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BEA APP – Pilot project

Sustainable DH System in Kaunas

Lithuanian Energy Institute, PP9

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Content

1. Background to pilot

Kaunas City is the central city of Kaunas Region and the second largest city in Lithuania with population of 297 669 (year 2016).

In year 2010, when the first RES plan was developed, the share of RES (mainly biogas from wastewater treatment sludge) in district heating sector was approximately 4%. And though the first Sustainable Energy Action Plan for the City of Kaunas for the Covenant of Mayors from 2010 just made assumption that the energy output of the new waste incineration plant will be 490 GWh/year through the incineration of municipal waste, wood waste and bio-fuel with CO_2 emissions of 25,600 t/year.

Later, after 2012 Kaunas City Municipality together with district heating company has developed an ambitious plan for district heating sector (which covers about 65% of total heated area) to transfer from natural gas DH, which made approximately 96% in fuel balance in year 2010, to RES based DH sector with biomass making 100% in fuel balance in year 2020.

This plan is successfully being implemented via involving new capacities under Kaunas DH company (AB “Kauno energija”) as well as independent heat producers, connecting to integrated City DH network. The pilot project discloses the full range of this ambitious plan, starting with description of the initial situation, planning process and criteria, public involvement and social partners, available financial support and schemes, options for development of RES, implementation process, weaknesses and bottlenecks as well as lessons learnt and recommendations for the purpose of improving the spatial planning procedures.

2. Description of the area

Kaunas City is the second largest city in Lithuania – it is situated at the jointure of two largest rivers in Lithuania Nemunas and Nėris, has rather complicated landscape. Average altitude of Kaunas City is 48 m above sea level. The main data about Kaunas City is provided in the table below:

City area	157 sq.km
Population	292,691 (2017 01 01)
Density	1864,3 person/sq.km (2017 01 01)
Geography:	North latitude 54º 56 ' East longitude 24º 51' Elevation 24 – 90 m above the sea level
Distance from Kaunas	to Vilnius (the capital) –103 km, to Klaipėda (the seaport) – 209 km.
Climate (in 2016)**:**	Average annual temperature 7,7 ºC; Average temperature in July 18 ºC; Annual precipitation 844 mm.

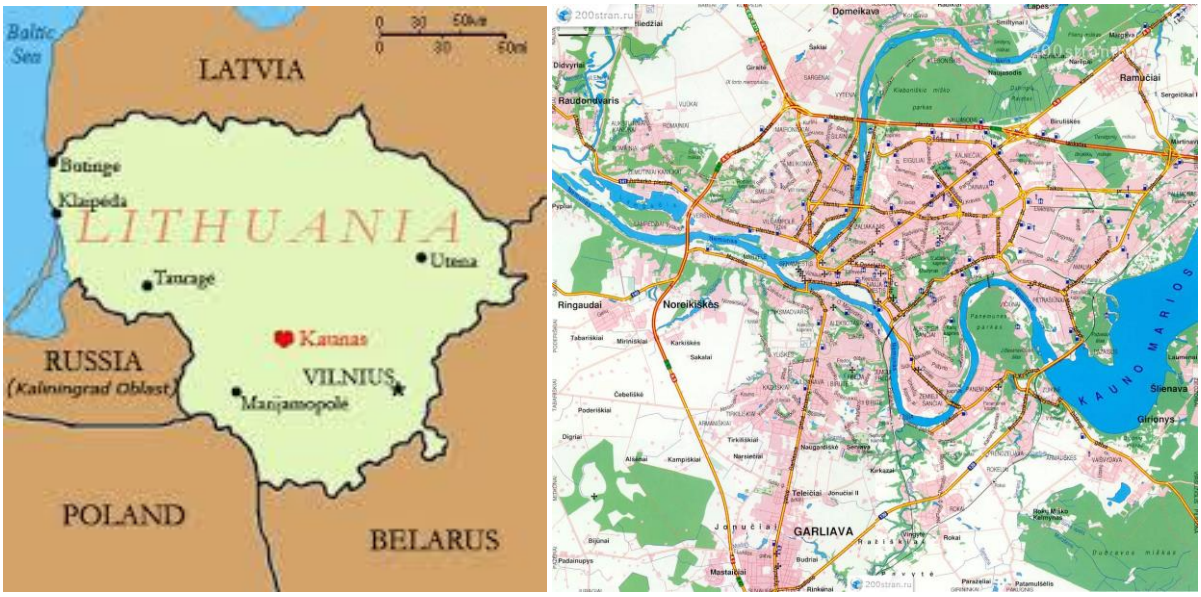


Figure 1. Kaunas location on the map of Lithuania and Kaunas map.

District heating company AB "Kauno energija" supplies heat for the most of city area via integrated network, except several districts, where single family houses are dominating. This includes mixed industrial/residential urban area: multi-apartment residential houses, partly industry and services sector.

Activity areas of AB „Kauno energija" are as follows:

- Heat and power generation and supply;
- Hot water supply;
- Operation and maintenance of engineering installations and heat network;

- Operation of heat and power generation sources.

The company generates and supplies heat to the residents of Kaunas City, Jurbarkas town, and a number of small towns and settlements in Kaunas regional municipality (Akademija setl., Ežerėlis, Domeikava, Garliava, Girionys, Neveronys, Raudondvaris). Approximately 115 thousand residents, 3.5 thousand companies and institutions are connected to integrated and local pipelines, which belong to the company.

AB Kauno energija. Indrė Sesartė (VŽ) photo.

3. Type of RES

The ideas to use RES in district heating sector included mainly several types of renewables, where biomass is dominating:

- Solid biomass:
  - wood chips from forest cutting residues,
  - biodegradable share of municipal waste.
- Biogas:
  - from sewerage sludge, and
  - from landfills.
- Other RES:
  - solar and geothermal installations for heating needs on energy production and demand side.

First biogas plants were installed in Noreikiškės CHP plant, which used biogas from Kaunas waste treatment plant (power capacity 750 kW_{el} (150 kW_{el} x 5), thermal capacity 1050 kW_{th} (210 kW_{th} x 5)) in 2005; and in Domeikava CHP, which was supplied with landfill gas from nearby Lapės landfill (power capacity 1200 kW_{el} and thermal capacity 1504 kW_{th}) in 2008. Total biomass share in company energy balance was approximately 4%.

Figure 2. Noreikiškės CHP plant Domeikava boiler-house;.

Situation has not changed till year 2012, when the first solid biomass boiler was launched in Garliava (Kaunas suburb) with thermal capacity 6.5 MW (5.2 MW biomass boiler and 1.3 condensing economizer). This started the biomass based heating era in Kaunas City and Kaunas regional municipalities.

Figure 3. Garliava biomass boiler-house

Currently the new Fortum CHP for incineration of municipal waste is under construction. This plant is to be launched in 2020. However, due to improper planning and overcapacities on Kaunas and national levels, the capacity of this plant is still under discussions.

Figure 4. Fortum CHP for municipal waste (project).

The most new development is introduction of solar and geothermal energy on energy generation side. Two boiler-houses have solar collectors on the roofs, with the aim to reduce heat generation losses during summer period:

- year 2011 – 2 blocks x 12 collectors on the roof of Kaunas DH company building – capacity 20.4 kW for hot water generation with heat pumps;
- year 2015 – 1 block x 12 collectors on the roof of Pergale boiler-house buildings – capacity 10.2 kW for hot water.

Figure 5. Solar collectors on the building of AB Kauno energija and Pergalė boiler-house.

4. Involved stakeholders

Requirements for public involvement are defined under the Environmental Impact Assessment Act for the Planned Economic Activity (I-1495). It says that interested society has right to receive information on environment impact assessment of planned economic activity from the stakeholders of this activity. This impact assessment should be ordered by the owner of planned activity, by the assessment process defined by the Ministry of Environment. The elaborated Environmental Impact Assessment is provided for the access of interested institutions as well as wide public for discussion and input.

