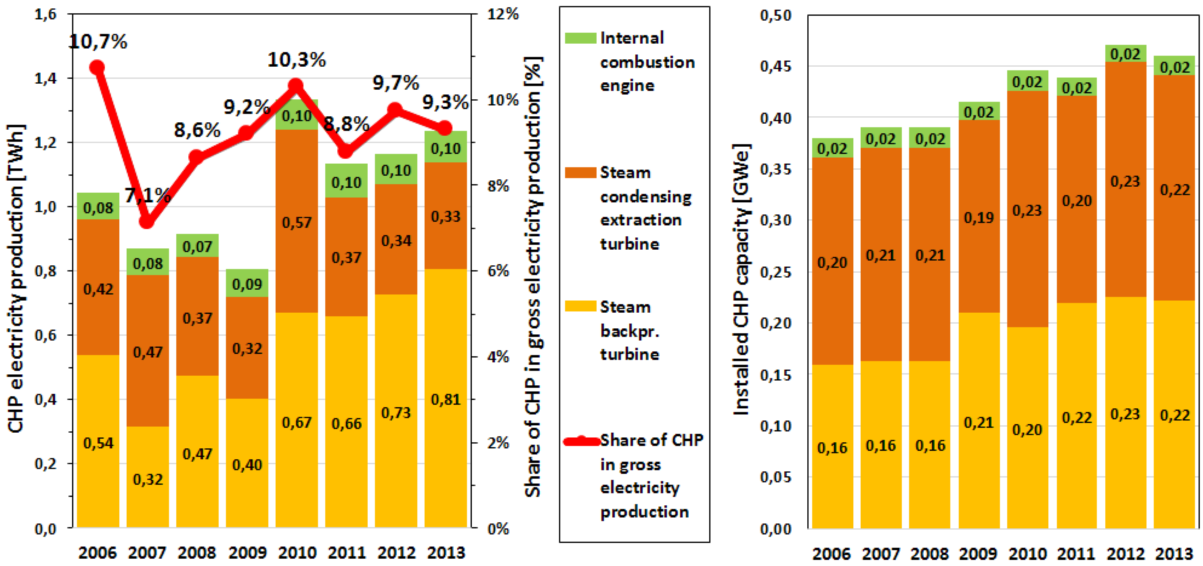

Figure 2: CHP electricity production and installed capacity by technology in Estonia

[8] 24 steam turbines with 441 MWe capacity and 15 units of internal combustion engines with 19 MWe total electrical capacity, source Statistics Estonia2013.
[9] Eurostat: Combined Heat and Power (CHP) data, 11 June 2013

1.2. Energy and Climate Strategy of Estonia

Sustainable development of the energy sector is a part of the sustainable development strategy and sustainable use of natural resources in Estonia. The main goals of Estonian energy and climate policy till 2020 are continuous energy supply, diversification of energy sources with gradual decrease of predominant share of domestic oil shale, to increase the share of renewable energy sources to 25%, to achieve 20% cogeneration electricity production in gross domestic consumption and further decrease of GHG emissions. A new long term goal toward 2030 of Estonia is to become a net exporter of energy.

The development of the energy sector in Estonia is based on the sustainable development strategy and sustainable use of natural resources[10]. The development energy plan is based on the vision, that "the efficient energy sector supports the sustainable and balanced development of Estonia"

The adopted National development plan of the energy sector until 2020[11] is an umbrella for different development plans of the electricity, oil shale, biomass and bioenergy sectors as well as the "energy conservation target programme". Measures for the achievement of the main strategic objectives of the Development plan to 2020 include measures to ensure continuous energy supply for the Estonian population, diversification of energy sources, sustainable development (supply and consumption) and ensuring justified energy prices for consumers. Main goals are the reduction of the share of oil shale under 30% in energy supply, increase of the share of renewable energy sources in the final energy consumption to 25% and achieve 20% share of cogeneration electricity generation in the gross electricity consumption by 2020.

The objectives of the proposal of the "Estonian National Development Plan of the Energy Sector Until 2030[12]" are to ensure the energy supply at a reasonable price and effort and with an acceptable environmental condition, while observing the terms and conditions established in the long-term energy and climate policy of the European Union with a long term goal that Estonia would become a net exporter of energy.

The objective of the Development plan of the Estonian electricity sector until 2018 is to guarantee continuous power supply, reduction of the burden on the environment, creation of international energy links, opening of the electricity market and decrease of electricity consumption. Key challenges are structural changes in electricity production to achieve reduction of emissions from the electricity sector, more sustainable use of oil shale and more competitive electricity prices for consumers.

Estonia has significantly decreased GHG emissions (for more than 50% in 2011 compared to the 1990 level) and fulfilled Kyoto commitment (8% reduction) and is almost on the track to the goal in the year 2020[13]. More than 70% of 21 Mt CO_{2eq} emissions were emitted by the energy sector [5]

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[10] Estonian National Strategy on Sustainable Development "Sustainable Estonia 21", September, 2005

[11] National development plan of the energy sector until 2020, approved by the Parliament in June 2009, (http://www.encharter.org/fileadmin/user_upload/Energy_policies_and_legislation/Estonia_2009_National_Development_Plan_of_the_Energy_Sector_to_2020_ENG.pdf)

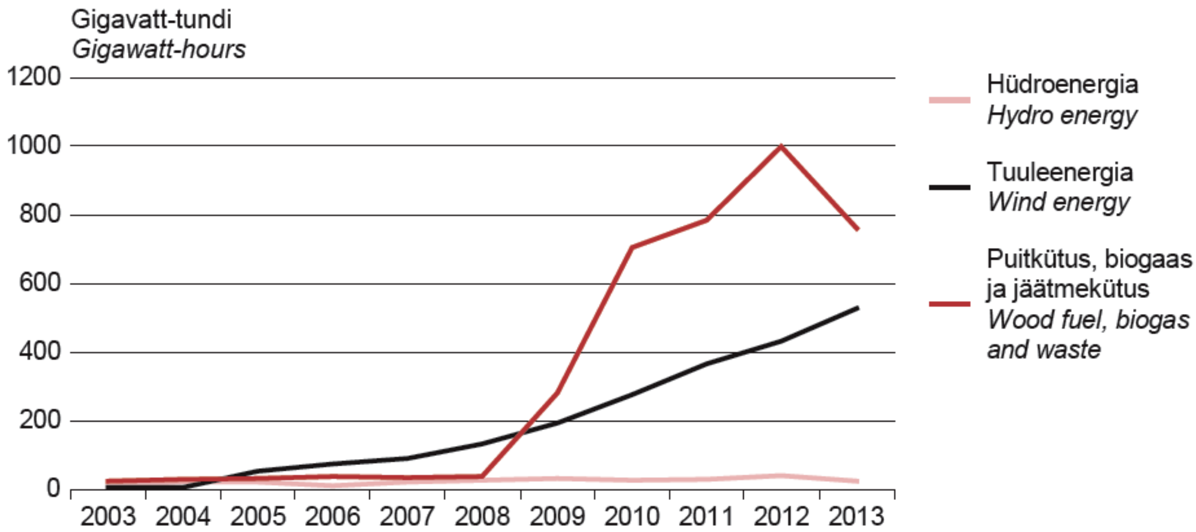
[12] The "Estonian National Development Plan of the Energy Sector Until 2030" will be prepared at the end of 2014.

[13] Estonia may increase its emissions not covered by the EU ETS by 11% compared to 2005, according to the Effort Sharing Decision.

