BEA APP - Concept on spatial planning via introduction of planning criteria and value added for regional RE sector on the example of Kaunas City Municipality

Lithuanian Energy Institute, PP9

Content

1. Introduction to concept

Implementation of National Energy Strategy, as well as other EU and country strategic documents, development of energy objects used for energy generation from renewable energy sources, is fast fostered in Lithuania. Selection of proper geographic locations for implementation of above objects, such as wind parks, bioenergy plants of solar PV plants, etc., is of key importance. The task for spatial planners is to make possibilities to install energy objects in specific and proper locations. At the same time it is important to find balance between the use of certain areas for energy and other competing purposes, such as farming, tourism, cultural landscape, environmental protection, etc.

Finding such balance is a huge challenge in itself. Municipal spatial planners, using existing planning requirements (regulated by legal acts) not always have experience and skills, as well as proper tools for solving such tasks. Besides, they often meet with resistance of local population, when locations are selected for energy generation using renewable.

Planning of energy objects in Lithuania is performed on the basis of existing legislation, however Renewable Energy (RE) projects are usually initiated by business interests and actual plans in this case just "follow" by including projects under implementation.

Existing legislation defined obligatory planning (general, special, district heating development, RES actions plans) are often not adjusted among themselves and are not compatible with general programs, have no general vision in the planned region. Municipalities can actually plan just the activities of municipal utilities, or investments into buildings, owned by municipalities. On the other hand, support schemes promote business investment not just in locations, where these should be used to meet public interests in the most efficient way. There is also lack of constructive public discussions (e.g. on actual pollution for residents living in the vicinity of biomass boiler-houses due to increased transportation and solid particles from generating sources, though most often no environment impact assessment (EIA) is performed; on impact of wind farms to local population, etc.). The most appropriate technologies for urban and rural areas are neglected.

With regard to at least partial solution of emerging problems one needs to improve existing planning system for energy objects, extend definition of planning criteria, evaluate new innovative project funding possibilities (funding schemes), impact to regional economics and apply new dialogue methods between project developers and publicity.

Problems related to negative consequences of existing planning process are similar in all BSR states. Thus the aim of this concept is preparing the Concept on development spatial planning of renewable energy in Kaunas City Municipality by the year 2027 on the basis of the results obtained during implementation of Interreg BSR Programme Project „Baltic

Energy Areas – A Planning Perspective (BEA-APP)“ (outputs of WP2: WP2.1 Creating space for Renewables; WP2.3 Report on regional added value; and WP2.3 General criteria to plan renewable energy in the BSR) for Kaunas City Municipality, which is the largest energy producer and consumer in Kaunas Region. The concept will provide the main ideas for development existing planning methods, the use new, innovative projects financing schemes, expected added value and general planning criteria, appropriate for the specific area, potential technologies, climate conditions, maximal demand, etc.

2. Theoretical background for RE planning

2.1. Creating space for renewables

Implementation of National Energy Independence Strategy, as well as other strategic documents, development of energy objects used for energy generation from renewable energy sources, is fast fostered in Lithuania. Selection of proper geographic locations for implementation of above objects, such as wind parks, bioenergy plants of solar PV plants, etc., is of key importance. The task for spatial planners is to make possibilities to install energy objects in specific and proper locations. At the same time it is important to find balance between the use of certain areas for energy and other competing purposes, such as farming, tourism, cultural landscape, environmental protection, etc.

Finding such balance is a huge challenge in itself. Municipal spatial planners not always have experience and skills, as well as proper tools for solving such tasks. Besides, they often meet with resistance of local population, when locations are selected for energy generation using renewables.

Various spatial planning methods in various Baltic Sea Region countries were first compared during COMMIN project [1]. Achieved results have been generalised in EU political document [2], which was elaborated and was revised every year till 2007. The aim of the project was formation of general understanding about development and planning of the areas in Baltic Sea Region. Besides others, the aim was improving international cooperation, experience exchange and seeking for more efficient transnational communication, improved qualification of experts using innovating methodologies for spatial planning.

Several states of the region joined European Union during the period from 2004-2007 and needed to harmonised own legislation with that of EU. Besides several legal acts and regulations were issued by EU, having impacts on spatial planning, such as Energy Policy for Europe [3], the first and the second Strategic Energy Reviews [4, 5], EU Third Energy Package (on gas and electricity) [6], European Climate Change Plan [7] and the Strategic Energy Technology Plan [8].

Problems and negative consequences of current planning system are similar or nearly the same in all Baltic Sea Region. Planning of energy projects is implemented following the order defined in legislation, however RES projects are initiated by business interests, and usually “follow” and include ongoing project.

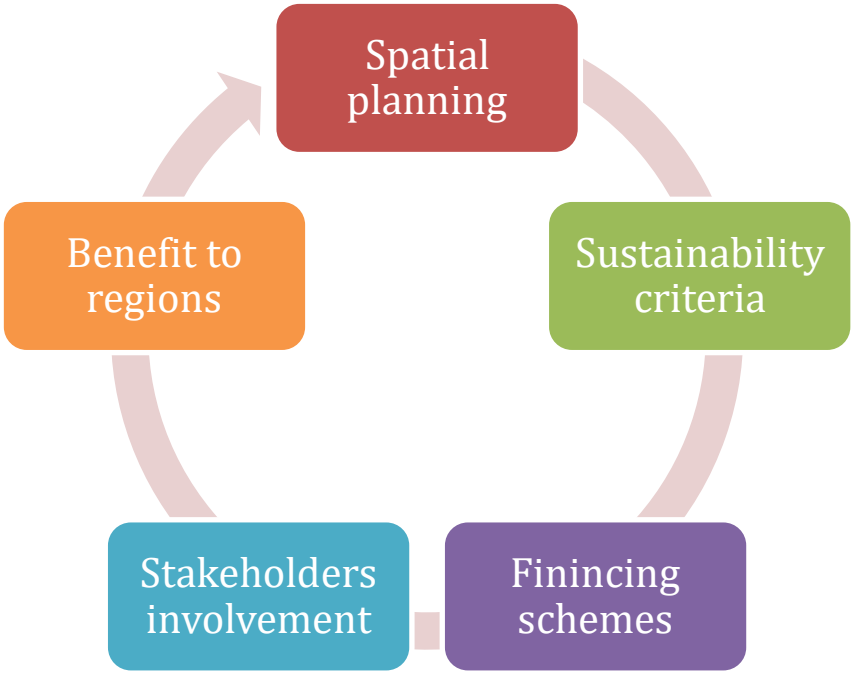
Various plans (general, special, district heating development, RES actions) are often not adjusted among themselves and are not compatible with general programs, have no general vision if the planned region. Municipalities can actually plan just the activities of municipal utilities, or investments into buildings, owned by municipalities. On the other hand, support schemes promote business investment not just in locations, where these should be used to meet public interests in the most efficient way. There is also lack of

public discussions (e.g. on actual pollution for residents living in the vicinity of biomass boiler-houses due to increased transportation and solid particles from generating sources, though most often no environment impact assessment (EIA) is performed; on impact of wind farms to local population, etc.). The most appropriate technologies for urban and rural areas are neglected.