The development of district heating sector has a number of stakeholders and social partners, who participate in development using RES process:

1. Municipality of Kaunas City, operating via Energy Department of the Administration of Kaunas City Municipality - the main owner and partner of municipal DH company;
2. AB Kauno energija – Kaunas district heating company;
3. Lithuanian District Heating Association – Professional DH association;
4. Lithuanian Biomass Energy Association – Professional biomass association;
5. A number of independent heat producers in Kaunas City and Kaunas Regional municipalities, among which:
    a. UAB “Foxita” (unregulated);
    b. UAB “Danpower Baltic Taika” – boiler-house (unregulated);
    c. UAB “Danpower Baltic Taika” – CHP (unregulated);
    d. UAB “Lorizon Energy” (unregulated);
    e. Kaunas CHP plant (unregulated);
    f. UAB “Petrašiūnų katilinė” (regulated);
    g. UAB “Aldec General” (unregulated);
    h. UAB “Danpower Baltic Biruliškių” (unregulated);
    i. UAB “Ekopartneris” (regulated);
    j. UAB “ENG” (regulated);
    k. UAB “Ekoresursai”, (regulated).
6. Biomass Exchange – electronic trading system under BALTPOOL, Energy Exchange;
7. Other biomass suppliers;
8. Energy consultants, scientists, etc.;
9. Consumer rights protection bodies;
10. City residents, living in block residential houses – clients of district heating company.

The role of different stakeholders may differ significantly from active participants, such as planners, energy producers, fuel suppliers and consumers, to external partners, such as consultants, professional associations, consumer’s rights protectors. The links among stakeholders are provided in Figure 6.

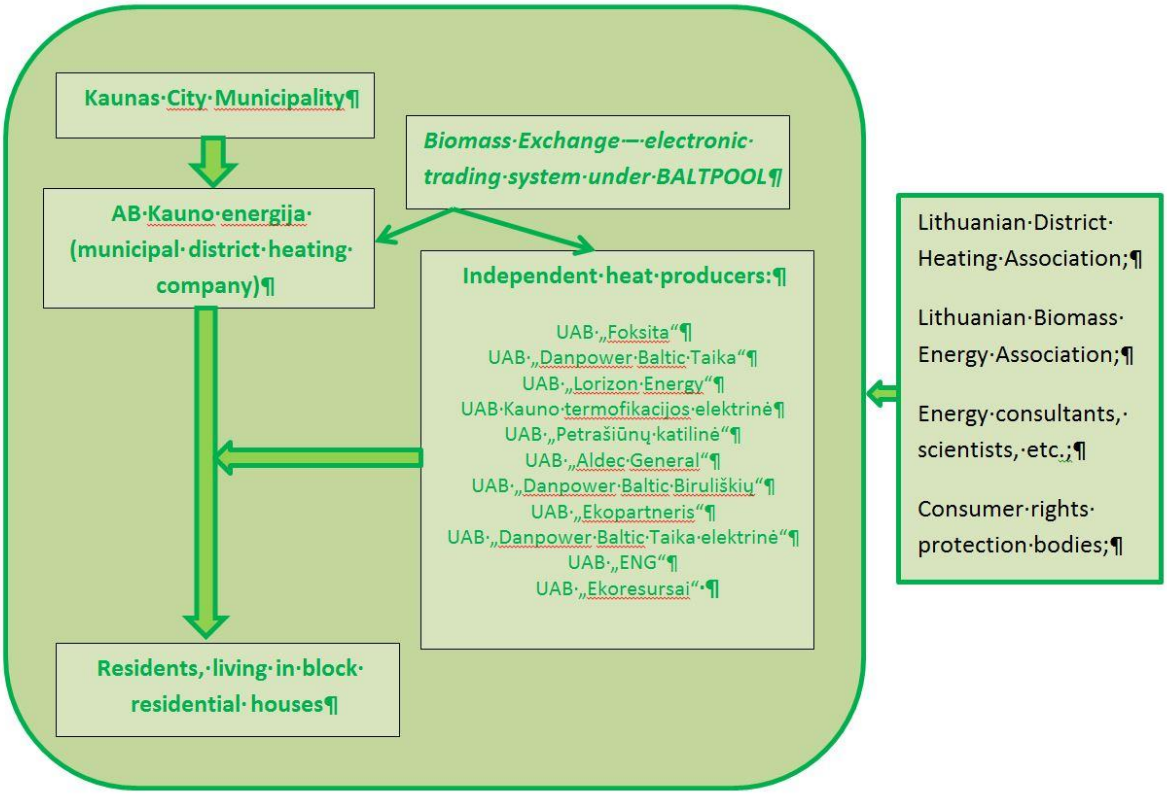


Figure 6. Co-operation links with involved stakeholders

5. Objectives

National Programme for Development of Heat Sector for Years 2014-2020 defines RES target for district heating sector is 70% share in fuel balance till year 2020. The process started in about 2000 with pure 2% share of biomass and the reason was to replace heavy oil fuel in small towns as response to EU environmental requirements to eliminate fossil fuels with high sulphur content. However, two largest cities – Vilnius and Kaunas – accounted for approximately 50% of district heating in Lithuania till year 2012. The main fuel in those two cities used to be natural gas, and the share of RES was insignificant. This share was just 4% in Kaunas City.

For Kaunas City National Programme for Development of Heat Sector for Years 2014-2020 envisaged 180 MW of new biomass installations by 2020. Kaunas DH Company has even more ambitious plans - with support for investment from EU Structural Funds defined a rather bold challenge – to achieve 85% of biomass in annual fuel balance. Since decision on construction of waste incineration plant in Kaunas Free Economic zone, the final target is foreseen to produce 100% of heat using renewables. In accordance with National Energy Strategy, National RES plan, National Programme for Development of Heat Sector for Years 2014-2020 and other strategic documents the growth of RES share in district heating sector is based on biomass mainly with insignificant use of solar, geothermal energy, which is used mainly on demand side.

Besides above mentioned programs two main reasons for development of biomass based district heating sector in Kaunas City are as follows:

1) Reduction of heat tariffs for populations with regard to reduce poverty level and social support needs for municipality;
2) Improve competition among municipal and private heat generators in district heating sector.

Other possibilities, like introduction of other RES into heat sector, such as solar collectors and heat pumps, both on supply and demand side, are of minor importance, as not this feasible, however some efforts were made here as well.

6. Implementation

6.1. Planning

Spatial planning for renewable energy on municipal level in Lithuania is defined by the following legislation:

1) The Law on Renewable Energy Sources of Lithuanian Republic (LR) (XI-1375) by assigning the functions, defined in Article 12, empowering Municipalities to develop the use of renewable energy among others via: developing and harmonization of municipal RES action plans; providing thermal energy in municipal area ensuring the use of renewable; elaborating and adopting financing programs and defining order to use them.
2) The Municipal law of LR (I-533) defines the function on planning and arranging heat provision in the area of the Municipality and using RES in municipal public buildings.
3) The Heat Law of LR (IX-1565) defines national requirement for developing National Development Program for Heat Sector, including the use of renewable, residual energy sources and municipal waste; defining financing need and financial sources. Municipalities are responsible for maintaining municipal heat sector on the basis of developed special plans, which has the aim to cover the needs of consumers with the least costs and not exceeding negative impact to environment.
4) The Law on Spatial Planning (I-1120) defines the requirement for municipalities to develop special plans, which defines existing and planned new areas of heat consumers and provides the principal technical solutions for the use of alternative energy and fuel for every specific area. Social partners – heat, electricity, gas supply companies and other stakeholders as well as consumer's rights protection bodies – participate in the planning process. Environmentally clean energy sources should be available in the whole area of the municipality.
5) Environmental Impact Assessment Act for the Planned Economic Activity (I-1495) requires selection for environmental impact assessment among others for thermal plants and other incineration plants and other industrial installations for generation of electricity, steam or water heating, when capacity is over 20 MW.

It is clearly evident that municipalities have plenty of responsibilities in planning and development of RES in heat sector and supply and decision-making process lies on the municipal councils. However, planning indicators should be defined under intermediate planned national RES indicators and main conditions, defined for development of district heating and cooling sector using renewable energy sources.

Besides, actual situation shows, that municipal energy planners have no respective competences for proper planning process at least defining clear priorities, indicators and criteria for development of energy producers, thus planning process is rather chaotic and leads to conflict situation among energy producers.

Spatial planning defines specific zones for energy consumers, but not energy producers, which also leads to technical conflicts between energy producers and suppliers.

6.2. Main criteria for RES planning

The EU Structural Funds support envisages very few criteria for RES planning:

- Planned heat generation, electricity generation (for CHP);
- Planned CO_2 savings, CH_4 savings (biogas) – environmental criteria;
- Planned thermal capacity costs, electricity costs (for CHP and air conditioning) – economic criteria;
- Planned savings due to fuel diversification;
- Simple payback period.

