

CODE2

**Cogeneration Observatory
and Dissemination Europe**



D5.1 Final Cogeneration Roadmap

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



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Introduction and Summary

The CODE2 project¹

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 Europe's cogeneration potential.

Draft roadmap methodology

This roadmap for CHP in Lithuania 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 experts². The roadmap was written over a longer period in the 2014. The national policy framework around CHP continues to evolve in Lithuania and at the time of publication of this roadmap (November 2014) several items considering revision of the support scheme are under discussion and this should be taken into account when using the material in the roadmap.

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

After the shut down of the Ignalina nuclear power plant in 2010, Lithuania is importing more than 50% of electricity and cogeneration became the largest domestic source of electricity with 36% share in the gross electricity generation. District heating is the major cogeneration sector with more than 70% share of natural gas in fuel structure and growing share of renewable energy sources (RES). Increase of energy efficiency, rise of renewable energy sources and a new nuclear power plant are key energy policy goals to decrease current more than 80% energy dependency of Lithuania. Especially cogeneration on renewable energy sources fits well to this goals, proved by the recent fast development of biomass CHP plants. Favourable CHP development In Lithuania is a result of proper CHP position in the national energy policy with the incentive support framework which are the key drivers for general high CHP awareness in Lithuania. How to preserve the current volume of CHP generation and further future development is a huge financial challenge in current unfavourable energy market conditions which have increased the requested CHP support intensity and enlarged the needed financial resources.

The CHP roadmap path would deliver up to 2.6 TWh/a of primary energy saving (PES) and 1.2 million tonnes of CO₂ reductions are achievable till 2030. Increase of sustainable CHP electricity generation by new CHP units mainly using RES for up to 1.2 TWh would decrease Lithuanian import dependency and is complementary to the planned further use of nuclear energy. Providing adequate EU financial resources for CHP support in the current unfavourable energy market conditions and transition to investment intensive RES CHP plants. Setting proper position and quantitative goals of cogeneration in the reviewed National Energy Strategy is of high importance for the future sustainable electricity generation mix in Lithuania.

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

1.1 Current status: Summary of currently installed cogeneration in Lithuania

More than 50% of the thermal electricity generation in Lithuania is produced in high efficient cogeneration mode. Cogeneration has more than 36% share in the total gross electricity generation after a significant decrease of domestic production by the closure of the Ignalina nuclear power plant in 2010 and close to 60% of electricity import consequently. Majority of CHP plants are located in district heating systems mainly fuelled by natural gas but with growing share of wood biomass and waste.

After the shutdown of the Ignalina nuclear power plant in 2010, energy dependency of Lithuania grew to about 82% in 2011³ and Lithuania is importing almost 60% of the gross inland electricity consumption (Figure 2 and Figure 1).

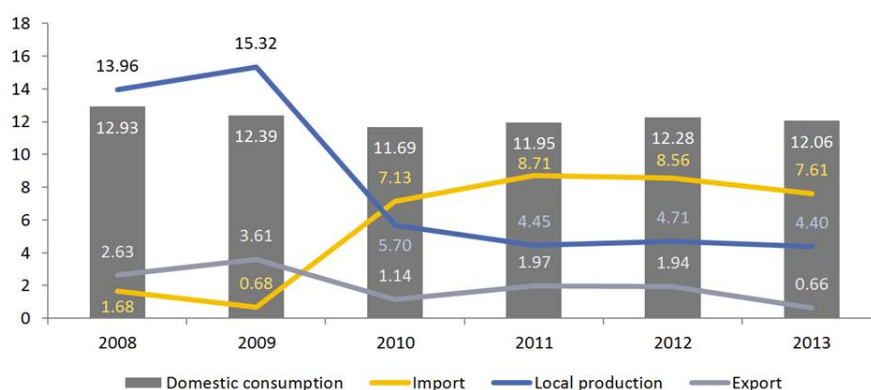


Figure 1: Country electricity balance 2008-2013, TWh⁴

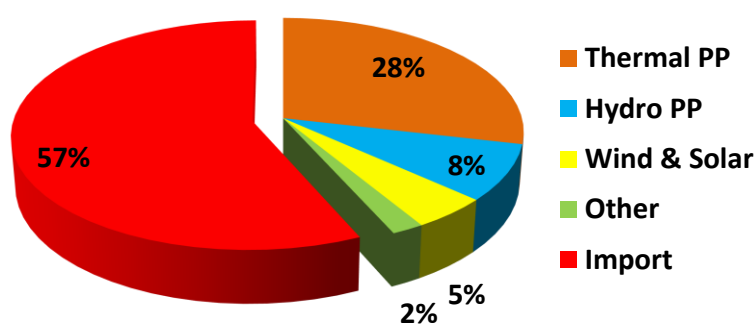


Figure 2: Structure of electricity supply in 2012⁵

³ Eurostat: SHARES 2011, July 2013

⁴ Source: The National Commission for Energy Control and Prices, <http://www.regula.lt/en/Pages/Electricity.aspx>

⁵ Source: Statistics Lithuania.

The main primary energy sources are oil and petroleum products with 36% share followed by natural gas with 31% share in the total primary energy supply. The share of renewable energy sources is growing and reached 21% share in 2013 (Figure 3).

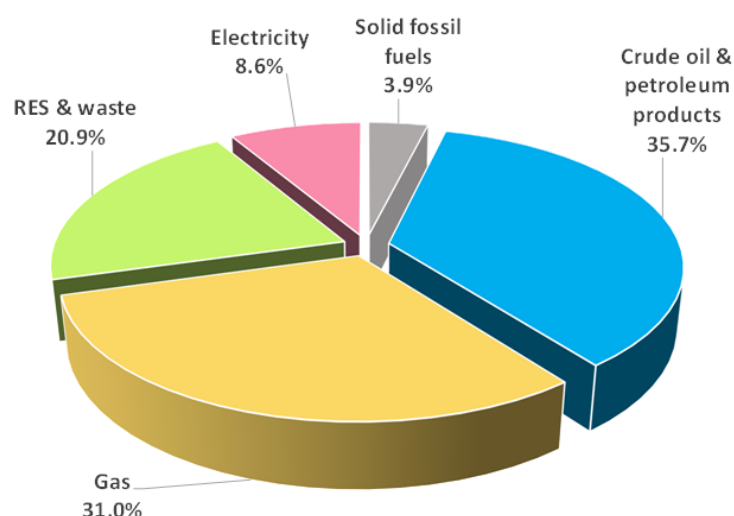


Figure 3: Structure of energy supply in Lithuania in 2013

The share of electricity from CHP in gross electricity generation increased sharply and reached a high around 36% share after the closure of the nuclear power plant and consequently reduction in the total generation of electricity. After the faster growth of cogeneration after the year 2004, CHP electricity generation in Lithuania varied around 1.9 TWh with a gradual capacity growth toward 1.2 GWe (Table 1 and **Error! Reference source not found.**).