1.3. Policy development in Estonia

The current key support instrument for cogeneration in Estonia is in form of a premium on electricity sold to the grid. Premium paid for 12 years is higher for the electricity generated from renewable energy sources and lower for the use of waste, peat and oil shale gas, whereas CHP plants using other fossil fuels are eligible only to the capacity up to 10 MWe.

Estonia introduced the first support scheme for electricity produced in cogeneration from renewable energy sources (RES) initially in 1998. The support framework have changed several times (major changes in 2007 and 2010) and the current support scheme is based on the amended Electricity market act[14] entered into force on 1 January 2013[15]. The support is especially focused on the efficient use of renewable energy sources and domestic fossil fuels (waste, peat and oil shale gas), whereas natural gas is eligible but not the policy priority. Positive effects of the support are evident on the significant growth of electricity generation from RES, especially biomass CHP and wind generation as shown in Figure 3. The RES electricity share in the total electricity consumption in the period 2009 – 2013 has more than doubled and reached 13,6% in 2013.



Source: Statistical yearbook of Estonia 2014, Statistics Estonia.

Figure 3: Electricity generation from RES

The CHP support framework in Estonia includes next elements:

- **Operating support[16]:** bonus paid for up to 12 years for the electricity supplied to the grid from high efficient CHP plants:
  - **53,7 EUR/MWh** for using renewable energy sources[17]

[14] Electricity Market Act, 2003 (https://www.riigiteataja.ee/en/eli/516052014001/consolide)

[15] Huge unexpected growth of share of electricity produced from renewable sources (from 1.5% in 2007 to 14.9% already in 2012, mainly due to growth of wind generation) that caused an increase of renewable energy charges via renewable energy support payments was the main reason for the support amendment.

[16] Defined in the Electricity Market Act, https://www.riigiteataja.ee/en/eli/516052014001/consolide

- **32,0 EUR/MWh** for using fossil fuels:
    - waste as defined in the Waste Act, peat or retort gas from oil shale processing,
    - other sources of energy for CHP units up to 10 MWe capacity.

- **Investment subsidies:** for switch from fossil fuels to small CHP plants using renewable energy. Support is granted under the Operational Programme for the Development of the Living Environment and from other state budget funds managed by the Environmental Investment Centre.

Soon a new support scheme based on the tender procedure will be introduced and is already in the notification procedure on the DG Competition[18].

1.4. Exchange of information and awareness in Estonia

A long CHP tradition in district heating and process industry and a good CHP position in the national energy policy are key drivers for general high CHP awareness in Estonia. High level awareness of domestic and foreign energy utilities is an important factor for new CHP investments with a proper support of domestic engineering and technical services. A positive attitude of banks for financing the CHP projects eligible for secure 12 years premium support is crucial to overcome the current lack of financial resources and ESCO services in Estonia.

A good awareness of the benefits of cogeneration, among the different socio-economic actors, is one of the basic conditions to create an active CHP market. This is necessary to achieve the full potential of CHP. Good awareness goes hand in hand with well-informed customers. Awareness among professional and influencers that inform and advise the other groups support policy makers to create and provide effective frameworks for a functioning market. For the purpose of this analysis the actors on the CHP market, were classified into four social-economic groups, shown in Figure 4. The level of awareness was assessed for each of the actors and rated 1-5, (1 poor and 5 Active market), as shown below. The detailed comments on each group are described in Annex 1.

[17] Only high efficient cogeneration is eligible for biomass support. The calculation of support rates for electricity produced from biomass power plants with capacity of 10 MW to 50 MW is based on the average price of biomass and weighted average price of the market price of electricity in the previous calendar month. The support rate is calculated as difference between fixed value (between 0.088 EUR and 0.103 EUR) and the weighted average price of the market price of electricity in the previous calendar month [11] .

[18] Decision was issued on 28th of October 2014 and will be published soon.

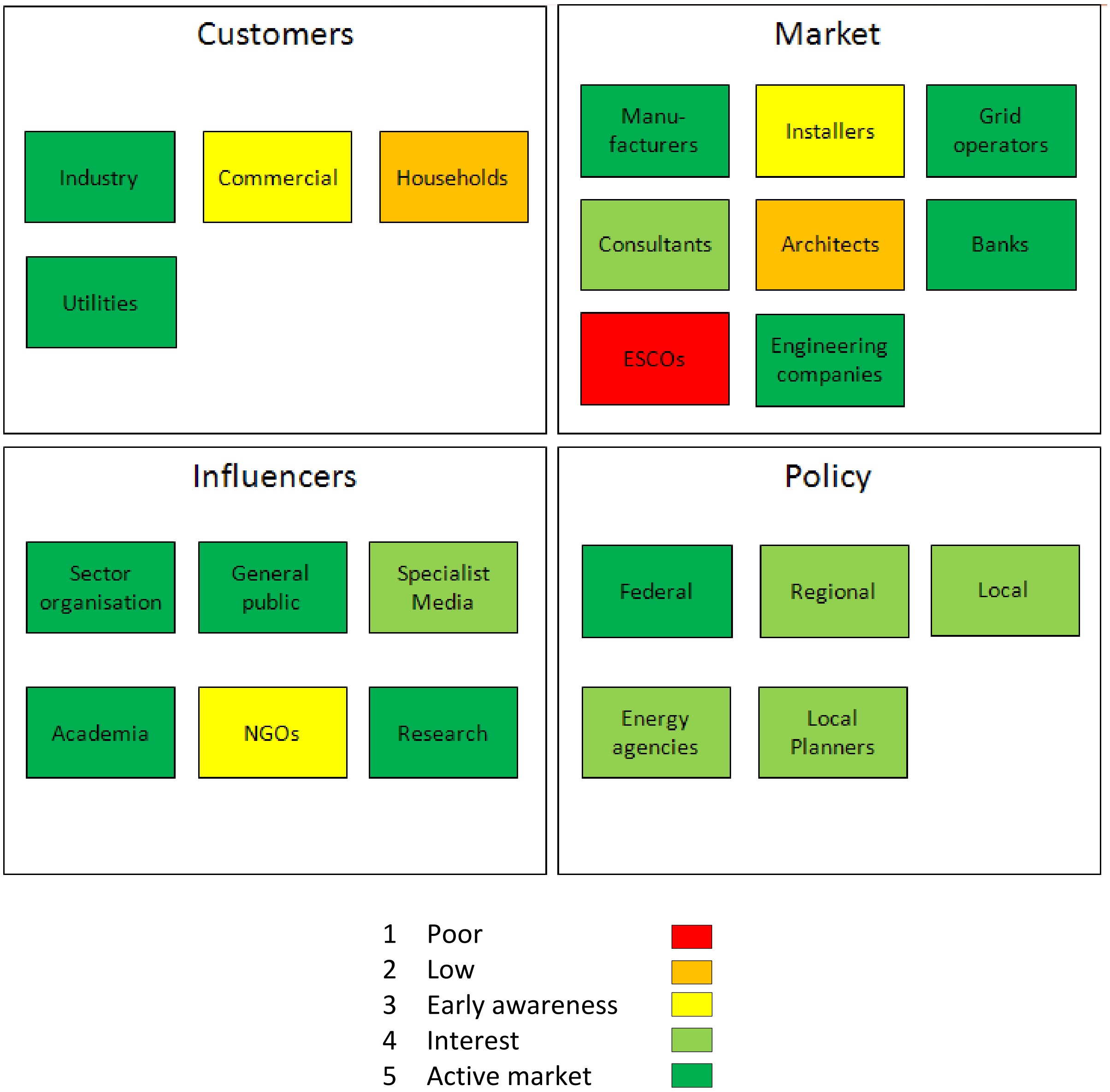


Figure 4: Assessment of four groups of the socio-economic actors' awareness of cogeneration in Estonia

Customers

Traditionally the use of cogeneration in the district heating sector and process industry is a main reason for high awareness of CHP in these sectors with several investments in recent years. The lack of investments in a small scale CHP application is influencing lower awareness in services, small and medium enterprises (SMEs) and households, although in the general public awareness is relatively on a high level.