In case of larger projects (over 20 MW) planning envisages Environment and social impact analysis study, which requires assessment of a larger group of aspects and criteria, which usually are as follows:

- Environment: water, environment air, soil, biodiversity, landscape,
- Social-economic environment,
- Ethnic-cultural environment,
- Human health.

Social impact analysis study is being prepared by the developer and is the document to be presented for public discussions before final decision making for the Project.

6.3. Existing planning documents and targets

There is a significant number of existing planning documents in Kaunas City Municipality, including those defining the development of RES in district heating sector. The three most important should be mentioned here:

- Strategy on Providing District Heating for Kaunas City (year 2012) – including also chapter on projections for mitigation of environment impact from heat generation using promotion of co-generation technologies and development of the use of renewable energy sources: the share of fossil fuel in DH should not exceed 50% (actual situation of 2010 was 90%) and 50% should be produced using RES.
- Kaunas City Renewable Energy Development Action Plan (first adopted in 2010, revised 2015) – the share of biomass in district heating was 27.8% in year 2013. First independent heat producers using biomass appeared in 2014 (19.2 MW, 20.0 MW and 48.5 MW respectively), besides Kaunas DH company initiated installation of own biomass boilers in two boiler-houses (42 MW).
- Kaunas City Municipality spatial plan – 2013-2023 (adopted on 2014) – defines zones assigned to district heating, contains 19 main maps, including 3 assigned for energy sectors, which are electricity supply, district heating and natural gas supply.
- Company plans of Kaunas DH company - Kaunas municipal DH company AB Kauno Energija performs operational planning of DH system, as well as own share of generating capacities: development of circular DH pipelines; construction and connection of new own biomass capacities; connection of new capacities of independent heat producers;

- Company plans of independent producers.

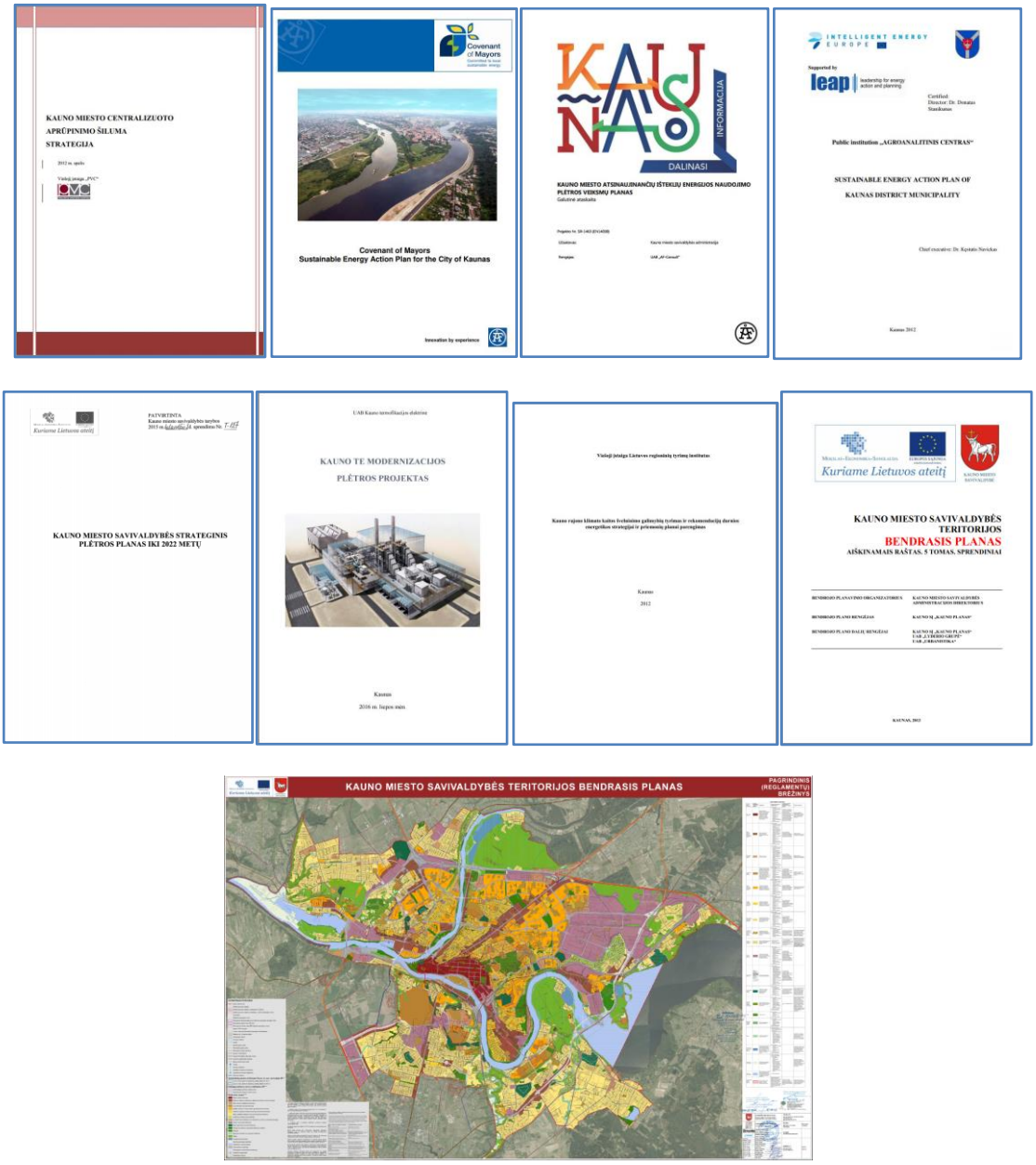
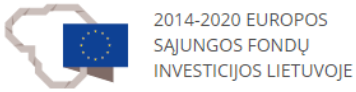


Figure 7. A variety of energy sector development plans and strategies for Kaunas and energy companies and spatial plan for Kaunas City

Spatial plans are produced for 3 energy subsectors (district heating, power supply and natural gas supply), however all these plans are oriented towards energy consumers and there are no plans for energy producers on the most appropriate locations for new installations in technical, and sustainability (environment protection, social and economic) terms. Thus new producers have possibilities for further development without regard to sustainability criteria and some technical aspects.

6.4. Available financing sources




There are several sources for implementation of investment in district heating sector:

1. For large projects (over 10 MW) - support for investment from EU Cohesion Funds under Cohesion Promotion Actions programme, Environment and Sustainable Development priority – the Use of Renewable Energy Sources for Energy Generation action;
2. For small projects (under 10 MW) – support from:
    a. Lithuanian Environment Protection Investment Fund Programme;
    b. Climate Change Special Programme;
3. Own funding of the district heating company;
4. Municipalities can partly subsidize projects as main stakeholders of municipal DH companies.

6.5. Implementation of planned actions

6.5.1. Baseyear (2010) situation and situation achieved in 2015 in District Heating sector in Kaunas City

The first Kaunas City Renewable Energy Development Action Plan was adopted by Kaunas City council in 2010. Later in year 2016 it has been revised. Thus situation in year 2010 should be considered as current situation for *base* year. The achieved result during period 2010-2015 discloses the shift in biomass share in fuel balance from 4% (biogas) to 71.36% (biomass) and estimated projections of 85% (biomass) by the end of 2016.

The *factsheet* for the base year and year 2015-2016 for Kaunas DH company and district heating sector in Kaunas City are presented in Table 1 below:

Table 1. Characteristics of Kaunas DH Company in base year (2010), 2015 and 2016

	2010	**2015**	**2016**
Heat generation, GWh			
Boiler-houses	193.3	518.0	582.6
CHP	13.8	4.3	0.7
Condensation economizers	-	86,0	103.0
Purchased from independent producers, GWh (%)	**1489.6 (100%)**	**800.7 (100%)**	**844.6**
JSC Kaunas Thermofication Plant (natural gas)	1485.2 (99.7%)	336.5 (25.4%)	194.6 (13.6%)
…..JSC Foksita (biomass)			59.4 (4.2%)
JSC Ekopartneris (biomass)	-	31.9 (2.4%)	60.0 (4.2%)
JSC ENG (wood chips)	-	22.7 (1.7%)	25.6 (1.8%)
JSC Danpower Baltic Biruliškių (former JSC Oneks Invest) (wood)	-	146.7 (11.1%)	162.8 (11.4%)
JSC Aldec General (wood	-	79.3 (6.0%)	75.4 (5.3%)

chips)			
JSC Petrašiūnai (wood chips)	-	68.5 (5.2%)	89.9 (6.3%)
JSC Lorizon energy (wood chips)	-	26.3 (2.0%)	43.4 (3.0%)
JSC SSPC –Taika, GECO (wood chips)	-	82.8 (6.3%)	62.0 (4.3%)
JSC Ekoresursai (biogas)	4.4 (0.3%)	6.1 (0.5%)	6.2 (0.4%)
Provided to network, GWh	1696.7	1323.0	1427.6
Transmission losses, GWh (%)	306.0 (18%)	219.5 (16.6%)	393.3 (17.4%)
Used to cover own needs, GWh	36.2	6.4	6.6
Sold to consumers, GWh	1381.9	1097.0	1193.7
Installed capacity, MW (independent producers)	2042.0	524.7 (1350.9)	541.2 (397.3)
Biomass, MW	9.6	73.8 (141.9)	78.8 (57.0)
Heavy oil fuel, MW	1865.2	268.2	268.2 (210.0)
Natural gas, MW	1924.6	449.8 (1209)	448.0 (332.1)
Light fuel oil, MW	30.8	18.3	32.4 (18.3)
Other, MW	10,6	0.0	6.3 (0.0)
Fuel consumption			
Natural gas, toe	17855	8037.4	8811.0
Heavy oil fuel, toe	-	-	
Biomass, toe	672	34252.2	39259
Biogas, toe		228.4	44.5
Peat, toe	890	114.5	101.0
Diesel fuel, toe	6	-	1.0
Operating boilers, MW	497.3	564,4	
Required capacity, MW			
Heating season	600(max), 390 (ave)	409.9(max), 217.1 (ave)	
Non-heating season	132 (max), 80 (ave)	120.0 (max), 59.9 (ave)	

Source: Lithuanian District Heating Association, 2017.

6.5.2. Projects implementation

Since year 2012 a big number of biomass projects were implemented in district heating sector by both: district heating company AB Kauno energija and a number of independent producers. These projects are described with more details in tables 2 (DH company) and 3 (independent producers.

Table 2. Replacement with biomass boilers in boiler-houses of Kaunas DH company

No	Boiler-house information	Capacity	Investment	Year
1	**Developer UAB ENG** – transferred to Kaunas DH company "Kauno energija", biomass boiler-house in Garliava (suburb of Kaunas City), Constructing company Axis Industries	Boiler capacity – 5.2 MW, Condensing flue gas economizer – 1.3 MW, **Total 6.5 MW**	1,74 mill €	2012

				
2	**Developer – Kaunas DH company "Kauno energija" –** "Šilkas" boiler-house Replacement was implemented in two stages 	Water heating boiler HHB9000 – 10 MW, Condensing flue gas economizer – 4 MW, Water heating boiler AK800P10T130 – 8 MW, **Total 22 MW**		2013 2015
3	**Developer - Kaunas DH company "Kauno energija"** – Ežerėlis boiler-house Boiler for peat, sawdust and straw. The boiler was designed on the order and constructed by consortium of UAB „Energijos taupymo centras", UAB „Enerstena" and AB „Axis Industries". 	Boiler – 3.5 MW, Condensing flue gas economizer – 1.5 MW, **Total 5 MW**	Partial funding of nearly 0.52 mill € from Lithuanian Environment Investment Fund (LAAIF). Total project value 1.32 mill € (excl. VAT).	2013

				
4	**Developer - Kaunas DH company "Kauno energija" – Noreikiškės boiler-house** It's the unique boiler-house in Lithuania, adjusted to burn various types of fuel, such as: wood chips, sawdust, straw, sewerage biogas from water treatment installations, natural gas and heavy fuel oil.  	Boiler – 4 MW	Total investment – 1.8 mill € (in this 0,67 mill € from Lithuanian Environment Fund)	2014
5	**Developer E-energija – UAB „Petrašiūnų katilinė" (is now being purchased by Kaunas DH company)** During heating season consumes approximately 600 m^3 of wood chips daily. Produces up to 10 % of heat necessary for Kaunas City during heating season and nearly 1/3 of heat necessary for production of hot tap water. 20 new jobs established.	2 boilers x 8 MW + 3.2 MW condensing economizer - total 19.2 MW	Total investment over 6 mill €, incl. 1.73 mill € from EU SF.	2014

	 			
6	**Developer - Kaunas DH company "Kauno energija" - Petrašiūnai CHP** Produces up to 12 % of total heat demand in Kaunas City. 	Heat capacity – 2 x 12 MW biomass water heating boilers + 6 MW condensing economizer – total 30 MW.		2014
7	**Developer Enerstena - AB „Kauno energija" Inkaras boiler-house** 10 % of total heat demand in Kaunas City.	Heat capacity – 2 x 8 MW boilers + 4 MW condensing economizer – total 20 MW.	Total investment – 4.93 mill €, incl. VAT (in this EU SF support up to 1.74 mill €)	2015

	 			
	Total biomass heat capacity	***106.7 MW***		

Table 3. New biomass boiler-houses developed by independent energy producers

no	Boiler-house information	Capacity	Investment	Year
1	**UAB GECO Kaunas boiler-house** Fuel – wood chips, cutting residues Designer – "Energetikos linijos". Installations producer – Enerstena. Facade design – architect-designer Algirdas Kaušpėdas group. 	Heat capacity – 2 x 8 MW boilers + 4 MW condensing economizer – total 20 MW.	INVESTMENT – 5.79 mill €	2012
2	**UAB Lorizon energy – developer UAB Naujoji šiluma** Boiler efficiency 88.1 %. Flue gas cleaning is via cyclones, chimney height 30 m, diameter 0.90 m.	Heat boiler capacity 10 MW.	Investment 3.9 mill €	2013

	 			
3	**UAB SSPC – Taika Biomass CHP plant** Installation parameters - 90 bar, 500°C.	Installation capacities: thermal – 20 MWth + 5 MWel.,		2014
4	**UAB „Oneks Invest“,** 2 blocks Fuel - biomass 60%, peat - 40%. Annual fuel consumption up to 170,140 tons (wood chips, cutting residues, total annual heat generation – up to 400 GWh. 	Heat capacity - Boilers 2 x 19.5=39 MW, + condensing economizers 2 x 4.75=9,5 MW, Total 48.5 MW		2014
5	**UAB „Foksita“** Biomass CHP plant	Installation capacities: thermal – 38 MWth + power 4.99 MWel.,		2015

	 			
6	**UAB „Ekopartneris“ (Kautra)** Flue gas cleaning: multi-cyclone, electrostatic filter. Fuel storage 5 m underground with automatic transportation line. Annual production appr. 120 GWh of heat. Fuel consumption appr. 50,000 t wood waste. 	Installation capacities: 2 x 7 MW=14 MW biomass boilers + 3.5 MW condensing economizer = total capacity 17.5 MW. Besides additional CHP installation with capacity - 160 kW_{el} and 180 kW_{th}.	Total investment of 5.9 mill €	2015
7	**UAB „Aldec General“** 	**Heat capacities:** **2 x 8 MW biomass boilers.**		2014

8	**„Danpower Baltic**“ – biomass CHP. The first investment of „Danpower GmbH“ in Lithuania. 84.9% shares of „Danpower GmbH“ belongs to Hannover Municipal „Stadtwerke Hannover AG“ company „Enercity“. 	Total capacity – 20 MW_{th} + 5 MW_{el}	20 mill €,	2016
	Total biomass heat capacity	***190 MW***		

Total installed biomass capacity – 296.7 MW with long-term January monthly average demand of integrated network is 290 MW