Table 1: Eurostat data on cogeneration in Lithuania in the period 2006 – 2012

CHP	Installed electrical capacity [GW]	Total heat supplied [TWh]	Total electricity generated [TWh]	Total % of gross electricity production
2006	1.04	5.53	1.78	14.3%
2007	1.05	4.69	1.84	13.2%
2008	1.08	4.22	1.77	12.7%
2009	1.09	4.59	2.14	13.9%
2010	1.10	5.37	1.99	34.6%
2011	1.21	4.40	1.81	37.5%
2012	1.17	4.28	1.82	36.2%

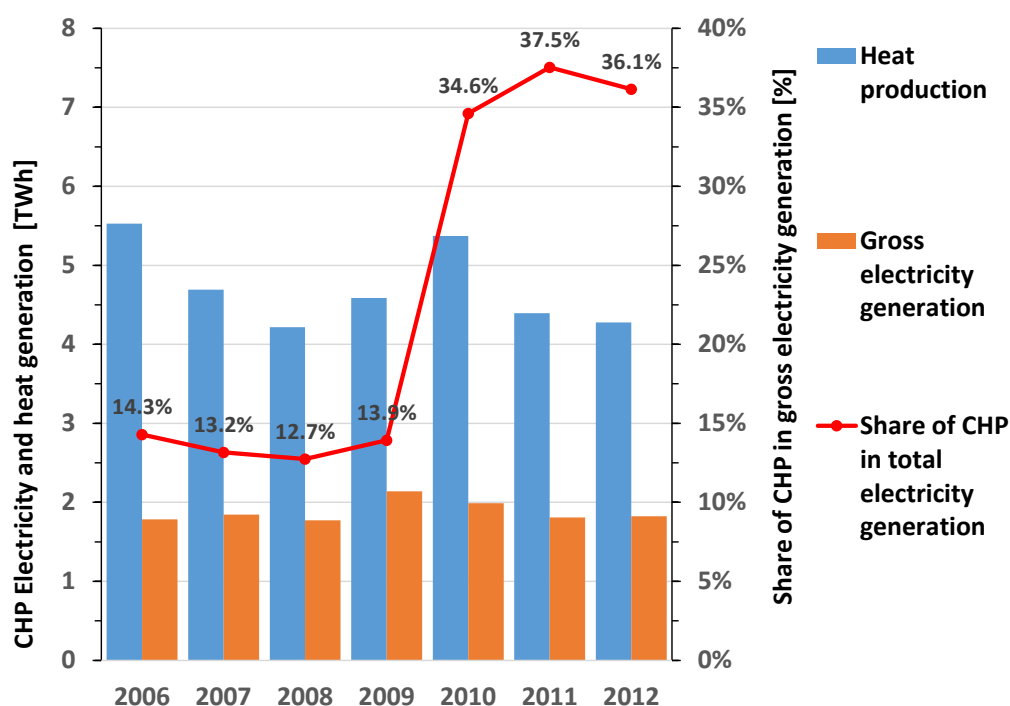


Figure 4: CHP electricity and heat generation in period 2006 – 2012

Steam turbines are the prevailing current cogeneration technologies with a growing share of combined cycle gas turbines and internal combustion engines. Natural gas has more than 70% share in the CHP fuel in 2010, followed by the 20% share of oil and close to 9% share of biomass with a growing trend in the last years (Figure 5). Majority or around 90% of CHP electricity generation is in district heating systems and the rest in industry⁶. Around 50% of the Lithuanian final heat demand is supplied by district heating systems with 8-9 TWh of heat supply with about 50% share of CHP heat generation.

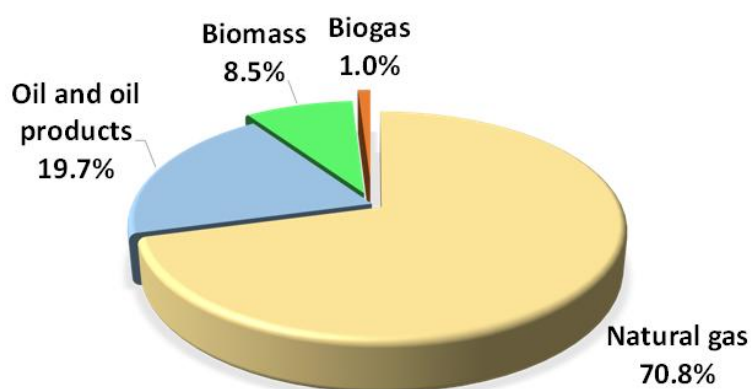


Figure 5: Structure of fuel consumption in CHP plants in 2010

⁶ 106 MWe combined cycle CHP plant installed in 2007 in oil refinery is the largest industrial CHP producer in Lithuania.

1.2. Energy and Climate Strategy of Lithuania

Increase of the use of renewable energy sources (RES), increase of the energy efficiency and further use of nuclear energy are key strategic goals of energy and climate policy based on the National Energy Independence Strategy of Lithuania and other strategic documents.

The “National Energy Independence Strategy of the Republic of Lithuania, 2012”[5] defines the main strategic objectives to ensure Lithuanian energy independence before the year 2020 and to lay the foundations for security of supply, competitive and sustainable development of the energy sector. The 3 main strategic principles of the strategy are shown on Figure 6 with next main directions toward 2020:

- Integration of power system of Lithuania with the EU systems,
- New regional nuclear power plant at Visaginas (1380 MW)⁷,
- New LNG import terminal (diversity of energy import)⁸,
- Increase of use of biomass for heating needs, and
- Energy use efficiency increase.

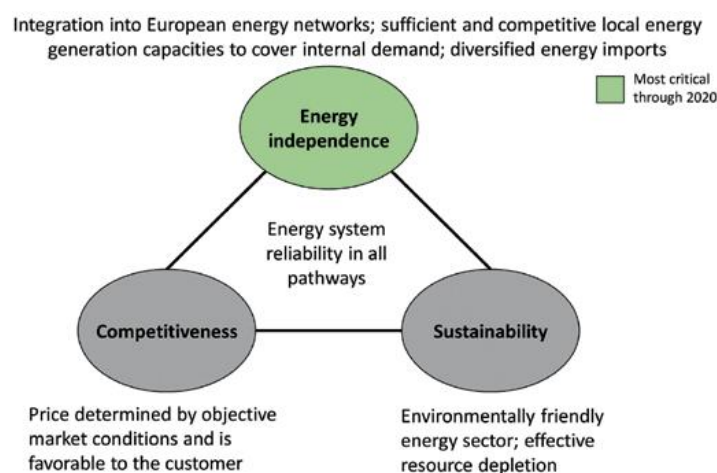


Figure 6: Key principles of the National Energy Independence Strategy for the energy sector

Currently, The National Energy Strategy of Lithuania is under review and is planned to be redrafted setting new goals for the future and depicting the current situation of the energy sector, including CHP.

Lithuania has the goal to achieve 23% share of renewable energy sources (RES) in gross energy consumption by 2020. The goals of RES strategy are to increase share of electricity generation from

⁷ The governments of Lithuanian, Latvia, Estonia and Poland agreed in 2007 to build the new nuclear power plant at Visaginas (Lithuania), but Poland subsequently withdrew from the project. The building of new nuclear power plants was rejected on advisory (not binding) referendum on 14 October 2012, but on March 2014, leaders of Lithuania's seven parliamentary parties had “underlined their commitment to the construction of the Visaginas nuclear power plant in a document setting out the nation's strategic goals www.world-nuclear-news.org/.

⁸ The new LNG import terminal in Cleipeda has been built on time and it started in operation in December 2014.

RES (mainly from biomass) to 20% of all electricity generation and to cover 60% of district heat production from biomass by 2020.

The emissions of GHG in Lithuania have significantly decreased for more than 50% in 2011 compared to the GHG emissions in 1990. Lithuania⁹ is permitted to increase its greenhouse gas (GHG) emissions by no more than 15% until 2020 compared to the basic 2005 level, in the sectors that are not covered by the European Union Emission Trading Scheme (ETS). On November 2012, the approved “National strategy for climate change management policy for 2013–2050¹⁰” (Climate change strategy) set next main measures to reducing GHG emissions in the energy sector:

- increase of energy efficiency,
- promotion of energy generation from renewable energy sources (RES) and
- nuclear power.

1.3. Policy development in Lithuania

The current key support instrument for CHP using RES in Lithuania is in form of feed-in tariff awarded through the auctions for units above 10 kWe and guaranteed for 12 years. Additionally investment subsidies are available from the EU structural funds. For non-RES CHP plants that supply heat for district heating systems support in form of public service obligation prices is available as the difference between the annually defined feed-in prices and forecast market price of electricity.