Market players

District heating utilities (several from abroad) and industrial companies are key CHP investors, well supported by skilled domestic engineering and technical service companies and project providers although there are no local CHP technology manufacturers in Estonia. Banks have a positive attitude to the CHP investments where reliable 12 years secure support payments are well accepted for CHP project financing. A premature ESCO market is an evident obstacle that could ease a current lack of financial resources for CHP investments especially in industry.

Influencers

Estonian District heating association and Estonian Renewable Energy Association have an important role in the successful discussion with the government and other authorities considering actual CHP issues. A properly positioned cogeneration learning in the education programme is a very important pillar for the high educated technical staff and awareness in the engineering area with an important influence also on the high general awareness on the cogeneration in Estonia.

Policy makers

Cogeneration awareness is on a rather high level as it is well positioned in the national energy policy which results in explicit 20% target for CHP till 2020, an incentive support framework and proper government communication on the energy efficiency policy role, targets and good practice promotion. Future development and regulation of energy markets, especially prices relations and security of natural gas supply will be crucial for the future CHP development where successful implementation of EED (ongoing) should have an important influence, especially on the analysis of the economic adequacy for new CHP plants in district heating systems.

1.5. The economics of CHP in Estonia

Current CHP support enables required profitability for medium and large scale CHP projects using renewable energy sources. Economics of fossil fuelled CHP is limited to units with a capacity up to 10 MWe using waste, peat or oil shale gas, whereas CHP units on the natural gas are not competitive in current market conditions with low electricity prices and high natural gas prices.

A cogeneration plant is a large investment and its feasibility is most of the time measured by its financial parameters, such as internal rate of return (IRR), return on investment (ROI) or payback period. An important factor is the capital cost of the cogeneration unit and its maintenance compared to a standard boiler. The most significant parameter however, is the spark spread. This is the theoretical gross margin of a gas-fired CHP from selling a unit of electricity, having bought the fuel required to produce this unit of electricity. The support systems described in Chapter 1.3 should improve the business case for CHP installations.

Assessment of current market conditions for new CHP investments proves a live although limited CHP market in Estonia (Table 2). A proper support framework for new CHP investments is established for medium size and larger CHP projects on renewable energy sources and domestic fossil fuels (waste, peat and shale gas) whereas current unfavourable market conditions are less appropriate for a natural gas CHP project where support is limited to units up to 10 MWe. Small scale and micro CHP market is not yet established due to high investment cost and high natural gas prices as such electricity generation is not competitive to current very low electricity market prices at a current uniform support level (no CHP size differentiation).

Table 2: Market economic situation of CHP in major user groups

Estonia	Micro		Small & Medium		Large		
	up to 50kW		*up to 10 MW*		*more than 10 MW*		
	Fossil	RES	Fossil	RES	NG	Other fossil*	RES
Industry	red	red	green	green	red	yellow	green
District heating	grey	grey	green	green	red	yellow	green
Services	red	red	yellow	yellow	grey	grey	grey
Households	red	red	grey	grey	grey	grey	grey

* *Oil shale gas, peat or waste (not coal!)*

Legend:

green	**"normal"**	CHP Investment has **good economic benefits**, return on investment acceptable (8-10%) for the investors, **interest for new investment exists**; there are no significant economic barriers for the implementation.
yellow	**"modest"**	CHP Investment has **modest/limited economic benefits** and return on investment (5-7%), **limited interest for new investments**.
red	**"poor"**	CHP Investment has **poor or negative return on investment or is not possible due to other limitations, no interest/possibilities for new investments**.
grey		**Not applicable** for the sector
NG		**Natural Gas** or appropriate fossil fuel
RES		**Renewable energy sources** (wood biomass, biogas, etc.)

1.6. Barriers to CHP in Estonia

Unfavourable energy market conditions with current very low electricity prices are a key barrier for faster CHP development in Estonia. High prices and risk of secure natural gas supply is an evident obstacle for any new CHP investment on natural gas at the moment. Lack of private and public financial resources and absence of ESCO services impede CHP potential exploitation in industry and district heating systems. Several changes of the CHP support scheme in recent years and ongoing transformation to the tendering procedure is an obstacle for the investors that are looking for stable and predictable investment environment.

In the second CHP progress report presented to the EC[19], the Estonian government has indicated that they did not identified any significant barriers in relation to administrative procedures or in relation to the electricity grid system but have stated next important obstacles:

- Huge fuel price variation on the energy market which poses high risks on cogeneration operation and investments.
- Lack of competition on the natural gas market due to the monopoly of one supplier (Gazprom), risk of security of gas supply (shortages in supply in the peak period in the western Russia) and no gas network in central and western Estonia and on the islands of Hiiumaa and Saaremaa have a negative impact on the development of cogeneration.
- The potential domestic fuel (peat) for cogeneration have a relatively high CO_2 content of the combustion, which is in contrast to the greenhouse gas emission allocation plan and the trading system.
- Increased demand of wood has caused the increasing of wood price and impact on the competitiveness of cogeneration using wood as fuel.
- Limited heat demand in smaller district heating systems (only in heating season).
- High investment costs of small scale cogeneration – not offering heat supply at the supportable cost level for consumers.

Although several listed barriers have been successfully mitigated and Estonia is one of the newer EU member states where current policy and regulatory framework is positive and adequate for substantial part of CHP investments, based on a recent market assessment and expert opinion we have identified three still existing barriers for faster and stable CHP development, listed in a descending order of importance:

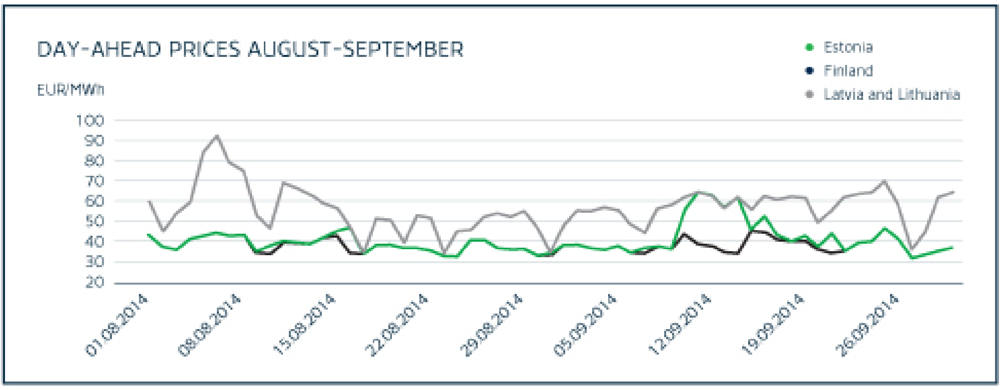
Barrier 1: Unfavourable energy market conditions have a negative effect on CHP investments

Estonia is reaching the lowest electricity market prices on the integrated regional Baltic electricity market[20] with average prices between 30 and 40 €/MWh in 2014 (Figure 5) at growing domestic generation and export of electricity. Such low electricity market prices request extremely optimal conditions for CHP investments, especially low investment and fuel cost and base load heat demand over the whole year. The latest condition is not fulfilled in several smaller district heating systems, where replacement of heat only boilers by CHP boilers is not economically feasible for an operation during the heating season only.