6.5.3. Baseyear (2010) situation and situation achieved in 2017 for main emissions in DH sector and general Kaunas City

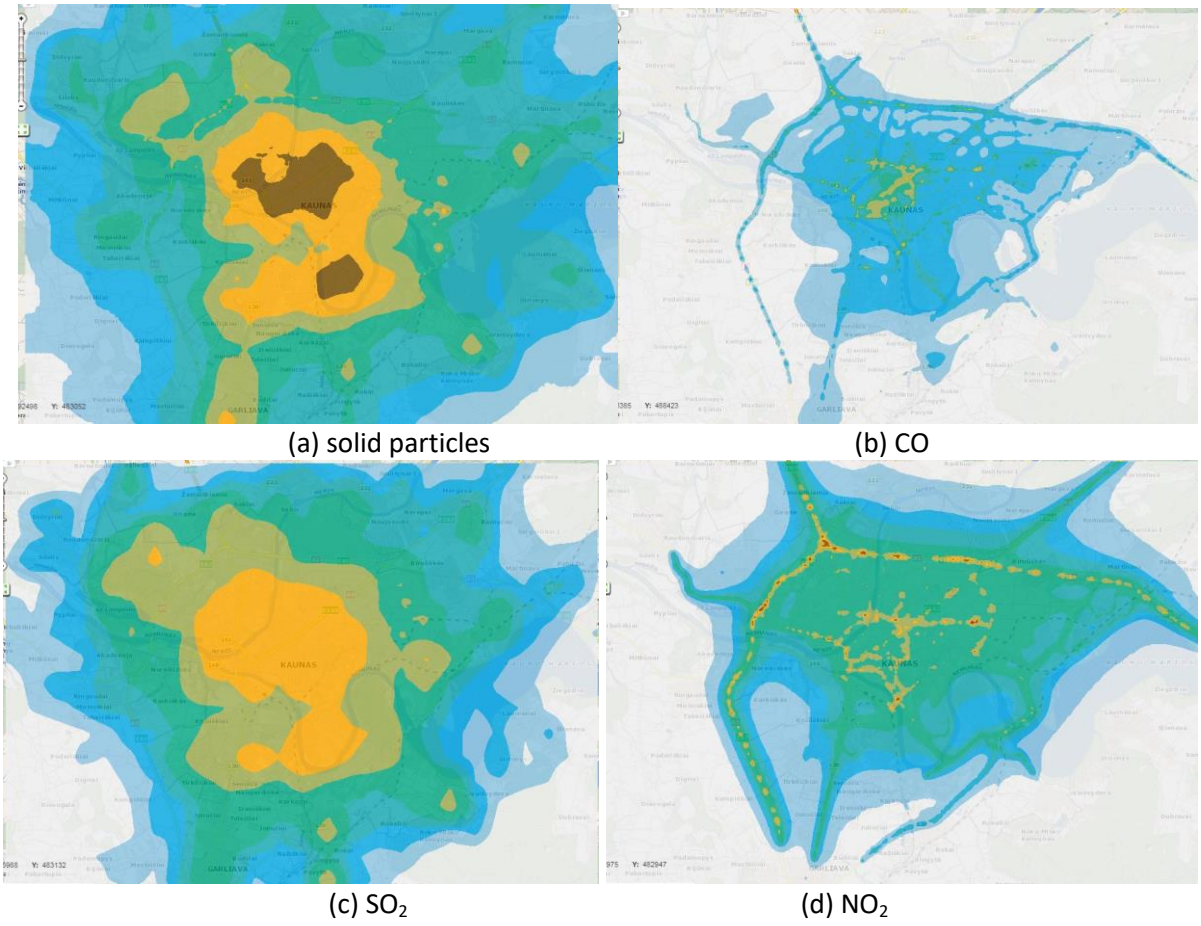
However, though biomass projects have reduced the share of greenhouse emissions for Kaunas City and region, it should be mentioned that local emissions, related to biomass based energy generation, have increased after all new installations, especially for solid particles, CO, NO_x and SO_2. We can see this in Table 4, providing data of Lithuanian District Heating Association for AB Kauno energija.

Table 4. Emissions of Kaunas DH Company in base year (2010), 2015 and 2016

	2010	**2015**	**2016**
Solid particles, t	8,5	-	90.1
CO, t	146,9	132.3	1297.3
NO_x, t	65,8	57.7	304.4
SO_2, t	7,3	-	232.4
V_2O_5, t	0,0	-	0
CH, t	2,7	5,9	4.3
Other emissions, t	0,4	0.4	0.4
Total, t	***231,7***	***196.3***	***1929.0***

Source: Lithuanian District Heating Association, 2017.

The National Environmental Protection Agency (EPA) has issued maps for all regions of Lithuania for the support measure “Replacement of boilers in individual households”, where one can see the main emissions and these are located geographically. Figure 8 shows the distribution of urban air pollution in Kaunas City with regard to 4 largest pollutants: (a) solid particles, (b) carbon monoxide CO, (c) sulphur dioxide SO_2, and (d) nitrogen dioxide NO_2.



(a) solid particles (b) CO

(c) SO_2 (d) NO_2

Figure 8. Distribution of urban air pollution in Kaunas City for (a) solid particles, (b) carbon monoxide CO, (c) sulphur dioxide SO_2, and (d) nitrogen dioxide NO_2.

Source: Environmental Protection Agency

6.5.4. Changes in heat tariffs

As it was mentioned in Chapter 5, one of the objectives was reduction of heat tariffs for consumers, mainly residents of multi-apartment residential houses. Constant reduction of heat tariffs is notified while implementing biomass conversion projects. This could be considered as the great success of the pilot project, however, distortion of market due to installed overcapacities, and challenge of the new waste incineration plant, which now is under construction, does not appear to be optimistic trend for further reduction of heat tariffs, which is due to the growing prices for biomass and not clear situation in future.

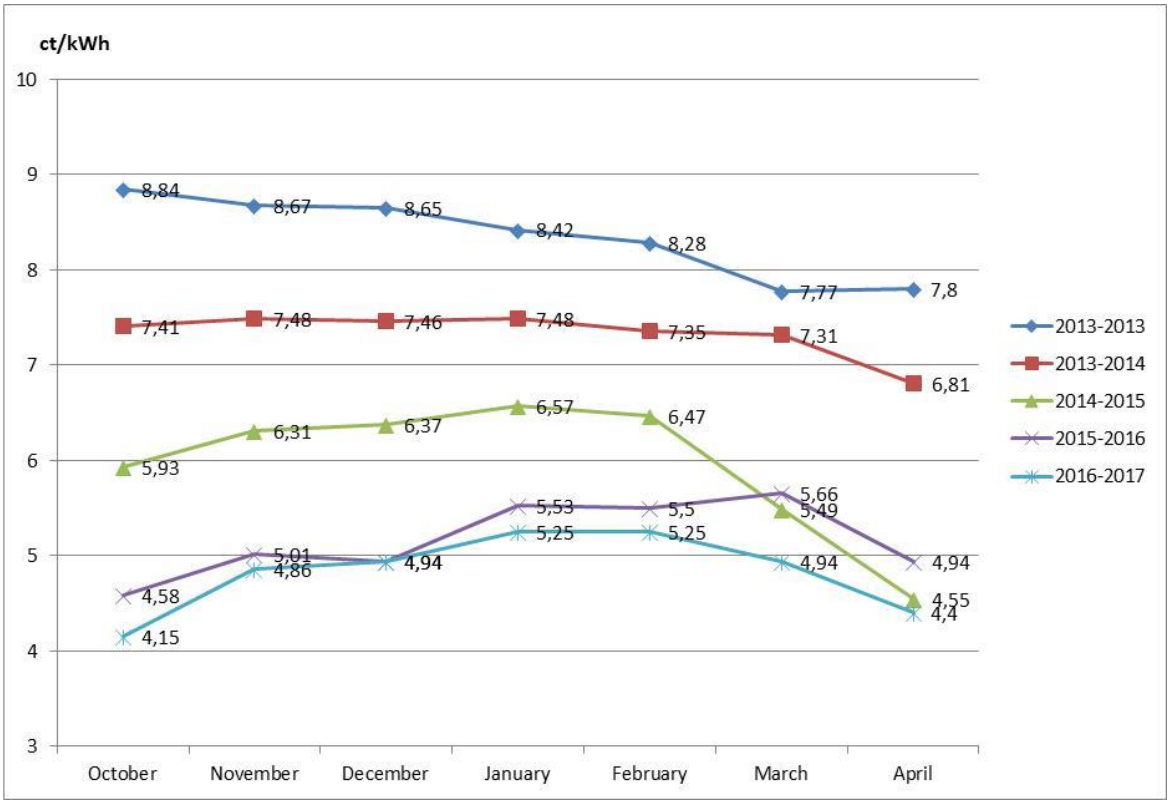


Figure 9. Changes of heat tariffs during project implementation period, excl VAT, ct/kWh.