With regard to solve at least some of above mentioned problems, project "Baltic Energy Areas – A Planning Perspective" (BEA-APP) under Baltic Sea Region Programme have elaborated the following outputs:

- Recommendations on the set of criteria for spatial planning, enabling selection of the most appropriate areas for further development of energy generation using RES;
- Innovating financing schemes for such projects, based in available experience of participating project partners;
- Suggestions for various stakeholders to be involved in spatial planning processes (conflicts resolution);
- Assessment of the benefit to regions from implementation of renewable energy action plans.

It would be expedient while preparing spatial plans define locations, which should be the most reasonable for RES projects with regard to technical, environmental and other requirements.



Scheme 1. Key elements of planning process for RES development

2.2. Spatial planning

This chapter deals with the issues of spatial planning and is based on the investigation Creating Space for Renewables, transnational report on state of play in spatial planning for renewable energy in the participating regions under BEA-APP project [9].

There are four main methods of spatial planning:

1. A regional economic planning method,
2. Integrated physical planning method,
3. An area of application-oriented planning method, and
4. Urbanism planning tradition, based on a number of predetermined rules for buildings and types of buildings in specific neighbourhoods (zoning).

Spatial planning can support the implementation of renewable energy. This implies that the first mentioned main type of spatial planning – the regional economic planning process – is of particular interest. Development of spatial planning seeks to support implementation of renewable energy sources, like different types of regional and urban regeneration plans, brownfield development plans and a number of Eco planning, especially the type of plans working with a combination of spatial planning with energy production and consumption.

The renewable primary energy source is typically tied to a particular site as the primary source of energy. They can then be used to produce heating, cooling, energy fuels such as biogas and solid biomass fuels, which can then be distributed. The spatial constraints of renewable energy put a particular focus on the spatial planning. There is a difference between the different renewable energy sources that will first be presented:

Bio-resources are typically residues from agriculture, forest, industry and households, typically used in three technologies, which are combustion, fermentation (biogas) and thermal gasification. The spatial dimension is the accessibility (distance) that is the crucial element.

Geo-resources are generally related to water (hydro, tide, wave), wind and solar energy. They are primary resources of energy and cannot be characterized as energy carriers. The renewable energy technologies have very different requirements concerning the size of the area that must be available for the energy plant.

The renewable resources as well as final consumption have a territorial dimension. Energy consumption follows the population, so cities have the largest energy consumption, but most of the renewable energy sources cannot be placed in the cities, thus renewable energy will mainly be consumed in the urban areas but be produced in the rural or suburban districts. Due to territorial characteristics physical planning faces a number of new requirements and challenges. The large-scale implementation of the renewable energy contains three main elements to create space for renewables:

- **The renewable energy sources**: location, accessibility and size of the resource. The utilization of resource depends on the availability and the economy of the technology, and the possibilities of locating the energy plant on a relevant site.
- **Technologies**: a wide variety of technologies that can exploit water, wind, solar or biomass. It is typical that a number of technologies are being scaled-up, i.e. the standard renewable energy plant is getting bigger and bigger which can provide better resource utilization but sharper the difficulty of finding suitable sites.
- **Space**: defines nature possibility of finding a location for a given renewable energy plant, where location opportunities often compete with a variety of other purposes and considerations.

Two more elements important for implementation of renewable energy:

- **The regulatory regime**: financial support for renewable energy. The resource-poorer location of the facility, the greater will be the subsidy requirement to achieve the target.
- **Socio-economic benefits**: the unconditional prerequisite is to contribute to the realization of a number of multilateral benefits, like local development (employment and revenue, basis for local investment, scaling the local environment and resources.

2.3. Sustainability criteria for development of renewable energy

Defining criteria is the first and the most important RES projects planning aspect. The largest share of these criteria is defined on the basis of spatial planning. Every regional planning area (in Lithuania's case this would be municipalities) provides a number of areas categories (Table 1). Implementation of RES projects in every of these categories can be permitted, permitted after environment impact assessment or restricted. These areas should be defined by spatial plans for every region.

RES objects planning criteria should be defined by spatial plans for each of here mentioned category of areas, which was defined in the outputs of BEA-APP project partners [10, 11]:

Table 1. Categories of areas in municipalities [10]

Categories of areas
Residential areas in cities, villages
Area for commerce and industry
Military facilities
Airfields and surroundings
Tourism key areas
Inland waters, main rivers and surroundings
Areas for coastal- and flood protection
Drinking water protection area
Forest areas
National parks
Natural parks
Biosphere reserve
Special Protection Areas (SPAs) under the Birds Directive 2009/147/EC
Breeding sites for birds
Protected areas under the Flora-Fauna-Habitat-Directive 92/43/EEC
Natura 2000 areas

The defined criteria should include the following issues:

1 **Aspect: Designated areas for renewable energies:** Areas intended for renewable energy installations.
   a. Clearly defined standard planning procedures;
   b. Special areas assigned for development of RES objects;
   c. RES development in categories (type of renewable) is possible in any case/ is possible after individual assessment/is not possible.
2 **Aspect: Standard planning processes:** Standardized planning processes in force for specific sizes and types of renewable energy installations and define e.g. the need for public participation, the legislative framework and authorities in charge.
The general aspects for society, as it is the vested interest of the concerned local communities that spatial planning decisions are understood and influenced by all of the interested parties and their representatives. The models, processes and rules of existing participation in the planning for renewable energy sources is a central aspect in spatial planning and therefore a general aspect.
3 **Aspect: Models for participation in spatial planning:** The purpose of public participation or at least stakeholder involvement is to ensure that stakeholder and public voices are heard. In this respect numerous participation models are in force and have to be considered for the spatial planning for renewable energies.
Despite various economic effects of the development of renewable energies, the necessary acceptance in the expansion of renewable energies can be achieved by an economic participation of affected citizens and communities. Economic participation is a strong tool to avoid conflicts and paves the way for a higher regional added value. Economic participation was selected as general aspect to improve the framework conditions for the spatial planning for renewable energies.
4 **Aspect: Economic participation models:** Economic participation can be achieved in the context of participation in regional energy cooperatives, community wind farms and solar parks and other formats. The goal is to increase local benefits for affected people from the added value of energy production.
5 **Aspect: Natural renewable energy resources:** The natural renewable energy resources can be evaluated by the use of renewable energy resource data sets providing information on e.g. feedstocks for bio-energy, the characteristics of solar energy or wind energy for a particular region.
6 Technical aspects:
   a. **6. Aspect: Grid capacity regarded in spatial planning:** Renewable energy production from wind and solar are subject to natural variability. This variability creates distinct challenges to integrate the generated power into larger power systems and grids. Therefore power generation has a significant impact on the capacities of high voltage grids that is likely to increase over time. Integration of renewable energy is a multilayer-challenge involving multiple decision-makers like energy storage resources, grid operators, energy market operators and transmission planning bodies.
   b. **7. Aspect: Capacity and height of installations regarded in spatial planning:** Especially for the spatial planning for wind energy, the capacity for power generation and height of the turbines is a central aspect. Capacity for power generation also plays an important role for the spatial planning for biogas- and biomass plants and solar power plants.

c. Other technical aspects.