On the other hand natural gas prices were growing in the last decade and reached the level around 40 €/MWh in 2014 (Figure 6). Such electricity and natural gas price ratio is extremely unfavourable for natural gas CHP unit's investments and operation, especially for district heating CHP plants that sell electricity to the market and is a key barrier for new CHP investments fuelled by natural gas. Whole eastern Baltic area relies entirely on natural gas supplies from Russia and only Latvia and Finland comply with N-1 rule regarding security of supply which pose an additional risk to the investors.

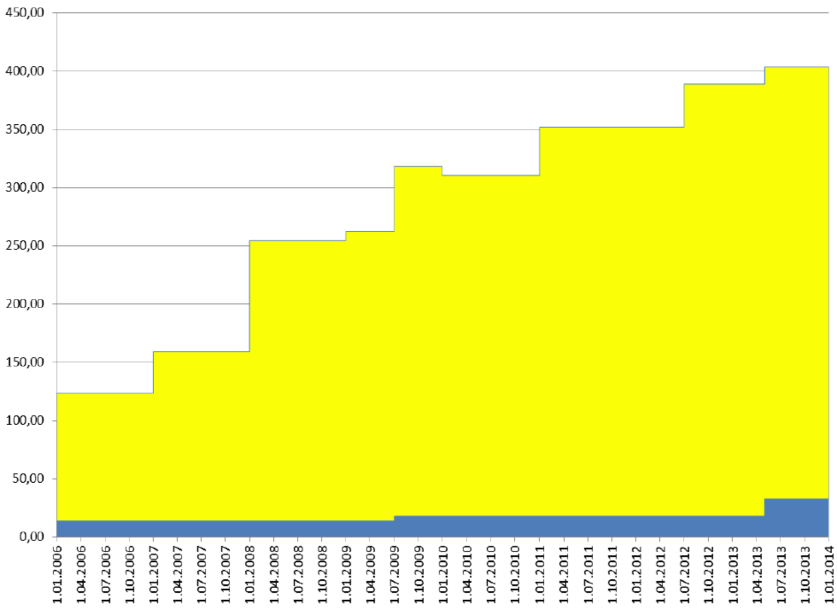
[19] Report by the Republic of Estonia in accordance with articles 6(3) and 10(2) of Directive 2004/8/EC of the European parliament and of the council on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EC, 2012.

[20] From 1st January 2013, Estonia's electricity market is completely open and Estonia is part of regional Nord Pool Spot market (http://www.nordpoolspot.com) which has the largest influence on the local electricity prices.



Source: *www.enefit.lt*

Figure 5: Regional Electricity market prices in Estonia – summer 2014



Source: Gas market in Estonia, Ministry of Economic affairs and communication, Estonia.

Figure 6: Consumer natural prices in Estonia 2006 – 2014 (€/1000 Sm3)

Barrier 2: Lack of financial resources is restricting new CHP investments in Industry

Current lack of financial resources is one of the important barriers for faster exploitation of the evident CHP potential in process industry (replacement of existing expired old units and new CHP locations) and SMEs. Although awareness of Estonian banks on the CHP technology is on a relatively high level, deficiency of own founds in the today demanding economic environment is an evident obstacle for new CHP investments. Premature ESCO market is not offering an adequate financial support for the implementation of profitable CHP projects in stable industrial companies and SMEs.

Limited EU and state budget resources for investment subsidies are restricting a faster switch from old fossil fuels boilers to small CHP plants using renewable energy in district heating systems and needed modernisation of district heating networks[21].

[21] Recent study of Estonian Development Fund proved extensive losses in heating network (the average loss is 21%) and significant potential for energy savings in district heating networks in volume up to 542 GWh [10]

Barrier 3: Frequent changes of the CHP support scheme decrease investors' confidence

Several changes of the CHP support scheme in recent years were not well accepted by investors as they are looking for a stable and predictable investment environment. Ongoing transformation of the CHP support scheme to the tendering procedure linked also with the notification procedure by DG competition is another disturbance on the market and requests a fast concerted action of all responsible stakeholders.

2. What is possible? Cogeneration potential and market opportunities in Estonia

A set target of 20% share of cogeneration electricity generation in domestic gross electricity consumption till 2020 seems realistic considering recent positive trends and several times higher assessed technical potential from 0,6 to 4 TWh of CHP electricity generation. Evident economical CHP potential will be re-assessed within the EED prescribed comprehensive assessment till the end of 2015. Recent growth of RES CHP electricity generation proves bio energy CHP potential assessed by a recent CODE2 analysis. Although a good natural gas infrastructure in Estonia enables good conditions for micro CHP units, a significant decrease of technology and natural gas costs is a prerequisite condition for their market application.

Following the latest National energy efficiency action plan [10] , a new comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling will be prepared in due time till the end of 2015 and in the meantime the results of the study Potential for Efficient Cogeneration of Heat and Power in Estonia[22] is the most relevant source on the cogeneration market potential.

Additional technical CHP potential till 2020 was estimated on the base of 2 – 4 TWh of potential heat load on:

- **600 – 750 GWh of electricity by using RES or**
- **from 2 to 4 TWh by using natural gas.**

Economic market potential was not precisely estimated[23] but the goal to reach 20% of cogeneration in domestic gross electricity consumption till 2030 was proved as a realistic target. This would require approximately 1,6 TWh of the total CHP electricity generation or increase for 30% from current 1,2 TWh which seems a realistic target. To enable such a CHP growth, partial reconstruction and refurbishment of existing old CHP plants and new investments would be necessary with a gradual switch to biofuels (especially wood biomass) and natural gas (more appropriate for medium and small scale CHP applications in industry and services).

Current and expected energy market and economic conditions till the year 2030 seem rather uncertain and it is very difficult to assess realistic CHP market potential, but the recent successful CHP investments in district heating systems (Tartu, Parnu, Tallinn, etc.) prove the market potential

[22] Report prepared by Tallinn University of technology in 2007 and used for reporting to the EC under CHP Directive.

[23] By listed indicative potential location the we estimated the total potential to around 0,3 TWh (60 MWe).

especially in district heating and industry, especially in case of a faster economic crisis recovery in EU.

Bio energy

Recent very fast growth of electricity generation from biomass (wood biomass, biogas and waste) from less than 50 GWh in 2009 to close to 800 GWh in 2013 proves an important potential and a lot of opportunities for bio energy use in Estonia. More than 35% share of RES in fuel used by CHP plants and CHP heat generation already in 2010 demonstrate the important role of renewable energy sources in CHP generation in Estonia with a further potential to growth, especially with co-combustion of wood biomass with peat and waste in larger CHP units and technology development of biomass gasification in smaller CHP applications.

The analysis on Bio CHP potential carried out within CODE2 project, based on the "score cards analysis" proves the growing role of bio CHP generation till the year 2030 (see Annex 3 for the details)[24]. The analysis was influenced by the expectations of limited and decreasing biomass availability in Estonia which was not proved in reality as even with a growing consumption of wood biomass in recent years[25]Estonia has significantly increased export of wood pellets in recent years[26]. Estonia has very good preconditions for utilisation of bioenergy in line with the energy policy orientation to the use of domestic energy resources and RES, especially wood biomass.

Micro CHP

The CODE2 micro CHP potential analysis estimated a very limited market potential for micro CHP units on around 10 units per year in the year 2020, majority of them of size ±40 kWe in services and only first sells of ±1 kWe in households. At least the households CHP development is very uncertain due to high current technology and fuel costs although in case of expected decrease of investment costs, the sales of micro CHP units in 2030 could reach up to 200 units per year. Around 40% share of natural gas for heating in Estonia enables good environment for micro CHP development if market conditions would provide requested profitability for these units. For more details see Annex 2.