The following information, such as heat price, share of fuel mix for heat generation for integrated network in Kaunas, is provided at the website of Kaunas DH company on daily basis:

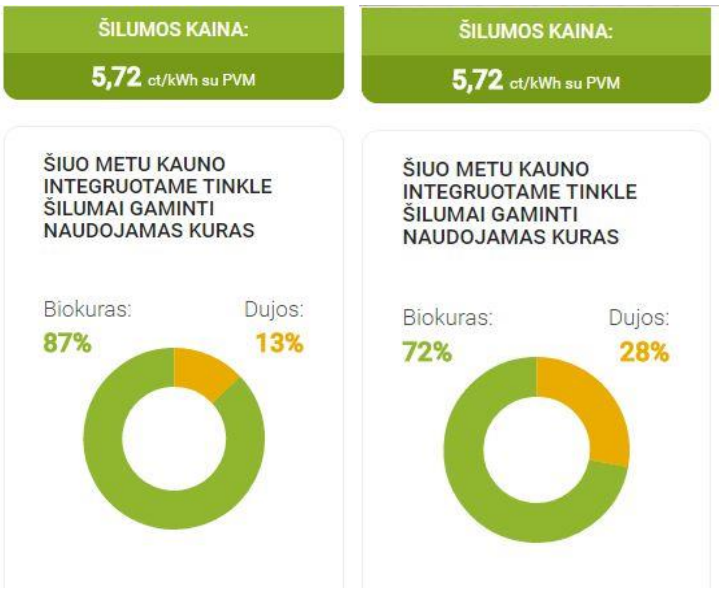


Figure 10. Data of Kaunas DH company on a) 2017-01-06, fuel 87% biomass, 13% natural gas, outside temperature -19 °C; b) 2017-01-11, fuel 72% biomass, 28% natural gas, outside temperature -11°C. Heat tariff 5.72 ct/kWh (incl. VAT)

7. Plans for future

JSC "Kaunas CHP plant" is under construction for combined heat and power production. The plant plans using sorted municipal waste, industrial waste and dried sewerage sludge as fuel. 49% of shares belongs to "Fortum Heat Lietuva" and 51% of shares to Lietuvos energija.

Figure 11. *JSC "Kaunas CHP plant" (design)**.*

Expected capacity of the CHP plant is thermal - 70 MW_{th} and power - 24 MW_{el}. This capacity will allow the rational use of approximately 200,000 tons of municipal waste, formed in the region and sorted, as well as generation of about 500 GWh of heat and about 170 GWh of electricity per year. This amount could cover approximately 40 % of heat demand in Kaunas City.

Total investment will be appr. 140 mill €, and funded by the own capital of involved partners, bank loans. The project was approved by the Government of The Republic of Lithuania on May 28, 2015.

Here we should also notify other **small-scale RES possibilities**, which could improve the share of RES in heating sector. These are solar collectors with heat storage installations, which could be used for production of hot tap water during summer season, thus reducing heat losses in the transmission network. These installations can be and already are installed both, on supply and demand sides.

2 pilots were already implemented, using **combined solar and heat pumps** energy with total capacity 30.6 kW for hot water. Both cover up to 40% hot water demand in spring/autumn and up to 80% in summer. Relative annual heat generation is 478.82 kWh/m^2. Kaunas DH company has estimated possibility for more significant use solar energy on supply side, which could cover summer demand thus reducing heat supply losses in the pipelines. Three more installations in minor boiler-houses in Kaunas Regional municipality – Neveronys, Raudondvaris and Panemunė (with EU financial support) are planned. Unfortunately, heat generation costs are too high (costs are 4-5 ct/kWh for at least 5000 m^2 solar collectors), thus installation is feasible with financial support at present.

Figure 12. Solar collectors on the roof of the Kaunas DH company building (20.4 kW)

Another option is the use of solar collectors on municipal and residential buildings on demand side. Kaunas City Municipality has shown a good practice example and has installed solar collectors of the roof of the Municipality building in 2013. Heat is used for hot tap water production. The area of collectors – 22 m^2. Annual heat generation 22-25 MWh, which is sufficient for all hot water used in the building with daily water use 1.8 m^3. Total investment was appr. 21,000 €.

Figure 13. Solar collectors on the roof of the Kaunas City Municipality building

Other residential and industrial buildings joined the initiative. One of industrial initiatives was vacuum solar collectors and geothermal energy.

Similar vacuum solar collectors with storage tanks were installed in multi-apartment residential house in Kaunas.

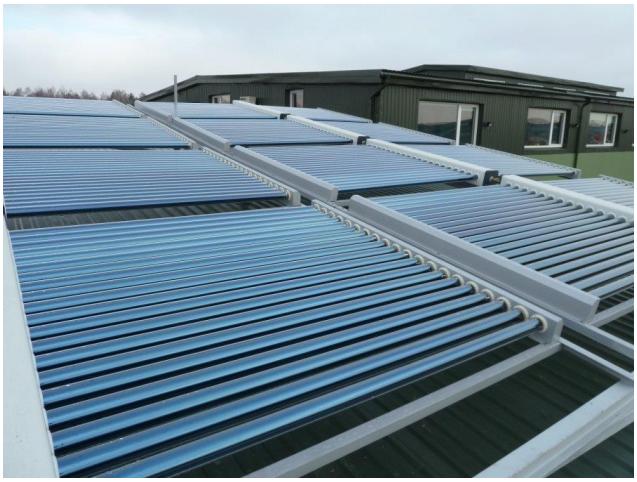


Figure 14. Solar collectors, installed by pharmacy company „Acconitum“© Company photo

Figure 15. Solar collectors, installed on the roof of residential building Škirpos 15, Kaunas. © R.Tenys photo

Another opportunity is **geothermal heating (heat pumps)**. Such examples already exist in some other towns in Lithuania.

Plans for district heating are as follows:

- Completion of started **biomass** projects of independent and DH company, regional biomass and waste incineration CHP plant till 2020, with target indicators for RES – 100% by year 2020 with total installed capacity ~735 MW.
- Completion of solar heat projects – 200-1000 kW of solar collectors in buildings each year (4 multi-apartment residential buildings to half of all renovated buildings) during 2015-2020.
- Possible development of heat pumps (geothermal energy) in residential buildings – 20–60 kW of total capacity (1 to 3 buildings) during 2015-2020.
- Possible development of solar heat projects in municipal buildings – 40-120 kW of solar collectors (1 to 3 buildings).

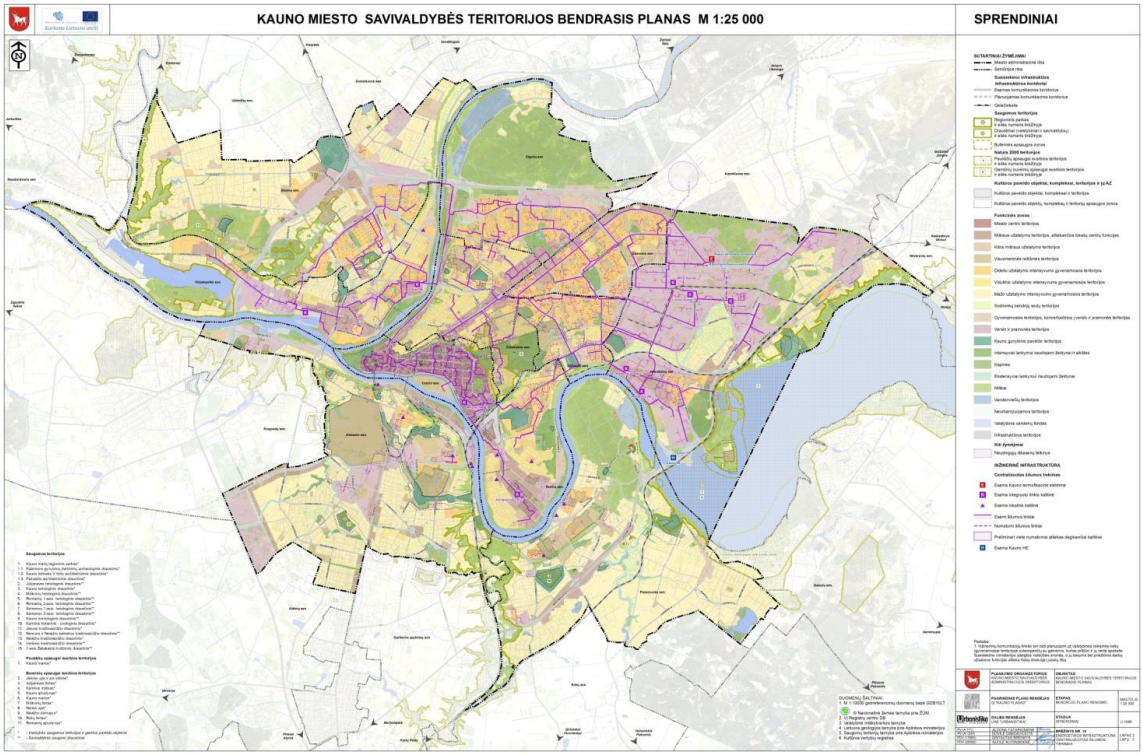
8. Involvement and conflicts with stakeholders, lessons learnt

There are three groups of stakeholders, actively involved in the project process: planning stakeholders (municipality), technical stakeholders (DH company, independent energy producers), who directly participate in the process and public stakeholders (residents living in the vicinity of heat boiler-houses and CHP plants, consumers rights protection bodies). These above mentioned two groups are in different types of relationship and their collaboration causes a number of problems, which are not always easy to solve.