7 **8. Aspect: Conflict potential:** Conflicts related to renewable energy installations occur in all participating regions around the Baltic Sea. Some conflicts are related to different renewable energy sources, other conflicts are specific to renewable energy sources depending from the way of energy generation. For wind energy such conflicts comprise e.g. environmental conflicts, landscape conflicts, or conflicts caused by noise, blinking and shadowing. Biogas plants can stand in contradiction to air quality and noise protection. Biomass burning connected to district heating systems often face the problem of the capacity for heat supply, local pollution, etc. Therefore, the conflict potential represent a general aspect for spatial planning for renewable energies.:

8 Other aspects:

a. Impact on landscape assessment in spatial planning;
b. Pollution assessment (emissions, visual, noise pollution, smells, etc.)
c. Logistics aspects regarded.

2.4. Funding

Projects funding is the other important planning aspect for RES projects. On one hand, business usually come with known funding scheme, i.e. most probably bank loans or own investment means. States – EU support recipients, such as Lithuania, use the means of EU funds for implementation of RES projects implementation, as well as Environmental and Climate Change Funds. On the other hand, municipalities should find innovative funding schemes, such as application of ESCO models (e.g. RES installations in buildings), business angels funds (e.g. electricity generation using biogas of large pig farms, etc.), use of cooperative means (e.g. several farmers can install biogas plant or several forest owners can fund a small-scale boiler-house with biomass fuel production in own forests, etc.). Municipalities can also support RES projects for the objects in their ownership [9].

RES projects implementation is successful due to proper support. Part of biomass heating projects were supported using EU Cohesion Funds, Lithuanian Environment Protection Investment Funds, Climate Change Special Program, own means of the companies.

Regarding other above mentioned programs, financial support mainly comes from feed-inn tariffs, but also via JESSICA fund, which co-finances renovation of residential houses. In case of municipal objects (streets lightening, parking places, etc.) funding is possible using municipal means as well as bank loans with guarantees.

Besides above mentioned, the Government of Lithuania is now providing new support possibilities for development of RES electricity installations in industry [12] and housing [13].

For industry the maximal support sum is 500,000 Eur and minimal 50,000 Eur. The support is defined for 4 types of companies: Large, Medium, Small and Micro. The support is 60% for Large companies, 70% for Medium size companies, 80% for Small size and Micro size companies [12].

The buildings the new mechanism of generating consumers was initiated [13]. Use for consumers:

- Lower bills for electricity;
- Possibility to be energy independent;
- Promotion of „green“life style and positive image.

Use for state:

- Promotion of national electricity generation (currently 2/3 are imported);
- Increase of energy security;
- Adding to obligations on mitigation of Climate Change (Paris Agreement);
- Positive impact to national economics via consumers investment into energy market (e.g. 100 MW of solar PV attracts 87 mill Eur investment, 20 mill additional taxes into state budget, 110 new jobs);

Two-sided electricity metering system started in 2015, enabling to use excess renewable energy (e.g. from solar PV) when you need it with storage in the grid. There were 887 such consumers in Lithuania on May 2018. Besides there is support for such type of investment, using:

- Financial support from Climate Change Fund and EU investment means;
- Producing consumers are not obliged to pay Public Service Obligations (PSO)

Besides, producing consumers are not included into system service providing market (tertiary capacity reserve, regulation, balancing of electricity purchasing/sales).

The goal for 2020 is to make every electricity consumer the producing consumer. Thus development of decentralised electricity generation will be implemented in several stages:

1. Since July 2018 – promotion of RES installations in individual houses;
2. Since January 2019 – promotions of RES installations in block residential buildings;
3. Since July 2019 – promotion of RES installations with possibility to separate geographically power generation and consumption locations;
4. Since January 2020 – including producing consumers into system service providing market.

This will be promoted in five most important areas:

I. Reduction of legal restrictions and widening of legal possibilities (DONE);
II. Reduction of administrational burden (documentation, licencing, duration and costs of procedures, collaboration with institutions), Plug&Play principle for smallest consumers (DONE);
III. Pricing (transparent pricing for double side metering) with the main principles (consumer pays for “stored in the grid and later returned electricity; grid

operator includes just economic annual capital, operation and other costs; energy grid operator must have clear benefit; consumer must have possibility to apply different payment plans) (DONE);

IV. Funding model based on foreign best practice is suggested (UNDER IMPLEMENTATION):
   a. All investment using own capital (with possibility of partial investment compensation);
   b. Lease;
   c. Power Purchase Agreement (PPA)

V. Information for consumers – the goal is to established uniform information platform, where consumers could find all necessary information for physical and juridical persons to start generating electricity for their own needs. Information coverage on "producing consumers"" in year 2021 is expected to be 90% of population (UNDER IMPLEMENTATION).

2.5. Stakeholders conflicts

Involving stakeholders for planning of RES projects in municipal areas is very important issue enabling to avoid conflicts in future. Thus it is important to start constant dialogue with local communities, including project developers, NGOs, local population and other interested groups. It is also highly important to maintain constructive dialogue between developers of various RES projects. In case RES projects are socially sensitive (e.g. wind farm, biogas plant, biomass or waste burning plant in the vicinity of residential houses), local population could be interested in financial participating, i.e. possibility to gain several shares and part of profit. Some conflicts may be mitigated via improvement of the living surroundings, solving some household problems for residents, thus promoting public support for RES projects.

5 storeys high placate on residential house against incineration of municipal waste from Vilnius in Kaunas

2.6. Added value of renewable energy for Kaunas

While planning renewable energy projects in the regions one must evaluate the impact of above projects for regional development [14]. Three main aspects should be evaluated – impact to reorganization of energy sector and introduction of renewable energy sources, impact to economics, i.e., capital and value added of the region, as well as necessary monitoring for the process comparative analysis and possibilities to support RES policy.

In regard to energy transition and introduction of RES into energy sector, we should notify that the largest development is in bioenergy, wind and solar energy. Cogeneration, boilers, wind farms are dominating technologies. The use of RES adds to improvement of macro-economy via value added, income and employment, though here we should pay attention that growth of jobs would be mainly in the initial stages of the projects – initiation, design, installation. Biomass fuel production and logistics should be mentioned separately. Factors having impact to RES development are energy price, activity regulation and promotion policy, funding conditions, promotion of research & development as well as knowledge dissemination. In global scale RES development serves mitigation of climate change and reliability of energy supply in electricity and heat markets. Additional benefit involves innovations, reduced air pollution (wind, solar, heat pumps cases), new jobs and local/regional value added.