3. How do we arrive there? The Roadmap

Following current ambitious energy policy goals and orientations of Estonia, it can further develop a very unique and sustainable energy supply path where cogeneration can play a very important role for efficient use of renewable energy, domestic fossil fuels and balanced use of natural gas. Cogeneration can significantly contribute to the key energy policy priorities: diversified sustainable energy supply based on the prevailing domestic energy resources with a significant increase of energy efficiency.

[24] Appropriate support mechanisms, high share of district heating heat supply, biomass availability and high awareness result of efficient promotion of Biomass association.

[25] Wood biomass consumption has increased from 3,8 Mm^3 to 4,3 Mm^3 in the period 2009 – 2013, Estonian statistics [12] .

[26] Export of wood pellets has increased from 4 PJ to almost 10 PJ in the period 2009 – 2013 [12] .

3.1. Overcoming existing barriers and creating a framework for action in Estonia

Preserving long term stable and predictable incentive legal framework for cogeneration is a key priority necessary for the future CHP development in Estonia. Fast and effective transition to the new CHP support scheme based on tendering procedure should be the first preference. Allocation of adequate EU and public funds in the new financial perspective 2014 – 2020 for the investment subsidies for modernisation of district heating systems is crucial to enable further sustainable and competitive development of district heating systems in Estonia. Faster integration of CHP units into grid ancillary services would have positive benefits especially on the profitability of natural gas fuelled CHP plants in current very unfavourable energy market conditions. EED implementation should be an important tool and push in the better heat supply planning and increase of efficiency.

Action 1: Preserving long term stable, incentive and predictable legal framework for cogeneration

Fast and effective transition to the new CHP support scheme based on a tendering procedure is a crucial task for the Ministry of Economic Affairs and communication for providing a predictable and stable condition for CHP investors.

Allocation of adequate EU and public funds in the new financial perspective 2014 – 2020 for the investment subsidies for modernisation of district heating systems to enable further sustainable and competitive development of district heating systems in Estonia:

1. Ongoing support scheme of Environmental Investment Center for switching from old boilers to small CHP plants using renewable energy
2. Planned support measure for modernization of the district heating networks from EU structural funds foreseen by the latest national Energy Efficiency Action Plan (NEAP 2014) [10] . and energy retrofit of district heating networks) is a crucial task of responsible institutions.

Action 2: New incentives to empower CHP position in the energy market

As current energy market prices and level of the support are not enabling economic conditions for profitable operation of CHP units in district heating systems with a limited heat supply to the heating season and CHP units on natural gas, additional market income is requested to trigger this untapped CHP potential in Estonia. Flexible CHP units with predictable operation could effectively provide different ancillary services for the grid which would improve their economic conditions without additional public funds.

Estonia as part of the very effective, liquid and well organised regional Nord Pool Spot market has very good opportunities[27] to study and develop different new options how to enable simple and fast access of CHP units to the ancillary service market (balancing energy, demand respond, reserve capacity, virtual power plants, aggregation of smaller capacities, etc.). Better integration of CHP units

[27] Elspot day-ahead market and Elbas intraday market which enables objective and precise price signals.

in the grid operation would strengthen the grid operation stability and enable a higher share of intermittent RES electricity generation and is an important step toward a smart active electric grid of the future. Special positive effects are expected for flexible natural gas CHP units and the solution would enable proper positioning of these units in the Estonian supply mix. A balanced involvement of all stakeholders (ministry, regulator, grid operators, research, local industry, etc.) is a prerequisite for successful implementation of this task.

Action 3: Fast and quality implementation of EED – especially comprehensive assessment and cost benefit analysis (CBA) for efficiency in heating and cooling

A new assessment of heating and cooling potential should bring new information of the actual technical and economic potential and advantages of cogeneration and DHC options. CBA for market potential could contribute to better awareness and ease implementation of the cogeneration opportunities in all sectors and potential contribution to the national strategic climate energy goals with an approval of necessary additional adequate measures for the cogeneration support.

EED implementation should bring also other benefits for increase efficiency in the heat supply:

- **Clear priorities in heat supply - Article 14(4):** new comprehensive approach as an effective support to already available possibility for local governments to establish district heating regions which would in justified cases rule out other heat supply alternatives in the area of existing or planned DH systems. Enforced local energy planning would identify new sustainable heat supply options integrated in other sectors (use of waste heat, etc.).
- **Assessment of the energy efficiency potential in gas and electricity infrastructure – Article 15 (2):** as cogeneration has a positive influence on better infrastructure utilisation, decrease of losses and load balancing, the assessment should better position the role and contribution of cogeneration units to the energy efficiency in gas and electricity grids.
- **Improving access to electricity networks and priority of dispatch for cogeneration** – **Article 15 (5):** introduction of improvements and new simple procedures, especially for small CHP units in SMEs.
- **Enable conditions for introduction of system services from cogeneration** - **Article 15 (6):** demand response, ancillary services, balancing, etc.

3.2. Possible paths to growth in Estonia

20% share of CHP electricity generation in gross domestic electricity consumption is realistic by the proposed CHP road map implementation. Needed 50% increase of current CHP electricity generation from 1,2 to 1,8 TWh could be provided by a necessary replacement of 140 MWe of existing expired CHP capacities and 80 MWe of new CHP capacities prevailing in district heating systems and industry and with a dominant use of renewable and domestic energy sources.

Following recent positive trends of high efficiency CHP electricity generation and assessed market potential we can objectively expect further moderate CHP growth toward 2030 to reach the set target 20% share of cogeneration electricity generation in gross domestic electricity consumption till

2020. **This would request increase of current 1,2 TWh CHP electricity generation to 1,6 TWh till 2020 and to 1,8 TWh till 2030 considering expected growth of electricity demand.**

With the proposed **CHP road map** implementation we can strengthen the CHP development and significantly contribute to the EU energy climate targets. Economic potential for CHP growth is evident although before the implementation of comprehensive assessment of actual potential we can reasonably take the actual goal of 20% CHP share in electricity consumption and target 1,8 TWh of total CHP electricity generation that could be till 2030 provided by:

- **Reconstruction of at least 30% of existing old CHP capacity** (**140 MWe**) – situated in district heating systems and industry, necessary due to the lifetime expiration and new environmental restrictions – **and increase of electricity generation for at least 0,2 TWh_e,**
- **80 MW_e of new CHP plants installations -** mainly in smaller district heating systems, industry and services- and **provide 0,4 TWh_e of additional electricity generation**,

as shown in Figure 7 and the following energy and environmental indicators for roadmap impact assessment.