8.1. Planning stakeholders

Planning process for RES development is still a complicated problem for planners, which often lack competences, clear visions and aims as well as clearly defined criteria. The example of Kaunas City shows that current planning could be considered as chaotic. So the serious transfer from rather "chaotic planning" of heat generation to "real planning", including spatial planning, use clearly defined criteria is considered as important topic for current position of the Ministry of Energy.

This sector must be carefully planned, evaluating every possible future benefit to consumers and investors, as well as national security of energy supply. Heat producers and suppliers expect that energy authorities will provide all necessary legal and organizational support for reduction of energy tariffs.

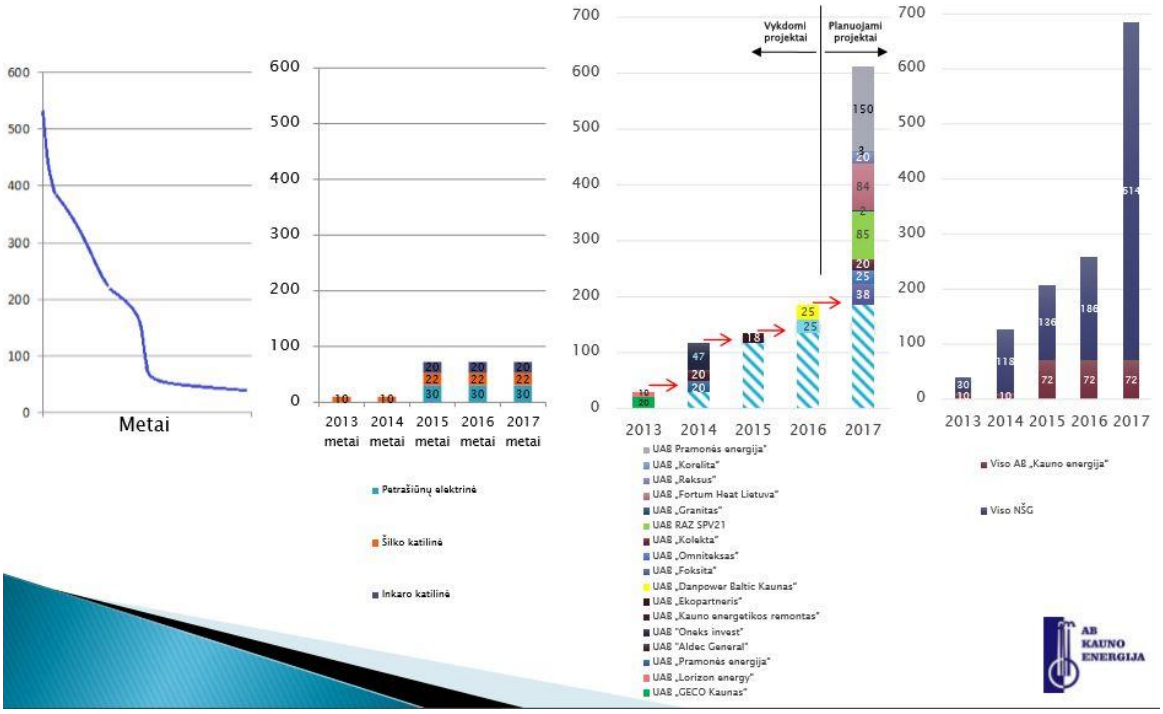


Source: Kaunas City Municipality

Figure 16. District heating infrastructure in Kaunas City (specific spatial plan 2013-2023)

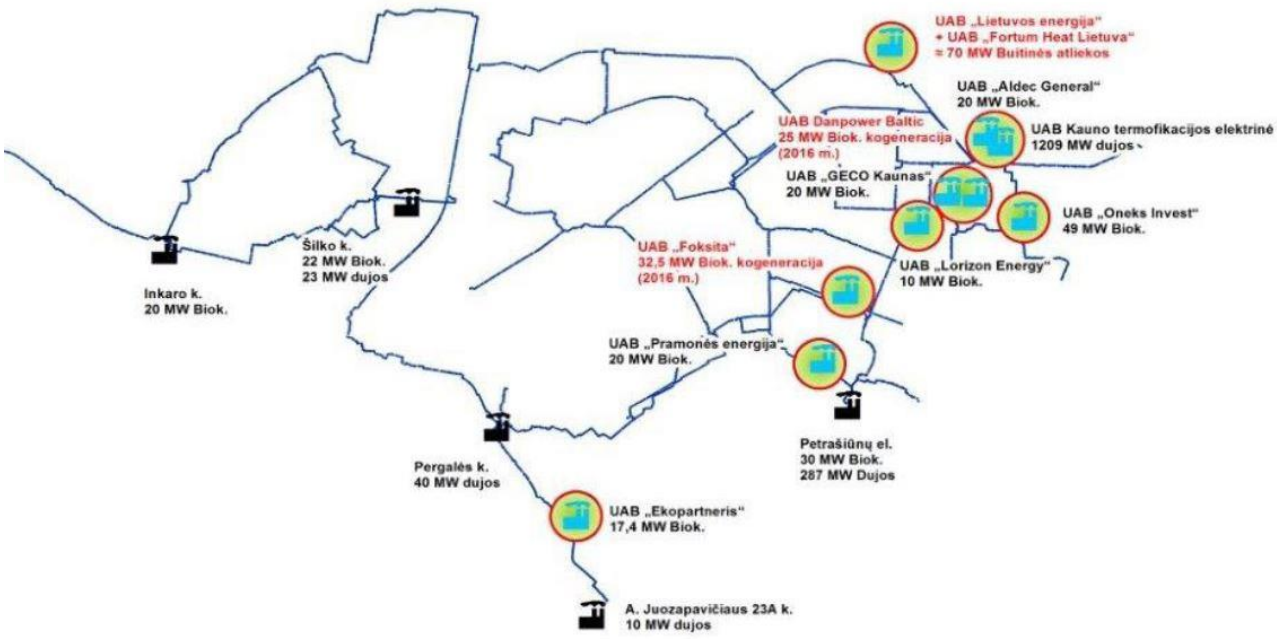
Spatial plans are implemented for 3 energy sectors for Kaunas City: district heating (Fig. 16 above), electricity supply and natural gas supply. However, we should notify, that spatial planning should be provided not only for consumers of district heating sector, but also for heat producers, including the defining of proper locations for energy generation to avoid disturbances in the integrated district heating network. This was not needed for former spatial plans, when there were no independent producers, but which are of high importance today to avoid conflict situations.

Besides, this should be the responsibility of municipal planner to define clear aims and limits (evaluating the current demand and future development) for maximal thermal capacities to avoid overcapacities and crash of recently implemented projects.



Source: Kaunas DH company

Figure 17. Plans of Kaunas DH company: a) DH network demand; b) AB Kauno energija sources; c) independent sources; d) all biomass sources



Source: Kaunas DH company

Figure 18. Actual and planned heat generation sources in Kaunas City

8.2. Technical stakeholders

The boost of biomass installations into district heating sector in Kaunas has introduced a big number of independent energy producers, which came into competition with regulated DH company. However the roles and responsibilities of both sides differ significantly.

Table 5. Responsibilities of DH company and independent producers

Kaunas DH company	**Independent producers**
– heat generation in own heat sources;	– heat generation in own heat sources;
– free of charge reservation of heat generation capacities for independent producers;	– providing 1 energy bill for DH company;
– reliable heat supply to consumers;	– accepting payment for generated heat.
– operation and renovation (reconstruction) of heat supply pipelines;	
– operation of hot water supply systems inside buildings (in cities with population less than 150,000);	
– installation, testing and change of heat meters;	
– collecting of heat consumption data;	
– billing for consumers (appr. 118,000 monthly bills in Kaunas City), printing and posting;	
– payments collecting and administration of debts;	

– service, consulting, etc. for consumers;	
– education for consumers and implementation of energy efficiency measures.	