The Lithuanian National Energy Strategy, adopted in 2007, has defined the increased use of the renewable energy sources and increase of share of electricity generated by cogeneration as measures for the sustainable development of the energy system. Currently, the National Energy Strategy of Lithuania is under review and is planned to be redrafted by setting new goals for the future and depicting the current situation of energy sector (including CHP - what is needed to be improved and refined).

Promotion of high efficient cogeneration using natural gas, renewable energy sources (RES) and waste for electricity production are effective measures to decrease the Lithuanian energy dependency, which is the key goal of the Lithuania’s energy policy at the current high import of electricity and natural gas.

The support for electricity from RES is promoted mainly through the feed-in tariff support scheme. The tariffs for RES plants with a capacity exceeding 10 kW are awarded through the auctions, which are organized by the National Control Commission for Prices and Energy. The commission quarterly sets the feed-in tariffs for RES plants with a generating capacity of up to 10 kW and maximum tariff levels for other RES plants¹¹ exceeding 10 kW (Table 2). The feed-in tariffs are guaranteed for 12 years for up to 50% of the total plant electricity generation within a calendar year. The rest 50% of generated electricity has to be used by the producers for their own needs.

⁹ Lithuania: National Reform Programme 2013, Vilnius, 2013

¹⁰ Seimas of the Republic of Lithuania: Resolution approving the National strategy for climate change management policy, 6 November 2012 No XI-2375, Vilnius

¹¹ The National Control Commission for Prices and Energy (NCC)-Maximum feed-in tariff for electricity from RES (<http://www.regula.lt/en/Pages/tariffs-for-electricity-from-res.aspx>)

Table 2: Feed-in tariff for electricity from biomass and biogas power plants in Lithuania

Index name		2014 I quart.	2014 II quart.	2014 III quart.	2014 IV quart.	2015 I quart
Biomass (for new power plant construction)						
IC < 10 kW	EUR ct/kWh	11.58	10.72	8.69	8.69	8.10
IC < 30 kW	EUR ct/kWh	9.85	9.27	7.53	7.53	7.00
10 kW < IC > 350 kW						
30 kW < IC > 350 kW						
350 < IC ≤ 5000 kW						
IC > 5000 kW	EUR ct/kWh	8.98	8.11	6.66	6.66	6.40
Biomass (reconstruction of operating plant)						
IC < 10 kW	EUR ct/kWh	10.72	9.27	7.24	7.24	6.40
10 < IC ≤ 350 kW	EUR ct/kWh	9.27	7.82	6.37	6.37	5.50
350 < IC ≤ 5000 kW						
IC > 5000 kW	EUR ct/kWh	8.40	6.95	5.50	5.50	5.50
Biogas (for power plants using landfill gas)						
IC < 10 kW	EURct/kWh	12.45	11.58	11.58	11.58	11.30
10 kW < IC > 5000 kW	EURct/kWh	11.87	11.30	11.30	11.30	11.00
IC > 5000 kW	EURct/kWh	9.56	8.98	8.98	8.98	8.70
Biogas (for power plants using biogas derived from anaerobic digestion or other biodegradable organic waste or substrates)						
IC < 10 kW	EURct/kWh	15.93	15.35	15.35	15.35	14.50
IC < 30 kW	EURct/kWh	14.77	13.90	13.90	13.90	13.30
10 kW < IC > 350 kW						
30 kW < IC > 350 kW						
350 kW < IC > 500 kW						
500 < IC ≤ 1000 kW	EURct/kWh	13.90	13.32	13.32	13.32	12.50
1000 < IC ≤ 2000 kW	EURct/kWh	13.32	12.74	12.74	12.74	11.90
IC > 2000 kW	EURct/kWh	12.74	12.16	12.16	12.16	11.60

The electricity production from CHP using fossil fuels which supplies heat for district heating system is supported under the mechanism of public service obligations (PSO) managed by The National Control Commission for Prices and Energy (NCC). The PSO price (premium) for purchase of electricity (supplying to the network) is the difference between the annually feed-in prices¹² defined by NCC and forecast market price of electricity. The range of minimum and maximum CHP electricity purchase prices in the period 2008 – 2013 is shown in Table 3 and the average electricity market

¹² The prices are set annually based on the average natural gas price for 3 different CHP capacity size groups: up to 5 MWe, 5-50 MWe and above 50 MWe.

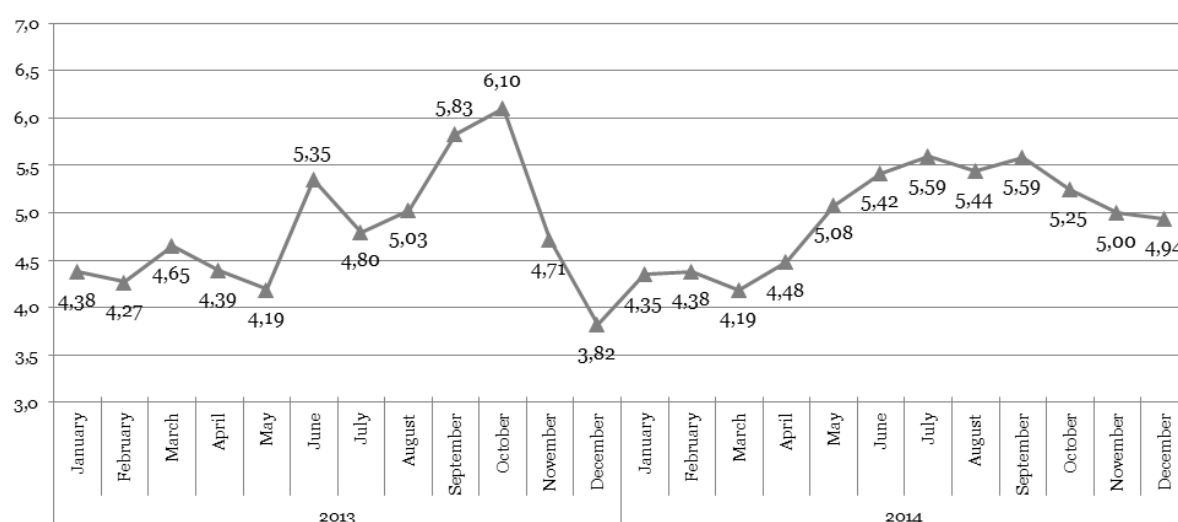
price in Figure 7. The NCC sets the annual amount of the PSO fund (budget) which is defined based on PSO price of electricity and is shown in Table 4¹³.

Table 3: The minimum and maximum purchase price of electricity from CHP using fossil fuels in Lithuania

		2011	2012	2013	2014
Minimum price	EUR ct/kWh	6.50	7.94	9.45	7.80
Maximum price	EUR ct/kWh	9.21	12.30	16.56	11.24

Table 4: PSO fund for CHP plants using fossil fuels for the period 2008 - 2014¹⁴

		2008	2009	2010	2011	2012	2013	2014
Combined Heat and Power Plant PSO found	mIn. Eur	46.46	87.26	10.34	24.82	33.93	48.71	27.24



Source: NCC

Figure 7: Average market price of electricity in Lithuania in 2013-2014 (EUR ct/kWh)

Investment subsidies were available in the financial perspective 2009 – 2013 for the development of cogeneration units using renewable energy sources financed by the European Union Structural Fund. Continuation of the activities is foreseen also in the period 2014 – 2020.