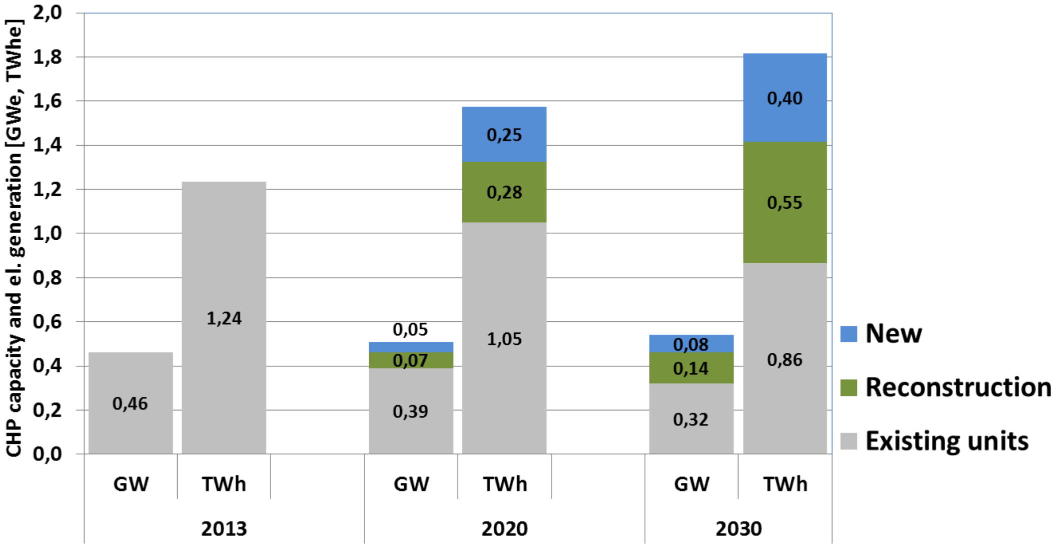


Figure 7: Target path to CHP growth till the year 2030

- **CHP electricity generation: increase for 0,6 TWh_e or for 50% compared to current high efficiency electricity generation in the year 2013**, with the balanced contribution of existing reconstructed CHP plants in district heating systems and industry and new installed CHP capacity.

- **Share of cogeneration electricity in gross electricity consumption:** increase of CHP **share from current 17% to the target 20% share in the year 2020 with a slight increase toward 2030** and provide high efficient exploitation of domestic RES and fossil fuels and reasonable volume of natural gas.

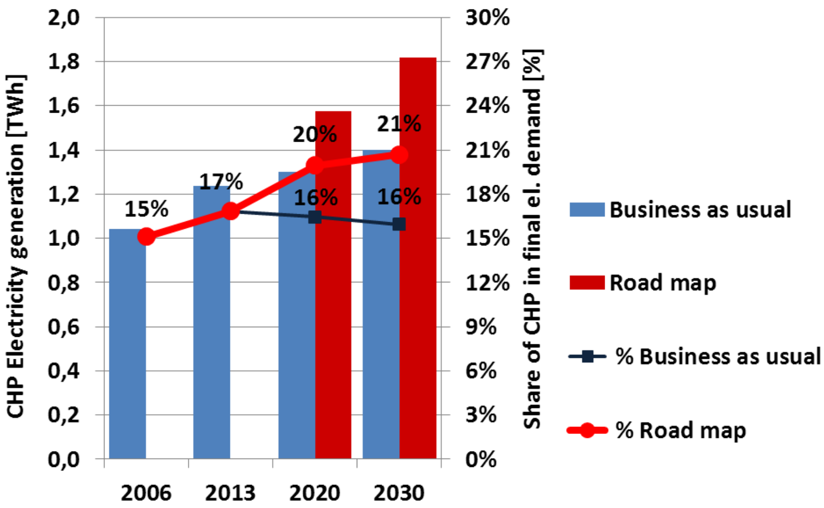


Figure 8: CHP Roadmap Electricity indicators

Future development of cogeneration could be even greater as we consider the proposed roadmap economic potential rather conservative, especially in faster economic growth and more favourable energy market conditions till the year 2030.

3.2. Saving of primary energy and CO_2 emissions by the CHP roadmap of Estonia

Potential CHP primary energy savings could contribute more than 20% of the indicative national target of primary energy savings till the year 2020 and reduce CO_2 emissions for up to 1 million tons of CO_2 till the year 2030. Growth of CHP generation will enable efficient and sustainable exploitation of domestic fossil and renewable resources and significantly contribute Estonia on the path to become a net exporter of energy.

Within CODE2 project two approaches for assessment of primary energy savings (PES) and CO_2 emissions savings are used to demonstrate advantages and contribution of CHP technology to the reduction of energy use and CO_2 emissions:

1. **Methodology prescribed by EED** (according to Annexes I and II) [28]
2. **Substitution method –** new developed method for the assessment of actual achieved savings[29]

New CHP generation proposed by the Road map would contribute around **1,4 TWh PES (5 PJ)** calculated by the EED methodology or by a substitution method as shown in Table 3[30]. Especially

[28] **EED method** is used at a member state level today for national reporting to the European Commission and at project level for determining if a specific CHP plant is highly efficient. In the methodology, the efficiency of each cogeneration unit is derived by comparing its actual operating performance data with the best available technology for separate production of heat and electricity on the same fuel in the market in the year of construction of the cogeneration unit using harmonized reference values which are determined by fuel type and year of construction.

[29] **Substitution method** has been developed within the project and estimates the amounts of electricity, heat and fuel which are actually replaced by additional new CHP based on a projection of the supply base changes in the member state supply over the period are calculated. The situation in 2030 is compared to the current status in the country.

new CHP plants on wood biomass which are replacing existing old steam turbines (mainly on oil shale and peat) contribute the majority of the potential PES which is important from the perspective of national goals till the year 2020 and 2030.

Assessed PES potential of CHP around 1,4 TWh till the year 2020 more than 20% of the 5,6 TWh set indicative national target of primary energy savings in the year 2020 in NEAP 2014 [10] which mean that implementation of the CHP roadmap can contribute a significant part or even increase the foreseen national goals for the year 2020 and additionally contribute to the new goals for the year 2030.

By using the same approach, potential really achievable CO_2 savings by the substitution method are 1,0 Mio.t of CO_2, much higher than only 0,05 Mio.t CO_2 savings by EED methodology[31] as shown in Table 3. By increasing the volume of the new CHP investment (both fuelled by renewable energy and natural gas), potential CO_2 savings would be even higher.

Table 3: Saving of primary energy and CO2 by the Estonia CHP roadmap till 2030

	Substitution method		EED method	
	Business as usual	**Road map**	**Business as usual**	**Road map**
PE saving	0,8 TWh/a	**1,4 TWh/a**	0,7 TWh/a	**1,4 TWh/a**
CO_2 saving	0,5 Mio t/a	**1,0 Mio t/a**	0,02 Mio t/a	**0,05 Mio t/a**
- per kWh_{el}*[32]	1,48 kg/kWh_{el}	**1,69 kg/kWh_{el}**		

[30] Due to higher share of RES CHP units replacing existing peat and oil shale units, the difference between both methods results is very small as EED efficiencies for the new bio energy separate electricity generation is close to current efficiency of old fossil units.

[31] CHP plants using renewable energy are not achieving CO_2 savings by EED methodology (compared to separate renewable generation), but in reality they are replacing current prevailing fossil generation.

[32] This value represents the CO_2 reduction of the power generation. It includes the avoided CO2 emissions from fuel savings for separate heat generation in boilers; it must not be confused with the considerably lower CO2 emissions of the substituted condensation electricity or with even lower emissions of compared power production according to the BAT approach in accordance with the EU CHP directive reference values.

Annex 1: Stakeholder group awareness assessment

Users	
Industry	CHP is well known and traditionally used especially in process intensive industry. Lack of financial resources is a key barrier for new investments in modernisation of old steam technology by introduction of new CHP technologies.
Utilities	The cogeneration is a traditional technology in larger district heating systems, operated by domestic and foreign energy companies. Heat demand limited to the heating season only is one of the important reasons that new cogeneration investments are not economically feasible in current market conditions.
SMEs	SMEs are getting slowly more aware of CHP technology, especially of gas engines, although due to actual risk of natural gas supply security, other heating alternatives are preferred (small scale CHP units on natural gas are not economically feasible in current market conditions).
Households	Now the CHP technology and their advantages through good government communication. Micro CHP is not yet an economic option for households where decrease of natural gas consumption for heating is happening by switching to heat pumps and wood biomass due to lower costs and more secure energy supply.
Market and supply chain	
Manufacturers/ Technology providers	There are no CHP technology manufacturing companies in Estonia (importing of CHP technology) but a lot of know-how on CHP engineering, operation and maintenance exists.
Installation companies	As cogeneration is not yet applicable on the small scale market, installation companies are not yet deeply acquainted with CHP technology.
Grid operators	Well acquainted with CHP installations, no problems with connection. CHP should pay various investment costs for connection.
Consultants	Consultants and engineering companies on the larger scale are very skilled with CHP (not yet on the small scale level due to current premature small scale CHP market).
Architects	Architects are less acquainted by cogeneration as it is not yet applicable on the micro level.
Banks, leasing	Stable support scheme with long term (12 years) secure income is well accepted by banks and financial institutions which are keen on good CHP project financing.
ESCOs	As ESCOs market is not yet well developed in Estonia no services for CHP solutions are yet available.