Source: Kaunas DH company

There are currently 10 independent producers in the integrated network of Kaunas City. Technical problem is that these companies constructed their generating sources, where ever they had plots and possibilities to connect to grid with the least costs, which is based on business logic. However, in terms of network development, these locations were not optimal or reasonable in engineering terms. The whole system became defragmented, pipelines are operating in non-favourable conditions in terms of temperature and hydraulic regime. Sustainability and safety regimes are not cared.

Thus in general, introduction of independent producers has it's advantages and drawbacks, which can be defined as follows.

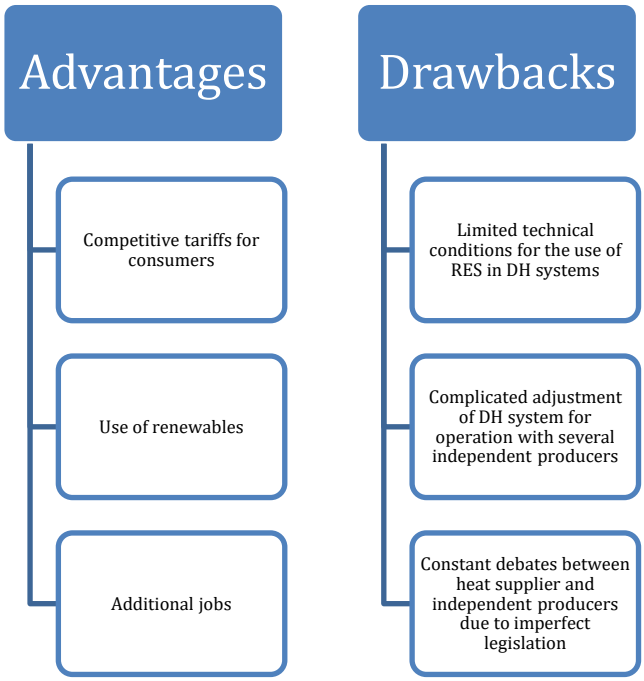


Figure 16. Advantages and drawbacks from involving independent producers (IP)

Possible solutions for solving technical problems:

Heat accumulation with storage tanks	All producers operate at basic mode
	Excess heat is accumulated in storage tank (appr. 1 mill € investment)
	Changes in legislation regarding basic, peak and excess energy costs.
Use of natural gas sources	Does not require investment
	Needs clear regulation on reservation of certain share of heat for gas sources
Introduction of CHP of high efficiency and	Transfer of the experience of small towns (similar

respective capacity (appr. 70 MW_{th})	capacities) to large cities makes operation of DH systems complicated
	Introduction of large CHP would enable more simple operation of DH system and stability of it's parameters

8.3. Public stakeholders

The last but not the least important group of stakeholders are residents, who are directly involved due to various reasons, and NGOs. On one hand most residents are really happy with reducing heat tariffs and implementation of really "green" energy in their city.

However, implementation of biomass burning boilers inside city area is related to reducing greenhouse emissions and growing local pollution, especially with solid particles, which cause lungs diseases and degrades environment, not only related to burning but also to fuel transportation, conditions for population living in the vicinity of such projects.

Nor all boiler-houses and CHP plants are situated in densely populated areas, some are in Free Economic Zone of the city. Those few boiler-houses, which are situated between living houses made serious attempts to meet the requirements of surrounding populations to reduce pollution and noise due to truck based fuel supply (as limiting fuel supply time to daytime, planting trees in "sensitive" streets to reduce pollution, installation of additional flue gas cleaning installations). Though met with some opposition, these projects were successfully implemented without resistance of society.

Source: Vilma Kasperavičienė © Lietuvos žinios

Meeting with the Mayor of Kaunas Visvaldas Matijošaitis during opening of construction work.

However, opposition became more active with started construction of waste incinerating CHP plant. The location of the plant, though situated in Free Economic Zone, is very close (300-400 meters) from small community of Ramučiai. Besides, this location was already used for construction of Kaunas Mechanical and Biologic Waste Treatment Plant several years ago. The residents of this location were suffering from bad smells, related to some accidents in the plant. All this and the fact that every such energy object increases local pollution caused strong opposition from local community, which votes for sorting and recycling and against burning of waste. Even more active opposition started after some statements of the government concerning not quite clear volumes of wastes and possibility, that new Vilnius CHP plant should burn biomass instead of municipal wastes, which should be transported to Kaunas CHP plant for burning. They considered this as manipulation with statistics and neglecting the rights of local community.

The representatives of the plant have arranged the meeting with local population and have promised that monitoring of environment pollution will be ensured for the settlement of Ramučiai via installation of mobile laboratory for measuring main pollutants. Measurements are to be performed 4 times during the year, constantly for 2 weeks uninterrupted on solid particles (SP10 and SP2.5), carbon monoxide (CO), ozone (O_3), sulphur dioxide (SO_2) and benzene (C_6H_6).

Source: Eitvydas Kinaitis © Kauno diena

Meeting of local population with the representatives AB “Lietuvos energija”

8.4. Lessons learnt

Planners’ and developers attitude

Planning of energy objects should be performed with clear aims, based on spatial planning and transparent criteria to avoid chaotic development of renewable energy sector.

Publicity and information is of key interest in solving planning conflicts. In case planner or developer implements just formal requirements on information, this might cause conflicts with residents, who live in the vicinity of the object. Thus there is need to invite the closest neighbourhood in person and discuss all possible “rough” issues and try to sooth interest party in case the need for such soothing arises.

Scientists’ attitude

1. Approximately 80% of multi-apartment residential buildings are in poor technical condition, after renovation heating demand reduces by at least 50%. Long-term plans for complex renovation by blocks gives important role to DH company due to renovation of DH transmission pipes.
2. Penetration of solar collectors, heat pumps and other decentralised solutions decreases heat demand for DH company and affects dispatching of DH system and consequently heat pricing.
3. Due to technical issues while DH system transfers from single heat producer to many IP (small-scale) starts playing the role of intermediary between users and as a storage.
4. Still there is conflict with regulatory legislation (appr. 100 laws and ~1000 acts of secondary legislation) and the lag to real life is significant and huge work is required here.
5. Speaking about future of using RES in DH sector, the following issues are important:
    - Improving technologies from renewable;
    - Distributed generation;
    - Storage;
    - Digitized solutions;
    - Energy efficiency management services, etc.

References

1. Kaunas City RES Development Plan. UAB „AF-Consult“ for the order of the Administration of Kaunas City Municipality. 2015.
2. Strategy for Providing District Heating to Kaunas City. Public Company „PVC“. 2012.
3. Lithuanian District Heating Sector information. Lithuanian District Heating Association. Presentations of years 2009, 2012-2017.
4. Lithuanian DH Statistics 2010, 2015-2016. Lithuanian District Heating Association.
5. National Commission for Energy Control and Prices: https://www.regula.lt/siluma/Puslapiai/nepriklausomi%20silumos%20gamintojai/nepriklausomi-silumos-gamintojai.aspx
6. BALTPOOL Biomass Exchange: https://www.baltpool.eu/en/
7. Kaunas District Heating sector information. AB Kauno energija. Presentations of years 2015-2018.
8. Spatial planning, energy planning, etc. legislation of the Lithuanian Republic.
9. The Environment protection Agency (EPA). Pollution maps: https://dts.aplinka.lt/map/viewer/external/#mapId=3151
10. Information from the website of AB Kauno energija: www.kaunoenergija.lt
11. Information from the website of Fortum company: https://www.fortum.lt/apie-mus/imones-lietuvoje/kauno-kogeneracine-jegaine
12. Information from the website of Danpower Baltic: http://www.danpowerbaltic.lt/
13. Information from the website of GECO: http://geco.lt/projektai/igyvendinti-projektai/20-mw-geco-biokuro-katiline-kaune/
14. Information from the website of Lorizon Energy: http://lorizonenergy.lt/
15. Information from the website of ENG company: http://englt.lt/
16. Information from the website of NEWHEAT Group: http://www.newheat.lt/
17. Information and illustrations from the website of Kaunas City Municipality: www.kaunas.lt
18. Information and illustrations from Kaunas City newspaper “Kauno diena”: http://kauno.diena.lt/
19. Information and illustrations from Kaunas city website: http://kaunas.kasvyksta.lt/