In regard to impact to economy, we should notify that in global sense use of RES adds to reduction of fluctuations of global energy prices. Dynamic promotion is usually applied to investment into RES projects with regard to reduce the risks of investors and capital costs. However, due to reducing technological costs such promotion should be reduced in future. RES use business model still is supported in Micro-economy and companies level. Business and technological cycles in wind and solar energy sectors are much faster comparing to traditional energy sector, and business indicators (e.g. Rate of Return) is still directed towards short-term profits. Energy price impacts final consumption and demand. Growing price during short-term makes consumers to use energy in more efficient way, and during long-term higher prices may stimulate investment into new more efficient technologies and processes [15].

While implementing planned RES projects it is important to perform monitoring of implementation, to perform comparative analysis and provide recommendations for promotion policy, while revising promotion schemes enabling smooth process. However, it was notified that monitoring of RES implementation is not performed in the most countries of Baltic Sea Region. This could be explaines by the fact that BSR still lacks statistical data in RES energy sector, especially in regional level, which does not permit appropriate monitoring and comparative analysis. Besides, since a significant number of RES project are implemented by business, we should notify that business statistics is not reliable and hardly available.

Thus strategic solutions are adopted on the basis of political will and principles, but not facts, figures and proofs.

3. Description of the area and energy sector

3.1. General data and statistics

Kaunas City Municipality – is administrational area unit in the central part of Lithuania (Figure 1). 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 total city area is 158 km^2; the density is 1,884 persons/km^2. Kaunas City is the important centre of industry, transport, science and culture. City is the centre of Kaunas City and Kaunas Regional Municipalities.

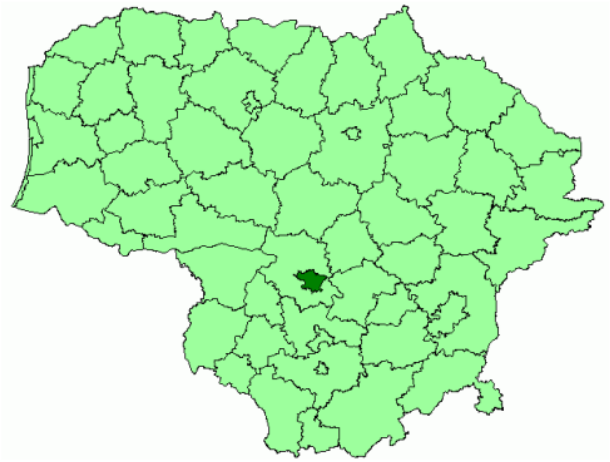


Figure 1. Geografic location of Kaunas City

Kaunas City Municipality is one of eight municipalities, forming Kaunas County. Kaunas City Municipality consists of 11 elderships (Figure 2): Aleksotas, Centras, Dainava, Eiguliai, Gričiupis, Panemunė, Petrašiūnai, Šančiai, Šilainiai, Vilijampolė and Žaliakalnis.

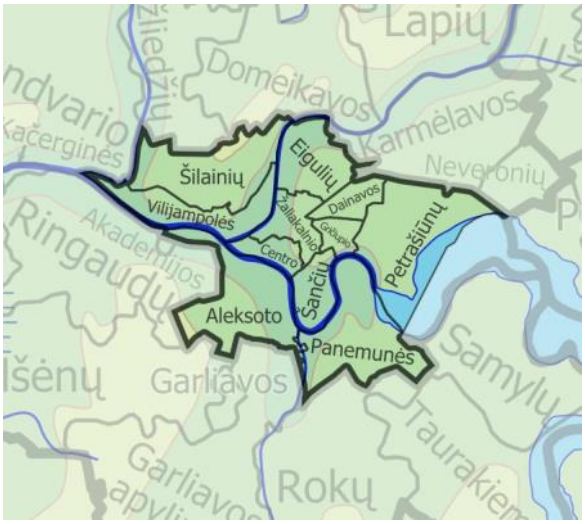


Figure 2. Elderships of Kaunas City

Of total city area of 157 km² (15 715 ha), 9.9 % makes farming land, 16.9 % – forests, 56.4 % – towns and villages (urban area), 6.2 % – highways and streets, 8.1 % – waters, 2.5 % – other areas.

Lithuania's Department of Statistics shows ([16]Figure 3) that population of Kaunas City is constantly reducing due to natural reasons, as well as emigration as in Lithuania (except Vilnius City). The number of residents was 288,363 on January 1, 2018. It is expected that this trend will maintained in the nearest future. However, we should notify, that certain share of population transferred from the City to Kaunas Regional Municipality with more favourable natural conditions, though they still are working in Kaunas City.

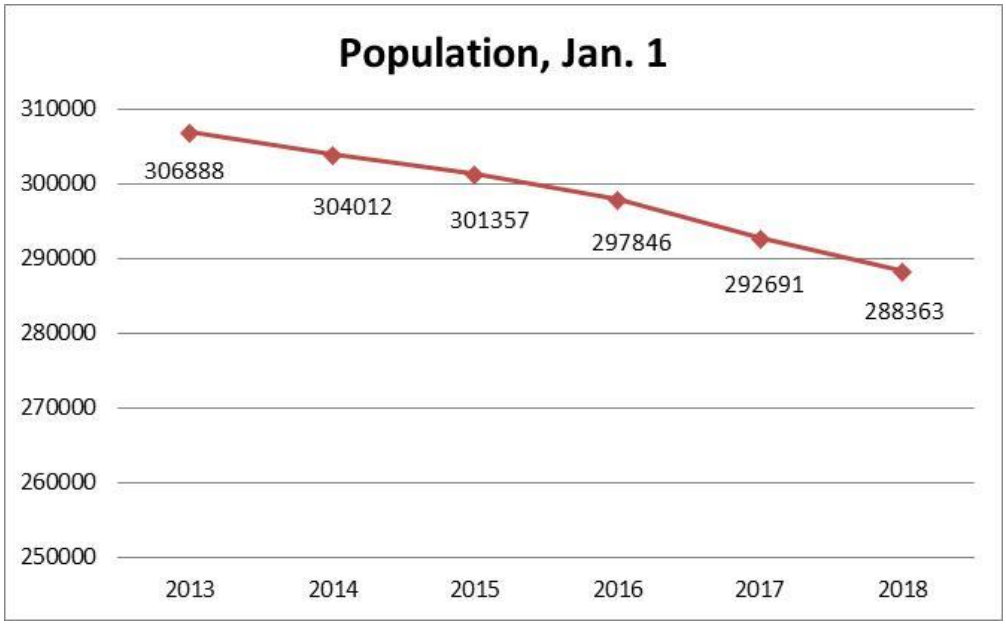


Figure 3. Dynamics of population in Kaunas City 2013-2018 (situation of January 1)

3.2. Energy demand and supply

3.2.1. Consumption

The data of National Land Service states that there were 39,425 buildings (except auxiliary buildings) with total volume 21,114,026 m³ and covered land area 9,855,755 m². In this number there are 22,546 1-2 apartment and 4,587 3 and more multi-apartment residential buildings with total living area 3,935,604 m² plus 7,637,310 m² and total covered land area 2,527,927 m² plus 1,751,946 m² [17].