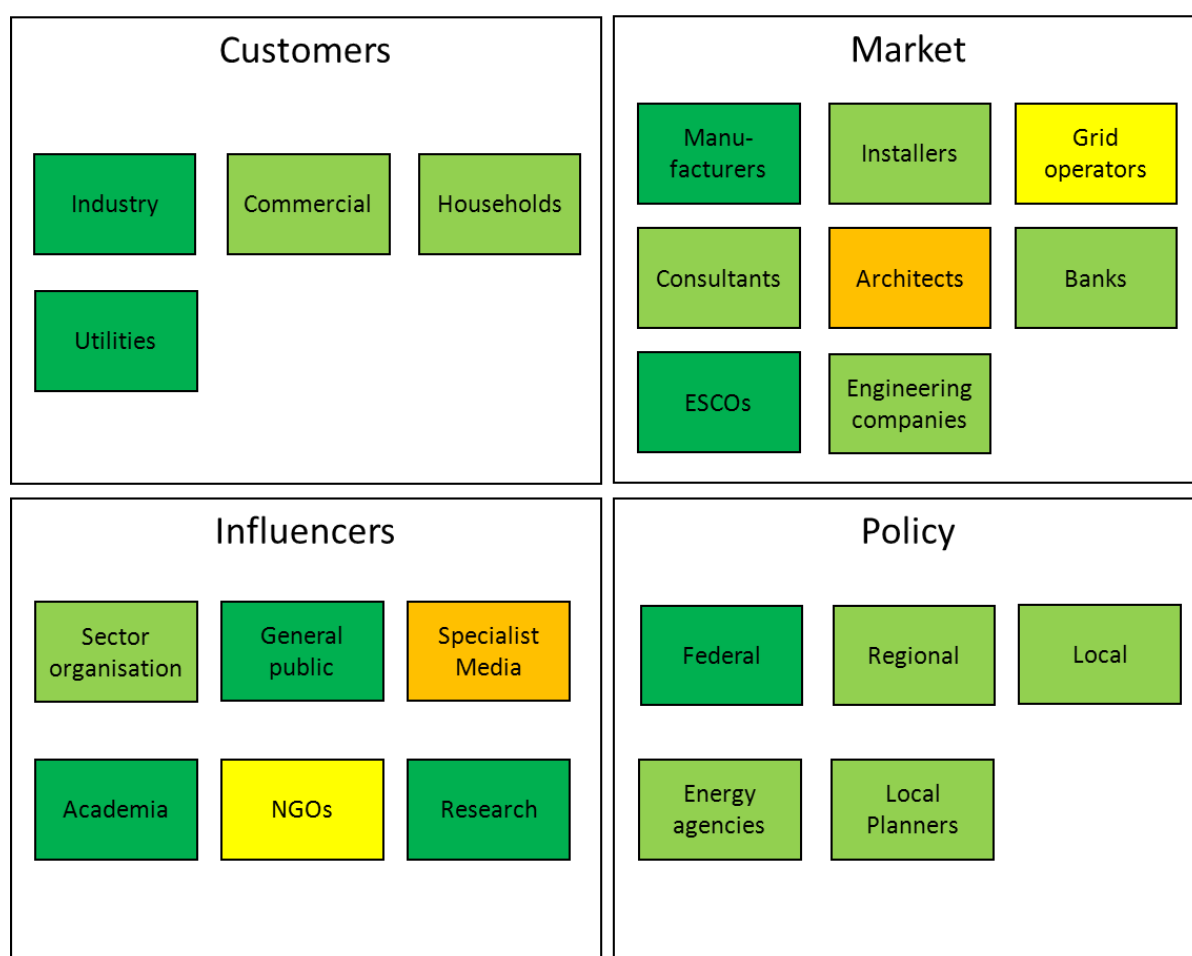
¹³ The annual quantities of the supported CHP electricity are planned to be gradually reduced (from 900 GWh in 2012 to 600 GWh in 2015 [4]).

¹⁴ Source NCC, significant decrease of PSO found in 2010 is result of the significant electricity market price increase after the shot down of Ignalina nuclear power plant.

1.4. Exchange of information and awareness in Lithuania

Fast recent growth and high penetration of cogeneration especially in district heating as a result of proper CHP position in the national energy policy with an incentive support framework are key drivers for general high CHP awareness in Lithuania. Several professional interest associations enable good expert support framework for cogeneration which has an important influence on the decent general awareness of cogeneration in Lithuania.

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, supports 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 8. 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.








1	Poor	
2	Low	
3	Early awareness	
4	Interest	
5	Active market	

Figure 8: Assessment of four groups of the socio-economic actors' awareness of cogeneration in Lithuania

Customers

Fast growth of cogeneration in the last decade especially in the district heating sector and a dominant role of cogeneration in Lithuania electricity generation after the shutdown of the Ignalina nuclear power plant is the main reason for rather high general awareness of CHP in Lithuania. Moderate investment's growth large refinery industry and medium and small scale CHP applications in industry are influencing cogeneration awareness in these sectors as well.

Market players

District heating utilities (public and private companies) are key CHP investors beside limited investments in industry, well supported by skilled domestic engineering and technical service companies and project providers. Premature Emerging ESCO market is not yet offering a proper support for CHP projects which could trigger some new CHP investments especially in industry.

Influencers

Several interest associations like the Lithuanian District heating association (LDHA), the Association of Biofuels Producers and Suppliers of Lithuania (LITBIOMA), Lithuanian Energy Consultants Association (LEKA) etc. have an important role in the successful discussion with the government and other authorities considering actual CHP issues. Cogeneration is well integrated in the education programmes of Vilnius and Kaunas University and supported by the Lithuanian Energy Institute which results in high educated technical staff and cogeneration awareness in the engineering area.

Policy makers

Cogeneration awareness is on a rather high level as it is well positioned in the national energy policy and goals and results in a broad incentive support framework. Future reshaping of the support framework will be more focused on the attractive renewable and waste CHP projects as the important policy measure for the decrease of Lithuanian import dependency.

1.5. The economics of CHP in Lithuania

Current CHP support enables required profitability for all CHP projects using renewable energy sources. Due to gradual reduction of the support volume for fossil CHP plants and obligation of heat supply to the district heating system current energy market conditions do not enable new investments outside district heating. Although supported, micro CHP units are not yet competitive due to still high investment costs.



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 an active CHP market for CHP units using renewable energy sources and waste (Table 5). Proper support framework as a combination of the feed-in tariffs and investment subsidies enables proper economic conditions for small, medium and large CHP investments whereas conditions for the micro CHP units are still boundary due to higher investment costs. Turn toward renewable CHP and gradual reduction of the support volume of public service obligation for cogeneration on fossil fuels supplying heat to district heating network is not providing needed support incentives for new investments for these CHP units on the current energy market.

Table 5: Market economic situation of CHP in major user groups

Lithuania	Micro		Small & Medium		Large		
	<i>up to 50kW</i>		<i>up to 10 MW</i>		<i>more than 10 MW</i>		
	NG	RES	NG	RES	NG	Coal	RES
Industry							
District heating							
Services							
Households							

Legend:

-  **"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.
-  **"modest"** CHP Investment has **modest/limited economic benefits** and return on investment (5-7%), **limited interest for new investments**.

	"poor"	CHP Investment has poor or negative return on investment or is not possible due to other limitations, no interest/possibilities for new investments.
		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 Lithuania

Current unfavourable energy market conditions have increased the requested CHP support intensity and limited the volume of supported electricity by the available financial resources. Availability of the adequate EU financial resources will have the key influence on the extent of the new CHP investments using renewable energy sources as new policy orientation and measure for the reduction of current high heat prices from CHP using natural gas. On-going review of the National Energy Strategy of Lithuania poses certain uncertainty to the future energy policy goals and priorities and the role of CHP.

In the second CHP progress report presented to the EC¹⁵, the Lithuanian government has stated that they did not identify any fundamental barrier in relation to administrative procedures and electricity grid system and tariff issues. They have warned on the natural gas security of supply issue due to the current exclusive supply from Russia and underdevelopment of the natural gas transmission system in the western part of the country. Both barriers will be mitigated by the recently built LNG terminal in Klaipeda and planned new gas transmission links to Poland.

