The Sustainable Growth Use of Renewable Energy Based on Spatial Energy Planning: Lithuanian Case

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***Abstract* — The article summarizes the results of research, identifying the main challenges to increasing sustainable use of Renewable Energy Sources (RES)-technologies. The main obstacle to the widespread use of RES is the failure to address the key issue – to measure the benefits to the society - reduction of pollution, energy supply for the future generations, huge and never-ending potential of energy resources, such as solar and wind energy, when introducing RES-technologies. There are also controversial phenomena, especially in the heat sector. Unreasonably huge role is assigned to biomass in usage projections of RES. Huge disproportion of used RES technologies is a serious challenge to the sustainable development of energy and threat to forests and their ecosystems. The aim of the research is to apply the methodological approach enabling assessment of external benefit of the use of renewable energy sources, which is usually not assessed for individual projects. External conditions and current infrastructure for RES technologies are different, thus spatial planning, such as urban energy development plans, is the most appropriate tool for the external benefit assessment Regional programs may be appropriate tools for reducing renewable energy adaptation costs, increasing competitiveness in the market, promoting social development and should be the main form for combination of different types of RES and consolidation of investment funds. The sustainable growth of renewable energy is based on the formulated methodology, which enables to achieve maximal benefit with minimal support for beneficiaries as well as for the state. Modified levelized cost of energy method enables analysis of economic benefit for the selected project investor, as well as relates the achieved results to macroeconomic indicators using external parameters. Combination of different types of RES may create large external effect and make a significant impact not only on individual consumer of RES, but on the whole society as well. The main output of the research is background for the support policy to encourage investors, which may be created on the basis of external benefits.**

Keywords-renewable energy; sustainable development; evaluation principles; external benefits.

I. INTRODUCTION

This publication is based on an article published in the IARIA conference proceedings "The Sustainable Growth Use of Renewable Energy Based on Spatial Energy Planning" [1]. The findings of this article are the result of many projects carried out by the authors. Like in other EU countries, so in Lithuania economic research of Renewable Energy Sources (further in the text – RES) has intensified in the recent years through implementation of European Union directives, with particular emphasis on the role of a territorial aspect (cities, districts). Incentives for wider use of RES are declared both in the European Union and in Lithuanian laws. Adoption of the Directive 2009/28/EC "On the promotion of the use of energy from renewable sources" [2] required the development of a National Renewable Energy Action Plan for 2010-2020 and many other documents at the local level. This indicates that the development of RES takes an increasingly more significant role in the energy policy of all member states, including the Republic of Lithuania.

The main obstacle to the widespread use of RES is the failure to address the key issue – to measure the benefits to the society (reduction of pollution, energy supply for the future generations, huge and never-ending potential of energy resources, such as solar and wind energy), when introducing RES-technologies and, on the basis of these benefits, to encourage investors. Therefore, when formally calculating, RES-technologies are not sufficiently competitive, compared to fossil-fuel technologies. This work deals specifically with the problem of the impact of RES-technologies both positive and negative. The impact analysis of RES-technologies on social welfare (on job creation) and on health (on the basis of environmental impact) has allowed the formation of a targeted, reliable methodology compatible with the status of existing statistical information. On the basis of it, algorithms calculating the impact for individual types of RES are formed [3].

Given that in the newly developed Energy Strategy high hopes to use RES-technologies are linked to the extremely low used energy sources, such as solar, wind and geothermal energy, significant efforts are needed to organize the accounting and statistics of decentralized RES-producers. Apart from this important condition, it is difficult to expect the proper process management of mastering RES. The analysis of positive and negative impact of RES usage in the research of Lithuania and other countries has shown that major part of positive impact of the RES development is related to reducing Green House Gas (further in the text – GHG) and other pollutant emissions, job creation and rural

development. The positive effects of biofuels, biogas and biofuel manufacturing sectors are mainly reflected on the increase of employment level in the regions, the reduction of heat prices and lower emissions of some fossil fuels, which in the long run could affect the decline in the incidence of certain diseases. The development of biogas production and use also plays an important role in solving the problem of organic waste management. The main positive effects of solar and wind energy technologies are the reduction of GHG emissions compared to the use of fossil fuels and biofuels as well as the creation of temporary jobs in Lithuania by installing new solar power plants or wind farms. Developing the manufacturing technology industry in Lithuania also has a positive effect on the creation of additional permanent jobs.