3.2.2. Supply

Heat sector. 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. Total installed thermal capacity is 496.08 MW, power capacity 8.75. Besides, the company operates approximately 406 km

of thermal heat supply pipelines. Total heat supply to the integrated network was 1427.6 MWh in 2016, in this 1130.7 MWh or 79% using biomass [18].

Besides, there were 11 independent producers in 2017 in Kaunas City and Regional Municipalities, most of which were producing heat using biomass fuel. The total average capacity demand for these producers was 160.8 and consumed capacity 1407.89 MW and annual heat generation was 890,403 MWh in 2017 [19].

Gas sector. Company AB "Lietuvos dujos" supplies natural gas from main gas pipelines via Kaunas gas distribution station. The main users in energy sector are Kaunas DH company AB "Kauno energija" – 113,435 MWh for heat generation and 258 MWh for combined heat and power generation, and independent producer CHP "Kauno termofikacinė elektrinė" 156,721 MWh in year 2016 [18]. However energy sector consumes about 22 % of total natural gas consumption, the rest us used by households (over 30%), public sector (about 25%) and industry (about 21%).

Electricity sector. Kaunas City electricity transmission and distribution system is part of Lithuanian Energy systems, which consists of high voltage transmission and distribution and low voltage distribution grid. The available data of 2013 shows, that annual electricity consumption is more than 1,126,010 MWh and is growing insignificantly every year. The main consumers are tertiary sector (appr. 70%) and household sector (close to 30%) [20].

3.2.3. Demand

It should be notified that the largest shift towards the use of RES in energy sector was transfer of district heating sector to biomass, which will be finished by year 2020, after commissioning of waste (household and industrial) incineration plant. For the same reason, we can hardly have any expectations regarding further RES development in the sector, except some solar energy development, which is seen as one possibility to reduce energy losses in thermal networks during summer periods.

Among energy consumers, which could be seen as most prominent possibilities for planning of RES development, are municipal (public) and residential buildings.

Residential buildings. We should notify that there just approximately 18% of residential buildings, which were constructed in 1991 and later and not assigned for building renovation. The most of the rest residential buildings are inefficient in terms of energy consumption and have been renovated during the last 20 years and the process is ongoing. AB "Kauno energija" supplies heat to 2,930 residential buildings with toal heated area 5,780.8 thousand m^2, which is 51.3% of total residential area in Kaunas City. Approximately 82% of natural gas balance is used for heating of residential houses (centrally and for individual house, which is appr. 100 mill nm^3 of natural gas).

However, there is no reliable data about the use of energy resources in the most of individual residential houses, however we can expect that fuel consumption is appr. 84 kWh/m^2, so it is expected that this unknown annual fuel consumption can reach nearly 461.3 GWh/a. The largest share here is biomass fuel (appr. 71.5%), i.e. firewood and wood

residues. Electricity volume supplied to residential buildings is approximately 350,000 MWh/a. Residential sector has also consumed appr. 33,500 thousand nm^3/a. all data comes from year 2013 [20]

In general, residential sector of Kaunas City consumes appr. 1,635.5 GWh of thermal energy (as fuel), nearly 349.5 GWh as electricity and 315.5 GWh of natural gas (Figure 4).

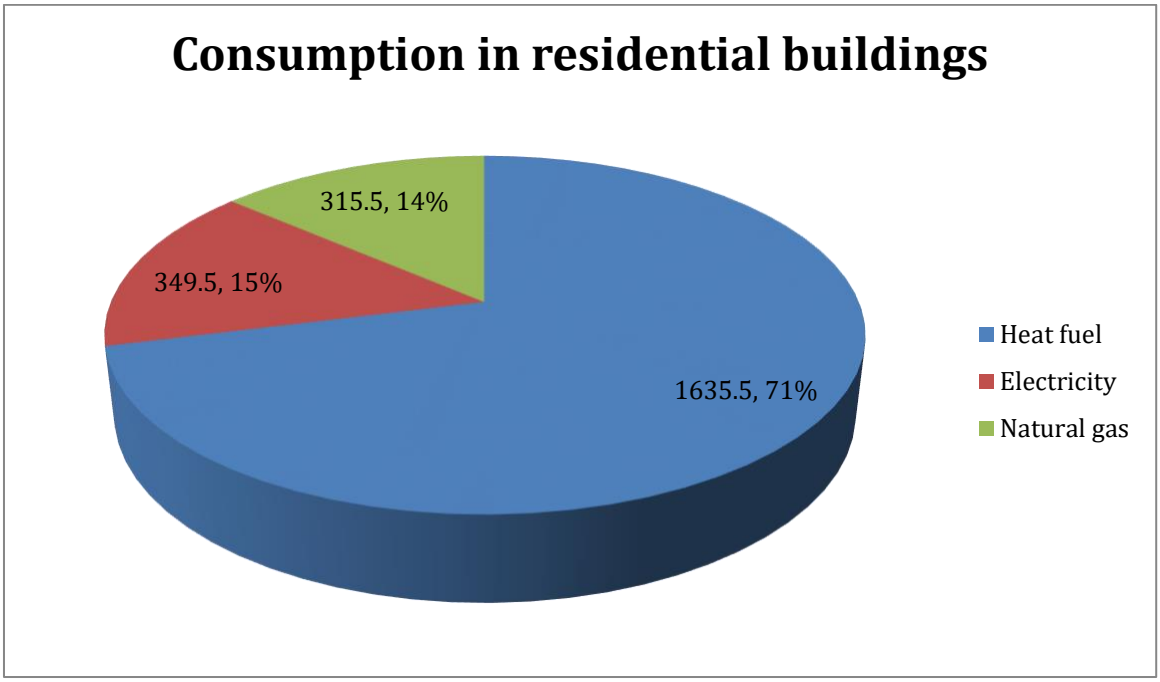


Figure 4. Annual energy consumption in residential buildings in 2013, GWh

Public buildings. This sector includes all hospitals and medical points, administrational buildings, schools and kindergartens, religious, cultural and other similar buildings. Total number of such buildings is 4,356 with area 4,218,839 m^2. Nearly 80% of these buildings are supplied with heat from district heating company, the rest use local boiler-houses or local heating installations.