Even though a recent very favourable Lithuanian cogeneration development which proved the absence of serious barriers for new CHP investments, based on the 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: Adequate EU financial resources are crucial for new CHP investments

For a switch from the natural gas to renewable energy sources (RES) and waste in the existing CHP units and construction of new RES facilities adequate EU funds are a prerequisite condition to enable new investments. Predominant use of natural gas in district heating at current high fuel costs results in high unsustainable end use prices where switch to RES or waste enables lower operation costs but higher starting investment cost. Due to reduced financial resources available for the CHP operational support, EU investment founding is crucial for the future development of CHP.

¹⁵ RE: Report on the progress towards increasing the share of high-efficiency cogeneration, Ministry of Energy of the Republic of Lithuania, January 2012.

Barrier 2: Unfavourable energy market conditions for operation and development of the natural gas based CHP generation

Current low electricity market prices on the integrated regional Baltic electricity market¹⁶(Figure 9) and high natural gas prices¹⁷ cause high support requirements and financial resources for the operation of existing CHP plants. Lithuanian turn toward the use of renewable energy sources is necessary and reasonable orientation and gradual reduction of the annual quantities of the supported electricity generation from fossil fuelled CHP as a consequence. At least minimum market based support for the existing natural gas CHP should still be provided also in the future to preserve current CHP generation in the transition period toward RES CHP generation. Non-existent support for the small scale CHP application outside district heating systems is the key barrier for the potential development in current energy market conditions.



Source: <http://www.nordpoolspot.com>

Figure 9: Average weekly electricity price on the Lithuanian Nord Pool Spot market (

Barrier 3: Uncertain new energy goals due to on-going review of the National Energy Strategy of Lithuania

Although Lithuania has well-formed energy policy supported by several strategies and action plans, on-going review of the National Energy Strategy of Lithuania poses certain uncertainty to the future energy policy goals and priorities. Based on the evaluation of the recent new energy market conditions (especially natural gas prices) and situation in the electricity sector (planned construction of the new nuclear power plant, etc.), the new strategy will set also future perspectives for the cogeneration in Lithuania. Till the end of the procedure it is difficult to assess properly the whole future role of CHP in Lithuania.

¹⁶ Lithuania is part of the regional Nord Pool Spot market (<http://www.nordpoolspot.com>) which has the largest influence on the local electricity prices. The average price of electricity in 2013 was 48.38 EUR/MWh, the average price in November 2014 was 50.44EUR/MWh (<http://www.nordpoolspot.com>)

¹⁷ Gazprom natural gas prices for Lithuania were above the Germany level, recently some discounts were negotiated in 2014 under the pressure of the completion of LNG terminal in Kleipeda.

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

Latest comprehensive assessments proved up to 200 MWe of additional CHP cost-effective potential in Vilnius and Kaunas with a partial switch of existing CHP units using natural gas on biofuel and waste. Following the National Energy Independence Strategy Lithuania will provide conditions for the installation of up to 355 MWe CHP plants using biomass till 2020. Recent fast growth of RES CHP electricity generation proves huge bio energy CHP opportunities assessed also by the recent CODE2 analysis. Good natural gas infrastructure offers a proper environment also for development of micro CHP units in SMEs outside the district heating if necessary new incentives would be introduced.

Following the latest National energy efficiency action plan [3] the Comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling has already been implemented. *“This assessment of the potential has revealed that additional cost-effective development of cogeneration in Lithuania can reach up to 200 MW of electric capacity in Vilnius and Kaunas. In this case, existing gas facilities will switch to biofuel, and the demand may in part be met by waste incineration cogeneration plants”*¹⁸.

Following the National Energy Independence Strategy [5], the State will provide conditions for the installation up to 355 MWe CHP plants using biomass till 2020. Recently published National Programme for the Development of Renewable Energy Resources [6] assessed the similar about 350 MWe technical potential for biofuel CHP plants in the district heating systems¹⁹. Even higher over 600 MWe is the assessment of the conservative biomass potential scenario of the Lithuanian renewable energy confederation [11]

Regarding the presented information we can conclude that evident CHP potential for increase of the current CHP electricity generation for up to 2 TWh exists in Lithuania, which fits to the key energy policy goals and could significantly contribute to the decrease of electricity import dependency.

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 presented information and the recent successful CHP investments in Lithuania prove the evident CHP market potential especially in district heating. Additional less processed potential exists also in other distributed CHP generation in services and SMEs, especially in case of a faster economic crisis recovery and new incentives for these sectors.

¹⁸ The study focus was primarily on the analysis of the district heating systems and industrial waste heat potential assessment.

¹⁹ In 2012 biofuel cogeneration facilities operating in Lithuania generated 176 GWh of electricity with the cumulative electric capacity of 41 MW. The theoretical potential of biofuel plants is sufficient to meet the electricity demand of the whole of Lithuania, while the technical potential only exists for efficient heat consumption, i.e. for the connection of biofuel plants to existing district heating systems. The technical potential is about 350 MW.

Bio energy

Recent fast growth of electricity generation from biomass²⁰ proved an important role and a huge technical potential of bioenergy in Lithuania. Regarding a new policy priority on bio CHP generation, an important further growth is expected in the future.

Analysis on Bio CHP potential carried out within the CODE2 project, based on the “score cards analysis” proves the huge growing role of bio CHP generation till the year 2030 (see Annex 3 for the details)²¹ which could significantly exceed the analysis expectation:

- The share of bio-fuels in CHP (bio-energy penetration rate in CHP markets) is expected to grow from 8.2% (2009) to 21.5% (2030)
- Expected bio CHP heat generation could be more than tripled till 2030 (164 ktoe) which is close to 50% of the assessed 350 MWe technical potential heat generation.

Micro CHP

The CODE2 micro CHP potential analysis estimated interesting market potential for micro CHP units on around 300 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 households CHP development is very uncertain due to high current technology and fuel costs although in case of the expected decrease of investment costs, the sales of micro CHP units in 2030 could exceed 2000 units per year. Good natural gas infrastructure in Lithuania enables also the development of dispersed micro CHP units if market conditions would provide the requested profitability for these units where additional incentives are prerequisite to trigger this potential.

3. How do we arrive there? The Roadmap

Following actual energy policy goals of Lithuania, cogeneration can play a key role for efficient use of renewable energy and increase of energy efficiency for sustainable supply of heat to the efficient district heating systems which is complementary to the planned further use of nuclear energy. Cogeneration can significantly contribute also to other energy policy priorities where decrease of the electricity import dependency, mitigation of the energy import risks and ensuring a stable energy supply to the consumers are high policy priorities.

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

To assure adequate EU financial resources and preserving long term stable and predictable incentive legal framework for cogeneration is a key priority necessary for keeping current volume and enabling further future CHP development in Lithuania with a special emphasis on the use of renewable energy sources. Setting proper position and quantitative goals of cogeneration in the reviewed National Energy Strategy is of high importance for the future sustainable electricity generation mix in Lithuania.

²⁰ Around 50 MWe new capacities were installed since 2012.

²¹ Appropriate support mechanisms, high share of district heating heat supply, biomass availability and high awareness result of clear strategic policy goals on renewables.

Action 1: Providing adequate EU financial resources and preserving long term stable, incentive and predictable legal framework for cogeneration

Huge financial burden for the support of new RES CHP investments is the key reason for the slower CHP development based on the limited financial resources to enable financially bearable conditions for the consumers – lower costs of the electricity and heat supply.

Providing adequate EU financial resources for the investment support of new CHP projects is the key condition for the further faster growth of CHP electricity generation, especially using RES. Energy retrofit of the district heating infrastructure requires additional EU resources to enable sustainable and economical operation of the district heating systems. Preserving long term stable, incentive and predictable legal framework for cogeneration is essential for the investors and support of the national economy²².