Policy	
Policy makers on different levels	Cogeneration awareness is traditionally on high level and is well positioned in the national energy policy and strategic documents as 20% CHP target till the year 2020 and several support instruments – subsidies and premium scheme for CHP.
Energy agencies	Energy agencies know CHP but are not very active in the promotion.
Planners	CHP is in principle a known technology especially on regional planning (district heating systems).
Influencers	
Sector organisations	Estonian District heating association is the largest professional association of companies in the field of energy and heat (established in 1995 and also Euro Heat and Power – member) focused on the regionally balanced development of the power and heat sector in Estonia. Estonian Renewable Energy Association was founded in 2011 by the main renewable energy producers in Estonia and associations from different renewable energy sectors such as biogas, biomass, hydro and wind. Both organisations are successfully leading discussion with the government and other authorities.
General public	General public awareness about cogeneration in Estonia is rather good through a proper government communication on the energy efficiency policy role, targets and good practice promotion.
Media	Media has in general a positive attitude to the district heating and cogeneration, incentivised also by the prize for the best Estonian journalist granted by the Estonian Power and Heat Association to highlight the importance of energy in the field of professional recognition, energy utilities and consumers.
Academic area/ Research	CHP part of technical programmes on faculties with a very skilled approach and good experts (not included in other study programmes).
NGOs	Not very active in the CHP sector.

Legend:

(dark green)	Active CHP market	(orange)	Low CHP awareness
(light green)	Interest in CHP	(red)	Poor CHP awareness
(yellow)	Early CHP awareness		

Annex 2: Micro CHP potential assessment

micro-CHP potential summary Estonia

Country statistics

Population: 1 340 000 (2010)

Number of households: 610 000 (2010)

GDP per capita: € 16 900 (2010)

Primary energy use: 2 900 ktoe/year (2010)

GHG-emissions: 21 Mton $CO_{2,eq}$/year (2010)

Household systems (±1 kWe)

Boiler replacement technology

Present market (2013)

Boiler stock: 35 000 units
Boiler sales: 4 400 units/year

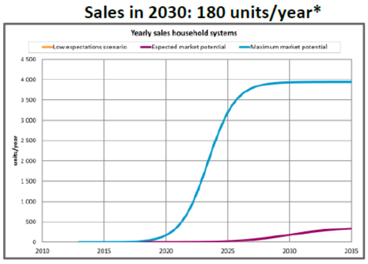
Potential estimation

Indicator	Score
Market alternatives	0
Global CBA	0
Legislation/support	1
Awareness	0
Purchasing power	1
Total	**2 out of 12**

Expected final market share: 8% of boiler sales in Household sector

Yearly sales

Sales in 2020: 2 units/year*
Sales in 2030: 180 units/year*



Stock

Stock in 2020: 6 units*
Stock in 2030: 600 units*
Stock in 2040: 3 200 units*

Potential savings in 2030

Primary energy savings:
0 PJ/year*
0 ktoe/year*
GHG-emissions reduction:
0.0 Mton $CO_{2,eq}$/year*

SME & Collective systems (±40 kWe)

Boiler add-on technology

Present market (2013)

Boiler stock: 4 000 units
Boiler sales: 500 units/year

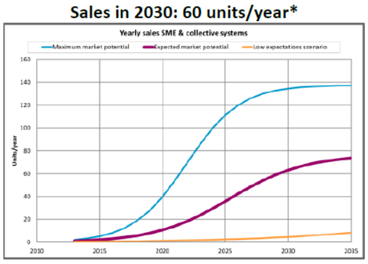
Potential estimation

Indicator	Score
Market alternatives	0
Global CBA	3
Legislation/support	2
Awareness	0
Total	**5 out of 9**

Expected final market share: 15% of boiler sales in SME & Coll. sector

Yearly sales

Sales in 2020: 10 units/year*
Sales in 2030: 60 units/year*



Stock

Stock in 2020: 70 units*
Stock in 2030: 400 units*
Stock in 2040: 700 units*

Potential savings in 2030

Primary energy savings:
0 PJ/year*
7 ktoe/year*
GHG-emissions reduction:
0.1 Mton $CO_{2,eq}$/year*

*Corresponding to the expected potential scenario.

micro-CHP score card
Argumentation

The score card is used to assess the relative position of an EU country based on current regulations, markets and economics. The score itself functions as input to the implementation model to 2030.

±1 kWe systems (Households)

Boiler replacement technology

Scorecard

Indicator	Score
Market alternatives	0
Global CBA	0
Legislation/support	1
Awareness	0
Purchasing power	1
Total	**2 out of 12**

Market alternatives

*There is **strong competition of other heating technologies in households**: district heating systems in towns, heat pumps (low electricity prices), wood biomass (cheap heating source). The **lack of a gas network** is a barrier for cogeneration in central and western Estonia.*

Global CBA

*SPOT: **29 years***

Legislation/support

***Current incentives on micro CHP are not yet sufficient** for the economic CHP project implementation in households*

Awareness

*Due to the too high investment costs and not sufficient support for the economic implementation, **current awareness of micro CHP technologies for households is still very low** or poor on all levels.*

***Manufacturers are not yet active** in the market.*

Purchasing power

*GDP: **€ 16 900 per year***

±40 kWe systems (SME & Collective systems)

Boiler add-on technology

Scorecard

Indicator	Score
Market alternatives	0
Global CBA	3
Legislation/support	2
Awareness	0
Total	**5 out of 9**

Market alternatives

*There is **very strong competition of other heating technologies** in services – especially district heating systems and heat pumps (low electricity prices) beside **lack of a gas network** in central and western Estonia.*

Global CBA

*SPOT: **5 years***

Legislation/support

***Current support offer moderate incentives** for implementation of micro CHP project in service sector.*

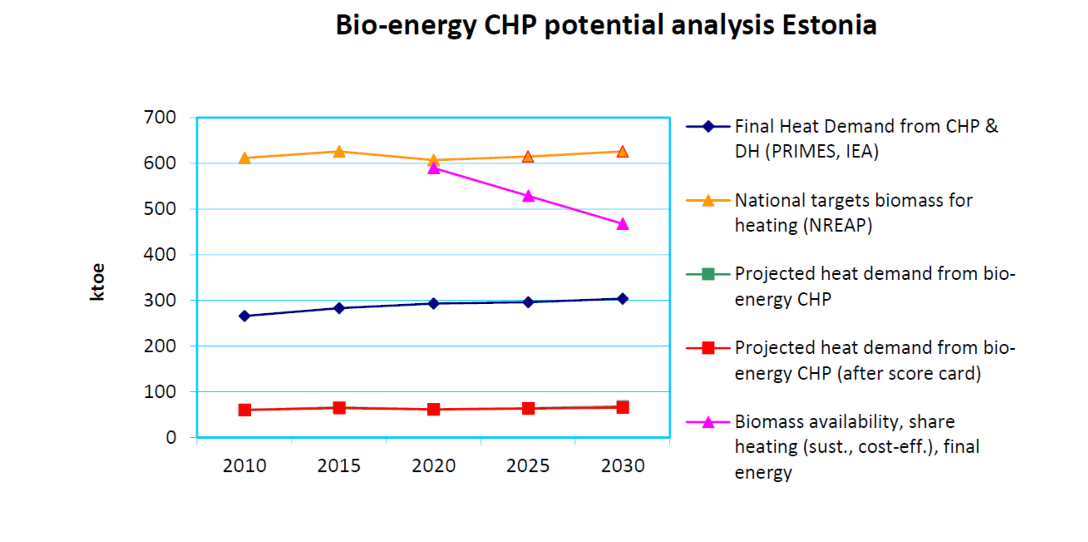
Awareness

Due to lack of good micro CHP practice examples, awareness of micro CHP in service sector is still on the very low level.