The data of year 2013 discloses that these buildings were consuming 92,369 MWh of primary energy for total heated area a bit more than 659,682 m^2. Defined comparative heat consumption reaches 140 kWh/m^2/a. DH company supplied more than 200,252 MWh of thermal energy (2,782.1 thousand m^2), which make appr. 266,765 MWh, including all conversion and transmission losses. There is no data available on other heat provided, thus our assumption will be based on heat consumption in the sector, i.e. 55.4 kWh/m^2. This shows 69,459 MWh/a of heat. Total energy consumption in public sector, besides electricity, makes nearly 364,666 MWh/a.

Electricity consumption in public sector was 70,374 MWh and natural gas consumption was 11,039 thousand nm^3 or 102,661 MWh [20].

In general, public sector of Kaunas City consumes appr. 364.8 GWh of thermal energy (as fuel), nearly 70.4 GWh as electricity and 102.67 GWh of natural gas (Figure 5).

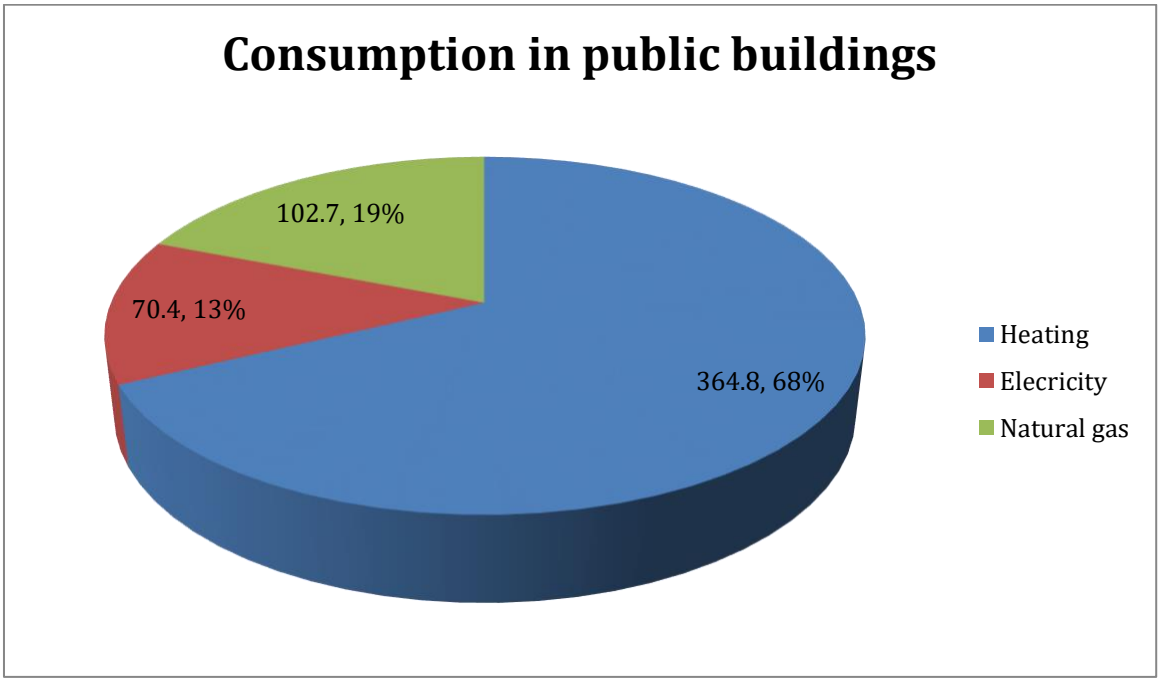


Figure 5. Annual energy consumption in public buildings in 2013, GWh

The other sector, where RES potential may be significant, is business sector, and though municipal planners have no impact on business decisions, some suggestions on the development of RES projects are possible in RES plans.

Industry. Industry (except energy sector) and farming are sectors, which have 6,559 buildings, such as industrial buildings, storages, garages and farming facilities, such as farms, greenhouses, auxiliary buildings with total area 4,588,422 m^2. There are 3,550 companies, registered in Kaunas City. These companies do not provide business data and official statistics is the only source, providing data on fuel balance [16]. Industry consumed appr. 495.3 GWh of primary energy in 2013. Electricity consumption was 692,659 MWh/a, and natural gas consumption in industry and agriculture was 22,548 thousand nm^3 (or 212,328 MWh). Thus energy consumption in Kaunas City was 495.5 GWh of fuel energy and nearly 692.7 GWh of electricity.

Transport. Public and institutional transport is the last, but not the least sector, where planning of "green" energy is performed under municipal planning process.

It is impossible to assess fuel consumption for all transport in Kaunas City, as data on individual and business levels is not available, so the main items are transport in municipal and public sectors.

Table 2. Fuel consumption in transport of Kaunas City

Property	Fuel consumption, l/a

	Petrol	Diesel	LPG
Municipal administration incl. elderships	10,253	0	0
Public and tertiary sectors	122,869	1,656,281	18,314

Total energy consumption was 125 MWh/a for municipal administration and 544 MWh/a for public transport.

3.3. Energy development trends by 2027

3.3.1. Housing sector

Renovation of multi-apartment residential buildings. Renovation of multi-apartment residential houses reduces energy demand in average by 40 %. About 135 buildings were renovated by year 2016, 131 more investment plans are being developed. In case of planned renovation, total energy demand could be reduced nearly 111,725 MWh or 18,621 MWh/a by 2020. We could expect that this figure could be at least doubled by year 2027, i.e. 223,450 MWh or 37,240 MWh/a. However, more realistic figures could be 60,000 MWh by year 2027, which would mean nearly 3.6 % reduction of thermal energy demand in residential sector.

District heating pipelines. Heat losses in the integrated heat pipeline was 17.4 % (nearly 248,200 MWh). We make assumption that targeted renovation of pipelines could be reduced by 40% till 2027, which would be 73,076 MWh or nearly 10,000 MWh/a, which means reduction of heat demand by 4.4 % in residential sector.

Population. Annual reduction rate is 1.8 %/a, so we can make assumption that reduction from 2018 till 2027 (10 years) is appr. 18 %. Though this reduction has little influence on heat consumption, however, reduction of hot water production and electricity consumption would reduce by appr. 60,000 MWh or 8,000 MWh/a, which means reduction of energy demand by 3.6 % in residential sector.

3.3.2. Public and tertiary sector

Modernization of public buildings. Tal area of such buildings in Kaunas is 1.1 mill m^2. It is planned that appr. 60,000 m^2 of this area could be renovated by 2027. Thus energy demand could be reduced by 5,130 MWh ir 734 MWh/a, which makes appr. 1.4 % reduction of energy demand by 2027 in public sector.

District heating pipelines. Reduction 16,300 MWh or nearly 2,330 MWh/a, which means reduction of heat demand by 4.4 % in public sector.