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

As current energy market prices do not enable economic conditions for a profitable operation of CHP units using natural gas without adequate support, additional market income is requested to preserve the operation of recently installed CHP units. Flexible CHP units on natural gas with predictable operation could effectively provide different ancillary services for the grid which would improve their economic conditions with limited additional public funds.

Lithuania participation on the very effective, liquid and well organised regional Nord Pool Spot market has very good opportunities²³ 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 in the grid operation would strengthen the grid operation stability and enable a higher share of intermittent RES electricity generation (actual growing of wind generation) and is an important step toward smart active electric grid of the future. Smaller dispersed CHP units outside district heating systems can play an important role in this grid issue where proper support for these units should be provided in the future to enable their development. Balanced involvement of all stakeholders (Ministry, Regulator, grid operators, research, local industry, etc.) is a prerequisite for successful implementation of this task in the transition period toward prevailing share of RES CHP.

The stable least feasible support which will preserve the operation of CHP plants using natural gas should be provided in the transition period toward prevailing cogeneration using RES where a proper combination of market and other instruments should be established also with regard to the strategic goal of decreasing the Lithuanian electricity imports and utilization of good natural gas infrastructure.

Action 3: Important role of cogeneration in the reviewed National Energy Strategy

On-going review of the National Energy Strategy is a good opportunity for proper position of cogeneration in the future energy supply of Lithuania. Beside ascendant use of RES in CHP plants, future development of cogeneration should be also focused on the flexible CHP electricity generation units which will enable higher share of intermittent RES electricity generation and will be complementary to the planned new nuclear power plant base load generation.

²² To preserve established new companies and new jobs linked to the CHP investments and operation in Lithuania.

²³ Elspot day-ahead market and Elbas intraday market which enables objective and precise price signals.

Setting of clear quantitative goals for cogeneration in the reviewed National Energy Strategy will assure clear signals for the potential investors to the new CHP plants and contribute to the sustainable future electricity generation mix in Lithuania.

3.2. Possible paths to growth in Lithuania

Increase for more than 60% or 1.2 TWh increase of current CHP electricity generation is proposed by the CHP road map implementation. Majority of 350 MWe of new CHP capacity would be installed in district heating and using renewable energy sources. Moderate CHP development is expected also in other sectors and SMEs. The current rather high 20% share of CHP electricity generation in final electricity demand could be increased up to 23% level till 2030 in spite of rather high expected demand growth.

According to past and actual positive trends of high efficiency CHP electricity generation development and the assessed evident market potential we can objectively expect further dynamic CHP growth toward 2030 with a prevailing use of renewable energy sources.

With the proposed **CHP roadmap** implementation we can strengthen further CHP development and significantly contribute to the Lithuanian strategic energy climate targets and increase of self-sufficient electricity generation. Economic potential for CHP growth is evident from the recent comprehensive assessment of the CHP potential which we can take as the reasonable basis for the CHP roadmap goals:

- **350 MWe of new CHP capacity till 2030** of that 220 MWe of new CHP units and 130 MWe reconstructions of existing CHP plants:
 - **305 MWe** of CHP units using renewable energy sources and waste
 - **45 MWe** of new CHP plants on natural gas

The proposed CHP development would increase current **1.8 TWh** CHP electricity generation to **2.6 TWh** till 2020 and to **3 TWh** till 2030 as shown in Figure 10 and the following energy and environmental indicators for roadmap impact assessment.

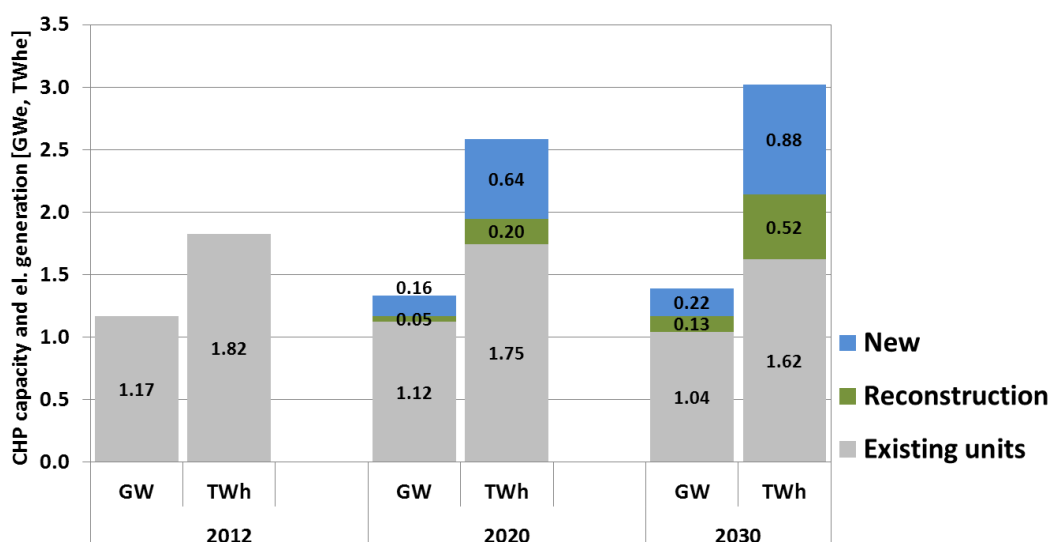


Figure 10: Target path to the CHP growth till the year 2030

- **CHP electricity generation:** increase for 1.2 TWh_e or for more than 60% compared to the current high efficiency electricity generation in the year 2012, with the major contribution of district heating CHP plants using RES.
- **Share of cogeneration electricity in gross electricity consumption:** slightly increase of current rather high 20% share to at least 23% level toward 2020 and 2030 considering expected rather high growth of electricity demand.
- **Share of renewable energy sources:** more than 85% of heat and more than 95% of electricity generation from new CHP plants produced from renewable energy sources.

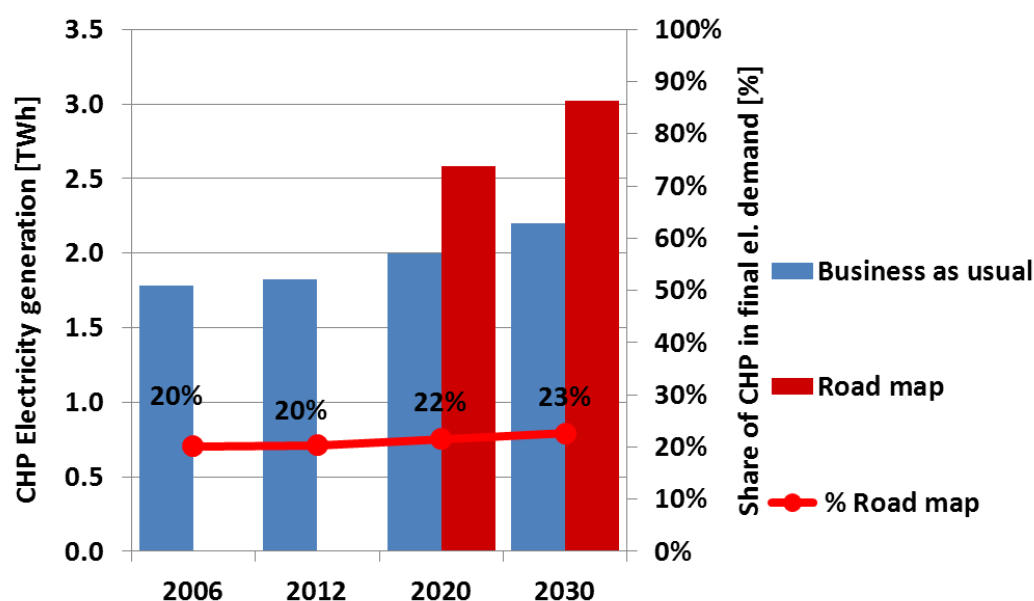


Figure 11: CHP Roadmap Electricity indicators

Considering assessed technical potential, a future development of cogeneration could be even greater or by using different technologies²⁴ as we consider the proposed roadmap economic potential rather conservative, especially in a faster economic growth and more favourable energy market conditions till the year 2030.