Annex 3: Bio CHP potential assessment

Bio-energy CHP potential analysis Estonia

Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	266	293	304
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	60	61	66
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	22,7% (2009)	20,9%	21,6%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		590	468



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	++ 3 (of 3)	• No barriers to administration procedure • No barriers for access to DH grid • Support for biomass CHP power
Suitability of heat market for switch to bio-energy CHP	o 1 (of 3)	• A small industry sector • Decrease of heat consumption • High price of imported primary energy
Share of Citizens served by DH	++ 3 (of 3)	• 53% citizen served by DH
National supply chain for biomass for energy	o 1 (of 3)	• A small available potential of biomass in country • Import of biomass in the future
Awareness for DH and CHP	++ 3 (of 3)	• Large utilization of biomass in residential sectors, • Intensive information activities about bioenergy • Biomass association

Annex 4: Assumptions used in the economics of CHP

A detailed economic analysis of four standard CHP cases was implemented in all pilot roadmaps and optionally in non-pilot roadmaps.

As requested detailed economic data for economic analysis of four standard CHP cases were not available or are not sufficiently reliable for making objective conclusions about the CHP profitability and comparison of economics with other member states, detailed calculation table is not included in this report.

Annex 5: Assumptions used in the market extrapolation

Roadmap scenario

Installed capacity (MWe)	2013	2020	2030	*2030-2010*
Existing units	460,00	391,00	322,00	-138,0
Reconstruction		69,00	138,00	138,0
New		50,00	80,00	80,0
Total CHP	**460,0**	**510,0**	**540,0**	**80,0**
Economic potential		**50,0**	**80,0**	
existing + reconstruction		58%	63%	
New		42%	37%	
Total new CHP investment		**119,0**	**218,0**	

Electricity generation [TWh]	2013	2020	2030	*2030-2010*
Existing units	1,24	1,05	0,86	-0,37
Reconstruction		0,28	0,55	0,55
New		0,25	0,40	0,4
Total CHP	**1,2**	**1,6**	**1,8**	**0,58**
Economic potential		**0,3**	**0,6**	
of that biomass		**70%**	**0,4**	
existing + reconstruction		27%	31%	
New		73%	69%	

Annex 6: Methodologies used to calculate the saving of primary energy and CO_2 emissions under the roadmap

Substitution method

This method has been developed in the CODE2 project. In doing this, two other approaches have been considered: 1) the "replacement mix method[33]" from the Munich FfE institute, which however cannot be used directly for a long term comparison as needed in CODE2; 2) a method used to calculate the CO_2 saving resulting from a voluntary commitment of the German industry for CO_2 reduction[34], however this method has been considered as too simple. Therefore the following more differentiated approach has been developed:

Based on an estimate of the increase in cogeneration electricity the thereby caused decrease of CO_2 emissions and primary energy consumption is estimated. In this approach, an attempt is made to determine the actual quantities saved compared to the base year (e.g. 2010). Hence it refers to the actual saving of fuels for the production of the amounts substituted by modern CHP plants

a) of electricity and heat in the replaced or retrofitted old CHP plants

b) of electricity in power plants

c) of heat in boilers.

The savings result from a combination of three effects:

- CHP effect

- Technology effect (improved CHP technologies)

- Fuel switching (e.g. lower carbon content of natural gas compared to coal, CO_2 neutrality of bioenergy)

The results show the savings actually induced by the expansion of CHP compared to the situation in the base year.

This approach differs fundamentally from the methods for checking the high-efficiency according to the CHP Directive or in accordance with ANNEX II of the EED (Directive 2012/27/EU on energy efficiency), in which a comparison between CHP and the best available Technology (BAT) of separate production of electricity and heat produced is carried out strictly on a same-fuel basis.

This procedure is considered to be inappropriate to deliver an estimate of the actual fuel saving quantities by CHP over a longer period, which is considered a relevant value, representing meaningfully the contribution of CHP to the long-term objectives of the EU to reduce CO_2 emissions and primary energy consumption. The BAT approach of the CHP Directive has been developed to verify the high efficiency of individual plants, but not to determine actual saved CO_2 emissions and primary energy quantities by CHP expansion.

In fact, the CHP expansion is closely associated with a replacement of old cogeneration technologies by new ones and a change in the structure of fuel from coal to natural gas and bio-energy. These three developments,

- replacement of separate generation by cogeneration

- replacement of old cogeneration technologies by new ones

- replacement of carbon-rich by low-carbon fuels,

- can be usefully seen only as an integrated process.

To account for the uncertainties in particular with regard to fuel shares and technology development, a window of possible developments with an upper value and a lower value of emission reduction and savings has been determined. The different levels of results are due to assumptions about key parameters such as

[33] 10. FfE Forschungsstelle für Energiewirtschaft e.V., Energiezukunft 2050; http://www.ffe.de/die-themen/erzeugung-und-markt/257

[34] The calculation has been made by the VIK Verband der Industriellen Energie- und Kraftwirtschaft e.V., 2010, Unpublished.

current share of electricity from cogeneration, which is replaced by electricity from new or retrofitted units, fuel shares in the replaced CHP plants, power plants and boilers as well as in the new CHP plants.

The results have been calculated based on the following input values: growth of CHP power production, share of current old CHP to be replaced by new installations and retrofitting, fuel efficiency and electric efficiency of new CHP and replaced CHP for different fuels, electric efficiency of replaced power from conventional power plants for different fuels, heat efficiency of replaced heat from boilers, corresponding fuel shares.

EED method

The Primary Energy Savings methodology of the EED is used at a country level for national reporting to the Commission, and at project level for determining if CHP is highly efficient. In the methodology, each cogeneration unit is compared with the best technology for separate production of heat and electricity on the same fuel on the market in the year of construction of the cogeneration unit and the harmonized reference values are determined by fuel type and year of construction.

The underlying principle is that, knowing that regularly new investments have to be made in new energy production units, it is necessary to compare CHP with the centralized production installation which could be built using the same fuel rather than assuming a displacement of a different fuel or introduction of a new fuel. It is a logical approach when looking at the decision making process of investors or a member state government. By investing in or supporting CHP, a certain electricity generating capacity will be produced by CHP and NOT by centralized production based on the same fuel (= principle of 'avoided production').

For the timeframe of the roadmap (between 2010 and 2030), and especially in countries where there is no overcapacity, it is relevant to compare installing a certain capacity (at the national level) of CHP compared to installing new capacity with another technology (power plant + gas boiler). Older installations being replaced with state-of-the-art technology.is a typical reinvestment decision. A new CHP-plant (or combination of smaller installations) would not necessarily lead to less production in older production installations, but would rather pre-empt investments in e.g. new CCGT investments.

Annex 7: Sources

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