3.3.3. Industry and farming sector

Due to lack of data, assumptions on development trends for industry and farming sectors are based on the GDP growth trends, which is expected to be 4.3 %/year since year 2017. This gives 43 % till year 2027, i.e. 213,027 MWh or 30,432 MWh/a. The development of RES installations in industry and farming sectors is expected due to support scheme, presented in 2.4. Funding chapter of this paper.

3.3.4. Transport sector

Population. As it was mentioned before annual reduction rate is 1.8 %/a, so we can make assumption that reduction from 2018 till 2027 (10 years) is appr. 18 %. This leads to reduction of energy consumption for transport needs. By year 2027 reduction of fuel consumption should be 360,915 MWh (31,033 t_{oe}) or 51,560 MWh/a (appr. 4,433 t_{oe}/a)

Renovation of public transport park. Upgrading the old inefficient transport park is defined in long-term plans. Every new vehicle is considered 30% more efficient that the old one. So if updating is expected as planned, fuel consumption is expected 480 MWh/a or 4,800 MWh in 10 years.

4. Concept of RES plan

4.1. Involved stakeholders

As it was notified above, there are four main municipal sectors, where RES planning and implementation are available for municipal planners, which are municipal facilities (DH, water supply and sewerage management, waste management); residential and public buildings; public lightening; and public and administration transport. Spatial planning for all these sectors requires a large number of stakeholders:

1. Municipality of Kaunas City, operating via Energy Department of the Adminitration of Kaunas City Municipality;
2. Municipal facilities:
    a. AB Kauno energija – Kaunas district heating company;
    b. AB Kauno vandenys – Kaunas water supply and sewerage management company;
    c. AB Kauno švara – Kaunas municipal waste management company;
    d. AB Kauno autobusai - Kaunas Public transport company;
    e. AB Kautra – Kaunas Public transport company;
    f. UAB Kauno gatvių apšvietimas – Kaunas Streets Lightening company;
    g. Etc.
3. Owners of buildings:
    a. Housing associations;
    b. Residents - joint property owners;
    c. Public, municipal, state companies, operating in public buildings;
    d. Etc.
4. Industrial companies;
5. RES projects and technologies developers;
6. RES lobbies and associations;
7. Energy producers;
8. Energy consultants, academics, etc.;
9. Consumers' rights protecting bodies;
10. City residents;
11. Etc.

Above mentioned stakeholders participate in the RES development process with higher or lower intensity. Some are directly involved in RES projects, others, like City residents and consumer's rights protectors are more involved in social and environmental problems, related to RES projects planning and development.

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.

4.2. Main requirements for spatial planning, criteria

There is a significant number of existing planning documents in Kaunas City Municipality. The three most important should be mentioned here:

- 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 municipal facilities, developing companies.

Municipality should provide specific locations, available and appropriate for development of RES projects, which is one of the main task of municipal spatial plan. The area of Free Economic Zone, divided between Kaunas City and Kaunas Regional Municipalities was allocated to most biomass plants, though in some cased in the part, very close to residential area. However, some biomass boiler-houses were developed in densely resided district of the city, which was considered not the best solution in terms of local pollution, noise as well as causing problems to district heating network.

Thus, special municipal plans, should not define not only the consumption zones for district heating, natural gas supply and electricity supply, but also to electricity and heat generation.

As currently most urban RES projects are expected to be solar collectors, PV and heat pumps, the spatial plan should define multi-apartment urban “sleeping” districts, public buildings with proper types and orientations of roofs for solar collectors and solar PV, and significant outside area between houses for drilling, enabling the use of geothermal energy for buildings. This would enable selection of buildings, which should undergo renovation, to choose solar collectors, heat pumps as additional RES measures for hot water preparing and partly heating during renovation process, which is financially supported. The new initiated support for producing consumers (electricity generation using solar PV on buildings to cover own needs and supply to the grid of excess electricity) is another opportunity for urban areas.

Certain locations for efficient and, maybe, “green” lightening and small consuming solutions such as parking (solar PV) should be also considered and defined.

Kaunas City is mainly urban area, including residential areas, commercial and industry areas, military facilities, airfields and surroundings, tourism key areas, inland waters (2 big and some minor rivers, ponds, etc.), areas for coastal and flood protection, forest areas, natural parks, biosphere reserves, Natura2000 areas.

This abundance of various types provides restrictions as well as new challenges and possibilities for variety of RES solutions. On the other hand, such variety of area types requires defining planning procedures for various types of renewables; producing spatial plans for energy generation in every area; evaluating all necessary technical aspects; involvement of public participation from the very start of planning process with the aim to avoid conflicts and enable financial participation; as well as evaluating environmental aspects, pollution, if there is potential, and logistics aspects.

4.3. Economic benefit

Evaluating that the share of biomass in district heating sector is about to reach 100% by year 2020, the RES action plans are achieved and exceeded. However, there is still space for development of renewable energy in such sectors as buildings (residential and public), industry, farming and trade, streets lightening and transport, which mainly involves such type of RES as solar collectors and PV, heat pumps combined with geo/aero/hydro-thermal energy and “green” (electric, hybrid, fuel cells, etc.) transport.

Current drivers of RES development include the price of energy, regulation and policy, financing conditions, incentives for R&D, and the availability of knowledge and technology spill-overs. Solar energy demonstrates a new wave of renewable jobs and value added. The growth for solar power has been exponential. Solar PV is the quickly growing renewable energy employer.

Investments in RES are facilitated by a dynamic regulatory framework that attempts to reduce the risk for investors and hence the cost of capital. However, incentives need to be reduced in line with falling technology costs, in order to avoid over-compensation which is a case in many countries and regions, whether related to the lock-ins in the energy market or to the emerging technologies. [14].

The creation of jobs in RES sector has not increased significantly, mainly biomass sector (about 10 new jobs in every new biomass boiler-house), for other RES (Solar, heat pumps) these jobs are not so much in operation, but rather in R&D, construction and maintenance. A larger share of value added is growing due to growing labor productivity.

The largest economic benefit is still foreseen for energy consumers due to reducing energy tariffs using biomass for heating, solar heat and heat pumps for hot water generation and space heating, as heating costs still make the significant share in family budgets.

5. Renewable Energy planning for Kaunas City

Usually Municipal RES Action plans are using 3-scenario method: basic (pessimistic), moderate (realistic) and optimistic (maximum). Here we are elaborating just the simple draft, as an example for our concept, thus we'll limit ourselves with the moderate realistic scenario, which is based on realistic development trend, evaluates municipal decisions, technological changes, consumers' behaviour projections as well as environment and climate conditions (Table 3).