3.2. Saving of primary energy and CO₂ emissions by the CHP roadmap of Lithuania

Potential CHP primary energy savings could contribute up to 1.7 TWh or around 5% of the indicative national target of primary energy savings till the year 2020 and reduce CO₂ emissions for up to 1.2 million tons of CO₂ till the year 2030. Growth of CHP generation will enable efficient and sustainable domestic electricity and heat generation mainly from renewable resources and significantly contribute to the decrease of Lithuanian import dependency.

²⁴ Especially use of RES CHP technologies is rather uncertain due to recent fast development (faster market availability of wood biomass gasification would even speed up development and increase the volume of RES electricity generation).

Within the CODE2 project two approaches for the assessment of primary energy savings (PES) and CO₂ emissions savings are used to demonstrate advantages and contribution of CHP technology to the reduction of energy use and CO₂ emissions:

1. **Methodology prescribed by EED** (according to Annexes I and II)²⁵
2. **Substitution method** – new developed method for the assessment of actual achieved savings²⁶

New CHP generation proposed by the Roadmap would contribute around **2.5 TWh PES (8.8 PJ)** calculated by the EED methodology or **2.6 TWh (9.4 PJ)** by the substitution method as shown in Table 6²⁷ if we consider that increased CHP production will mainly replace current condensing electricity generation from natural gas.

The assessed PES potential of CHP up to 1.7 TWh²⁸ till the year 2020 or around 5% of the 38 TWh set indicative national target of final energy savings in the year 2020 in NEAP 2014 [3] proves that the implementation of CHP roadmap can have an evident contribution to the foreseen national goals for the year 2020 and additionally contributes to the new goals for the year 2030.

By using the same approach, potential real achievable CO₂ savings by the substitution method are 1.2 Mio.t of CO₂, much higher than only 0.03 Mio.t CO₂ savings by EED methodology²⁹ as shown in Table 6. By increasing the volume of the new CHP investment, potential CO₂ savings would be even higher.

Table 6: Saving of primary energy and CO₂ by the Lithuanian CHP roadmap till 2030

	Substitution method		EED method	
	Business as usual	Roadmap	Business as usual	Roadmap
PE saving	0.8 TWh/a	2.6 TWh/a	0.7 TWh/a	2.5 TWh/a
CO₂ saving	0.4 Mio t/a	1.2 Mio t/a	0.01 Mio t/a	0.03 Mio t/a
- per kWh_{el}*³⁰	1.26 kg/kWh _{el}	1.04 kg/kWh_{el}		

²⁵ **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.

²⁶ **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.

²⁷ Methodology considers that CHP is replacing the existing condensing electricity generation from natural gas and heat generation in local boilers on natural gas.

²⁸ This is less than assessed 2.5 TWh of primary energy savings from district heating sector and decommissioning of the Lithuanian power plant in NEAP2014 [3] which fits better with the CHP roadmap assessment till the year 2030.

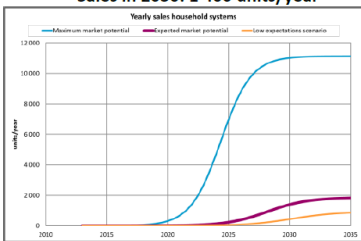
²⁹ CHP plants using renewable energy are not achieving CO₂ savings by EED methodology (compared to separate renewable generation), but in reality they are replacing current prevailing fossil generation.

³⁰ This value represents the CO₂ 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

The analysis on the awareness of CHP and its benefits in the main stakeholder groups was implemented by a contribution of different Lithuanian CHP experts. Due to the limited number of experts' opinion we stated that results of the analysis cannot be regarded as representative on the individual stakeholder level and are not presented in details in the report.

Annex 2: Micro CHP potential assessment

		<h1>micro-CHP potential summary Lithuania</h1>																													
<h2>Country statistics</h2>																															
Population: 3 190 000 (2010)																															
Number of households: 1 276 000 (2010)																															
GDP per capita: € 16 600 (2010)																															
Primary energy use: 4 800 ktoe/year (2010)																															
GHG-emissions: 20.8 Mton CO _{2,eq} /year (2010)																															
<h3>Household systems (±1 kW_e)</h3> <p>Boiler replacement technology</p>			<h3>SME & Collective systems (±40 kW_e)</h3> <p>Boiler add-on technology</p>																												
<p>Present market (2013)</p> <p>Boiler stock: 91 000 units</p> <p>Boiler sales: 22 500 units/year</p>			<p>Present market (2013)</p> <p>Boiler stock: 23 000 units</p> <p>Boiler sales: 5 600 units/year</p>																												
<h4>Potential estimation</h4>			<h4>Potential estimation</h4>																												
<table><thead><tr><th>Indicator</th><th>Score</th></tr></thead><tbody><tr><td>Market alternatives</td><td>0</td></tr><tr><td>Global CBA</td><td>1</td></tr><tr><td>Legislation/support</td><td>0</td></tr><tr><td>Awareness</td><td>0</td></tr><tr><td>Purchasing power</td><td>0</td></tr><tr><td>Total</td><td>1 out of 12</td></tr></tbody></table>			Indicator	Score	Market alternatives	0	Global CBA	1	Legislation/support	0	Awareness	0	Purchasing power	0	Total	1 out of 12	<table><thead><tr><th>Indicator</th><th>Score</th></tr></thead><tbody><tr><td>Market alternatives</td><td>0</td></tr><tr><td>Global CBA</td><td>4</td></tr><tr><td>Legislation/support</td><td>1</td></tr><tr><td>Awareness</td><td>0</td></tr><tr><td>Total</td><td>5 out of 9</td></tr></tbody></table>			Indicator	Score	Market alternatives	0	Global CBA	4	Legislation/support	1	Awareness	0	Total	5 out of 9
Indicator	Score																														
Market alternatives	0																														
Global CBA	1																														
Legislation/support	0																														
Awareness	0																														
Purchasing power	0																														
Total	1 out of 12																														
Indicator	Score																														
Market alternatives	0																														
Global CBA	4																														
Legislation/support	1																														
Awareness	0																														
Total	5 out of 9																														
Expected final market share: 8% of boiler sales in Household sector			Expected final market share: 15% of boiler sales in SME & Coll. sector																												
<h4>Yearly sales</h4>			<h4>Yearly sales</h4>																												
<p>Sales in 2020: 10 units/year*</p> <p>Sales in 2030: 1 400 units/year*</p>			<p>Sales in 2020: 300 units/year*</p> <p>Sales in 2030: 850 units/year*</p>																												
																															
<h4>Stock</h4>			<h4>Stock</h4>																												
<p>Stock in 2020: 30 units*</p> <p>Stock in 2030: 5 000 units*</p> <p>Stock in 2040: 18 000 units*</p>			<p>Stock in 2020: 1 600 units*</p> <p>Stock in 2030: 7 800 units*</p> <p>Stock in 2040: 8 600 units*</p>																												
<h4>Potential savings in 2030</h4>			<h4>Potential savings in 2030</h4>																												
<p>Primary energy savings:</p> <p>0 PJ/year*</p> <p>2 ktoe/year*</p> <p>GHG-emissions reduction:</p> <p>0 Mton CO_{2,eq}/year*</p>			<p>Primary energy savings:</p> <p>6 PJ/year*</p> <p>143 ktoe/year*</p> <p>GHG-emissions reduction:</p> <p>0 Mton CO_{2,eq}/year*</p>																												

*Corresponding to the expected potential scenario.