Table 3. Development of RES using moderate (realistic) scenario for Kaunas City

Type of RES	**Moderate (realistic) scenario**
Solar PV (individual projects)	Finalised already started projects with two-side power metering and support for producing consumers 100 kW/a (10 consumers) – total 1 MW by 2027.
Solar PV (on municipal buildings)	With two-side power metering and support for producing consumers 20 kW/a (2 buildings) – total 200 kW by 2027.
Power generation (new CHP plants)	Finished municipal waste burning CHP plant 24 MW_{el} by 2020. Annual electricity generation up to 170,000 MWh. Further development suspended.
Non District Heating heat (individual boiler-houses)	Annual growth of new biomass boilers, installed by physical or juridical persons with total capacity 1 MW/a - total 10 MW by 2027.
Non District Heating heat (solar collectors)	Annual growth of solar collector in new or renovated buildings, installed by physical or juridical persons with total capacity 1.5 MW/a - total 15 MW by 2027.
Non District Heating heat (heat pumps)	Annual growth of heat pumps in new or renovated buildings, installed by physical or juridical persons with total capacity 0.5 MW/a - total 5 MW by 2027.
District Heating (biomass boiler-houses)	Final object if municipal waste burning CHP plant with capacity appr. 70 MW_{th}. It will use about 200,000 tons of municipal waste and generate appr. 500,000 MWh of heat. Further development suspended due to achievement 100% biomass district heating.
District heating (solar collectors)	Annual growth of solar collectors on renovated multi-apartment houses – 200 kW/a (4 buildings) - total 2 MW by 2027.
District heating (heat pumps in municipal buildings	Annual growth of heat pumps on renovated multi-apartment houses – 20 kW/a (1 building) - total 200 kW by 2027.
District heating (solar collectors) in municipal buildings	Annual growth of solar collectors on renovated municipal buildings – 40 kW/a (1 building) - total 400 kW by 2027.
Electricity in transport (individual transport means)	Annual registration of electromobiles – 20/a – total 200 by 2027.

Electricity in transport (charging stations for electro-mobiles)	Annual installation of 4 charging stations – total 40 by 2027.
Electricity in transport (new trolley-busses)	Planned number of new vehicles acquired. Defined by municipal budget.
Fuel in transport sector (green/efficient busses)	Planned number of new vehicles acquired. Defined by municipal budget.

6. Recommendations

One of the challenges for improvement of planning perspectives for renewable energy is growing with the expansion of renewable energies. Spatial planning must further develop its methods, planning criteria and data basis for planning, participation and conflict management. With the increasing number of renewable energy plants and the expansion of energy networks, also demands on planning as well as conflict potential will increase.

Assessing the experience of spatial planners in Lithuania, including Kaunas Region, and other countries of Baltic Sea Region [21], the following recommendations for policy-makers on RES planning are presented:

1. To evaluate three main elements for creating space for renewables for the large-scale implementation of the renewable energy:
   - **The renewable energy sources,** which include their location, accessibility and size of the resource. The utilization of resource depends on the availability and the economy of the technology, and the possibilities of locating the energy plant on a relevant site.
   - **Technologies,** evaluating a wide variety of technologies that can exploit water, wind, solar or biomass. It is typical that a number of technologies are being scaled-up, i.e. the standard renewable energy plant is getting bigger and bigger which can provide better resource utilization but sharper the difficulty of finding suitable sites.
   - **Space,** which is defined by nature possibility of finding a location for a given renewable energy plant, where location opportunities often compete with a variety of other purposes and considerations.
2. Two more elements are important for implementation of renewable energy:
   - **The regulatory regime**, which is financial support for renewable energy. The resource-poorer location of the facility, the greater will be the subsidy requirement to achieve the target.
   - **Socio-economic benefits,** which is the unconditional prerequisite to contribute to the realization of a number of multilateral benefits, like local development (employment and revenue, basis for local investment, scaling the local environment and resources).
3. To pay special attention on the selection of planning criteria. The definition of criteria should include the following issues:

   a. **Designated areas for renewable energies:** Areas intended for renewable energy installations. This involves:
   a. Clearly defined standard planning procedures;
   b. Special areas assigned for development of RES objects;
   c. RES development in categories (type of renewable) is possible in any case/ is possible after individual assessment/is not possible.
   b. **Standard planning processes:** Standardized planning processes in force for specific sizes and types of renewable energy installations and define, e.g. the need for public participation, the legislative framework and authorities in charge.

c. **Models for participation in spatial planning:** The purpose of public participation or at least stakeholder involvement is to ensure that stakeholder and public voices are heard. In this respect numerous participation models are in force and have to be considered for the spatial planning for renewable energies.
d. **Economic participation models:** Economic participation is a strong tool to avoid conflicts and paves the way for a higher regional added value, that's why economic participation was selected as general aspect to improve the framework conditions for the spatial planning for renewable energies. Economic participation can be achieved in the context of participation in regional energy cooperatives, community wind farms and solar parks and other formats. The goal is to increase local benefits for affected people from the added value of energy production.
e. **Natural renewable energy resources:** The natural renewable energy resources can be evaluated by the use of renewable energy resource data sets providing information on e.g. feedstocks for bio-energy, the characteristics of solar energy or wind energy for a particular region.
f. **Grid capacity regarded in spatial planning:** Renewable energy production from wind and solar are subject to natural variability. This variability creates distinct challenges to integrate the generated power into larger power systems and grids. Therefore power generation has a significant impact on the capacities of high voltage grids that is likely to increase over time. Integration of renewable energy is a multilayer-challenge involving multiple decision-makers like energy storage resources, grid operators, energy market operators and transmission planning bodies.
g. **Capacity and height of installations regarded in spatial planning:** Especially for the spatial planning for wind energy, the capacity for power generation and height of the turbines is a central aspect. Capacity for power generation also plays an important role for the spatial planning for biogas- and biomass plants and solar power plants.

Other technical aspects.

h. **Conflict potential:** Conflicts related to renewable energy installations occur in all participating regions around the Baltic Sea. Some conflicts are related to different renewable energy sources, other conflicts are specific to renewable energy sources depending from the way of energy generation. For wind energy such conflicts comprise e.g. environmental conflicts, landscape conflicts, or conflicts caused by noise, blinking and shadowing. Biogas plants can stand in contradiction to air quality and noise protection. Biomass burning connected to district heating, often face the problem of the capacity for heat supply, local pollution, etc. Therefore, the conflict potential represents a general aspect for spatial planning for renewable energies.

4. Other aspects:
    a. Impact on landscape assessment in spatial planning;
    b. Pollution assessment (emissions, visual, noise pollution, smells, etc.)
    c. Logistics aspects regarded.
5. To increase involvement of stakeholders for planning of RES projects in municipal areas. It is a very important issue enabling to avoid conflicts among stakeholders in future. Thus it is important to initial constant dialogue with local communities, including project developers, NGOs, local population and other interested groups,

such as maintaining constructive dialogue between developers of various RES projects. In case RES projects are socially sensitive (e.g. wind farm, biogas plant, biomass or waste burning plant in the vicinity of residential houses), local population could be interested in financial participating, i.e. possibility to gain several shares and part of profit. Some conflicts may be mitigated via improvement of the living surroundings, solving some household problems for residents, thus promoting public support for RES projects.

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