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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		±40 kWe systems (SME & Collective systems) Boiler add-on technology	
Scorecard		Scorecard	
Indicator	Score	Indicator	Score
Market alternatives	0	Market alternatives	0
Global CBA	1	Global CBA	2
Legislation/support	0	Legislation/support	1
Awareness	0	Awareness	0
Purchasing power	1	Total	3 out of 9
Total	2 out of 12		
Market alternatives		Market alternatives	
There is strong competition of other heating technologies in households : district heating systems in towns, geothermal energy for heating, heat pumps (low electricity prices) and wood biomass (cheap heating source). Natural gas is not yet available in western part of Lithuania.		There is strong competition of other heating technologies in services : district heating systems, geothermal energy, and wood biomass. Natural gas is not yet available in western part of Lithuania.	
Global CBA		Global CBA	
SPOT: 13 years		SPOT: 9 years	
Legislation/support		Legislation/support	
Only CHP plants that supply heat to public networks are eligible for the support – micro CHP units in households have no proper support.		As current support system is limited to CHP unit that supply heat to public networks or use renewable energy sources , micro CHP projects in service sector have no proper incentives for implementation.	
Awareness		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.		Due to lack of micro CHP practice examples and high investment cost, awareness of micro CHP is still on the low level.	
Purchasing power			
GDP: € 16 600 per year			

Annex 3: Bio CHP potential assessment

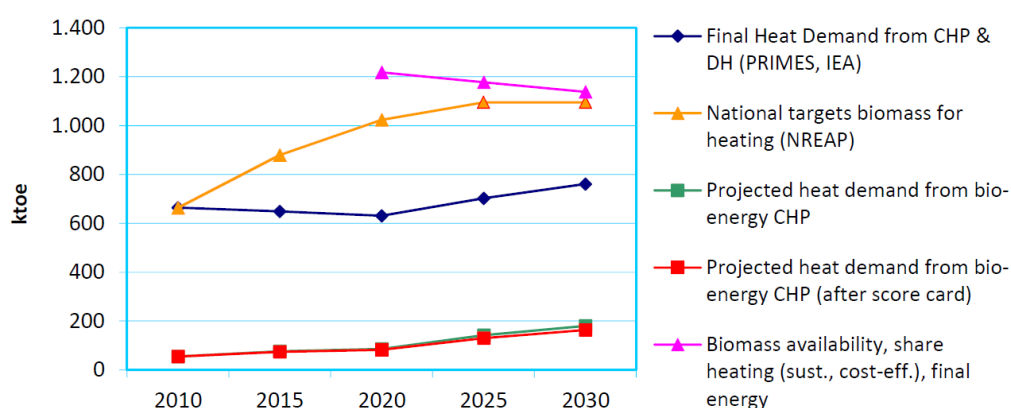


Bio-energy CHP potential analysis Lithuania



Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	664	632	761
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	55	82	164
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	8,2% (2009)	13,0%	21,5%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		1.217	1.137

Bio-energy CHP potential analysis Lithuania



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	++ 3 (of 3)	Support is granted to CHP supplying heat to DH grids High share of district heat Priority to sale heat from CHP and RES to DH companies
Suitability of heat market for switch to bio-energy CHP	+ 2 (of 3)	Expected increase of the share of heat and electricity from RES in the future
Share of Citizens served by DH	++ 3 (of 3)	63% citizen served by DH 39% share of heat from CHP in total heat produced in DH
National supply chain for biomass for energy	+ 2 (of 3)	The availability of biomass in the future (imported biomass).

Awareness for DH and CHP	++ 3 (of 3)	High increase of the share of CHP and DH from 2004
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Comments on country analysis

General comments

- The national framework assessment through the scorecard results in a good score (13 of 15 possible points).
- Thus, it is projected that the growth potential for bio-CHP until 2030 will be exploited to 87%.
- The possible bio-CHP penetration rate in 2030 (2030 dot of green curve) under ideal framework conditions is seen at 23,7% (the country's RE target according to RED (28/2009) is at 23% in 2020)
- The share of bio-fuels in CHP (bio-energy penetration rate in CHP markets) is expected to grow from 8,2% (2009) to 21,5% (2030)
- The national biomass availability (cost-efficient, sustainable; pink curve) is sufficient to enable the projected growth; however, these biomass resources include types of biomass which are currently not usually used in CHP, but are expected to be utilisable by 2030

Specific issues

- The projected development of CHP heat demand (PRIMES, blue curve) foresees almost constant figures until 2020, followed by significant growth
- National targets for biomass for heating (yellow curve) see a strong growth in the years to 2020, which is expected to be slightly less strong after 2020
- The growth projections of the bio-energy CHP heat demand (green and red curves) apply the average growth rates of both the blue and the yellow curve (weighting 50:50)

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)	2012	2020	2030	2030-2013
Existing units	1,171	1,121	1,041	-130.0
Reconstruction		50	130	130.0
New		160	220	220.0
Total CHP	1,171	1,331	1,391	220.0
Economic potential		160	220	
existing + reconstruction		24%	37%	
New		76%	63%	
Total new CHP investment		210	350	

Electricity generation [TWh]	2012	2020	2030	2030-2010
Existing units	1.82	1.75	1.62	-0.20
Reconstruction		0.20	0.52	0.52
New		0.64	0.88	0.9
Total CHP	1.8	2.6	3.0	1.2
Economic potential		0.8	1.2	
of that biofuel		86%	1.0	
existing + reconstruction		16%	27%	
New		84%	73%	

Annex 6: Methodologies used to calculate the saving of primary energy and CO₂ 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”³¹ 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 CO₂ saving resulting from a voluntary commitment of the German industry for CO₂ reduction³², 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 CO₂ 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, CO₂ 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 the 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 the contribution of CHP to the long-term objectives of the EU to reduce CO₂ emissions and primary energy consumption to be meaningful. The BAT approach of the CHP Directive has been developed to verify the high efficiency of individual plants, but not to determine actual saved CO₂ 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 away 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

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

³² 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 the 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 the 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. 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

- [1] *Energy in Lithuania 2012*, Lietuvos energetikos institutas 2013.
- [2] *Second National Energy Efficiency Action Plan of Latvia 2011 – 2013*.
- [3] *ENERGY EFFICIENCY ACTION PLAN 2014*, 30 May 2014 (NEAP2014).
- [4] *Report on the progress towards increasing the share of high-efficiency cogeneration*, Ministry of Energy of the Republic of Lithuania, January 2012.
- [5] *National Energy Independence Strategy of the Republic of Lithuania*, June, 2012.
- [6] Eurostat: *Combined Heat and Power (CHP) data*, 23 September 2014
- [7] *Lithuania: National Reform Programme 2013*, Vilnius, 2013
- [8] *Seimas of the Republic of Lithuania: Resolution approving the National strategy for climate change management policy*, 6 November 2012 No XI-2375, Vilnius
- [9] *The National Control Commission for Prices and Energy (NCC)-Maximum feed-in tariff for electricity from RES* (<http://www.regula.lt/en/Pages/tariffs-for-electricity-from-res.aspx>)
- [10] *The draft resolution of the Government of the Republic of Lithuania approving the National Programme for the Development of Renewable Energy Resources*, 25 March 2014.
- [11] *Biomass cogeneration as a key point for Lithuanian energy strategy*, Martyna Nagevičius, Lithuanian renewable energy confederation, 2013.
http://nobio.no/upload_dir/pics/MartynasNageviciusCorrect.pdf
- [12] *Information Report Republic of Latvia National Renewable Energy Action Plan for implementing 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 by 2020*.
- [13] *Energy Efficiency Policies and Measures in Latvia*, ODYSSEE- MURE 2010, Riga, September 2012.
- [14] *SMALL CHP PLANTS IN LATVIA: REALITY AND POSSIBILITIES*, Tatjana Odineca, Riga Technical University, 2012.
- [15] *National Development Plan of Latvia for 2014–2020*, December 2012.
- [16] *EUROSTAT Energy, transport and environment indicators, pocketbooks*, EU, 2013