Section II describes the concept of external utility of implementation of RES technologies. Evaluation of such utility may show the advantages, which are underestimated in the investment decisions. Section III presents a solution of the identified scientific problem; it is based on a system of territorial urban planning. In Section IV is presented a description of how RES programs can consolidate related urban development programs. This may serve to formation of financing assumptions and sources for their implementation. The methodology, which is based on spatial planning, identifies certain aspects that usually are not covered by routine investment evaluation techniques, namely, the existing problems in cities: high atmospheric pollution, unemployment, etc., may determine the validity conditions that allow interpolating results to assess technology for spatial energy planning for solving problems mentioned above. Long distances to centralized electricity and heat networks are defined by geolocation factors and may determine financial acceptability of small decentralized renewable energy technologies due to their technical benefits.

II. CONCEPT OF EXTERNAL BENEFIT OF RES TECHNOLOGIES AND CHALLENGES TO SUSTAINABILITY

In recent years, consumption of fossil fuel and mitigation of climate change have become major challenges for governments all over the world. To engage these challenges, many countries are pursuing research, development, and demonstration of RES [4]. In the past few years, usage of RES rapidly increased all over the world. RES have become important alternative energy sources to realize energy diversification. During the last few years, political support for renewable energies has been growing continuously both at the national and international level [5][6].

Increase of social and political pressure for fast development in clean energy, and financial crisis, which required adequate government measures to stimulate the economy. The industry of renewables could be important to generate employment and stimulate growth [7]. Investment in RES may bring considerable profits, so more and more enterprises will be involved in this field. The increased use of RES in the heat market can significantly alleviate the negative effects of high energy costs on the national economy. Successful commercialization of indigenous, renewable energy resources is expected to promote regional economic development and employment, enable to increase national energy security and to reduce a substantial portion of the increasing trade deficit necessity to import fossil fuels [8].

The use of renewable energy in rural as well as urban areas became the significant development thus adding to mitigation of climate change [9][10], reducing differences between rural and urban dwelling options [11], bringing new RES options for diversifying energy supply [12][13][14]. The role of local governance for energy and urban development appears highly important here [15].

However, there are also controversial phenomena, especially in the heat sector, where huge disproportion of used RES has appeared. Unreasonably huge role is assigned to biomass in usage projections of RES. Biomass is an energy resource that is the result of economic activity and depends on continuity of economic activity. Meanwhile, the use of an inexhaustible solar and geothermal energy potential is absolutely insufficient.

At present renewable energy sources (RES) are treated as an integrated whole, and all the advantages and disadvantages are classified as generalized, but at the same time separated from specific conditions and the infrastructure that is possible to use.

Therefore, one of the most difficult issues to be solved is that the utilization rate of RES in Lithuania (and maybe in other countries) is one-sided, focused on the use mainly of biomass for many reasons, which are not adequately investigated and identified. Meanwhile, other types of RES, such as solar, wind or geothermal energy, are scarcely used.

Figure 1 shows the state of the use of RES technologies in Lithuania.

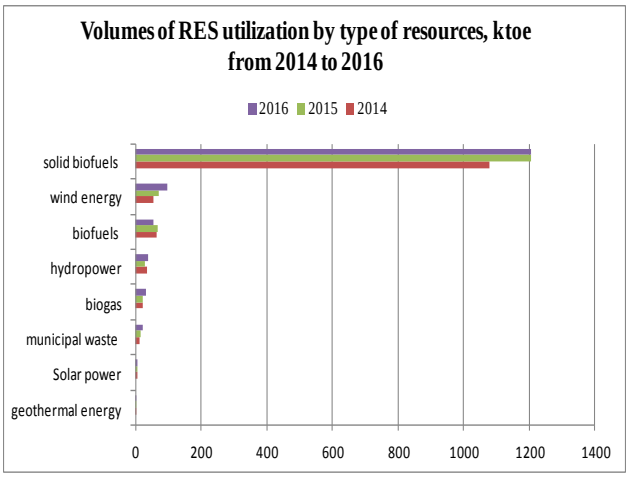

Figure 1. Disproportions of the use of RES-technologies in Lithuania.

The data of Figure 2 show the percentage of RES technologies utilization by regions in the heat sector. Here is dominated biofuels, whose combustion somehow treats as neutral in terms of CO2 emissions. This is a serious

challenge to the sustainable development of energy. There is also danger to forests and their ecosystems.

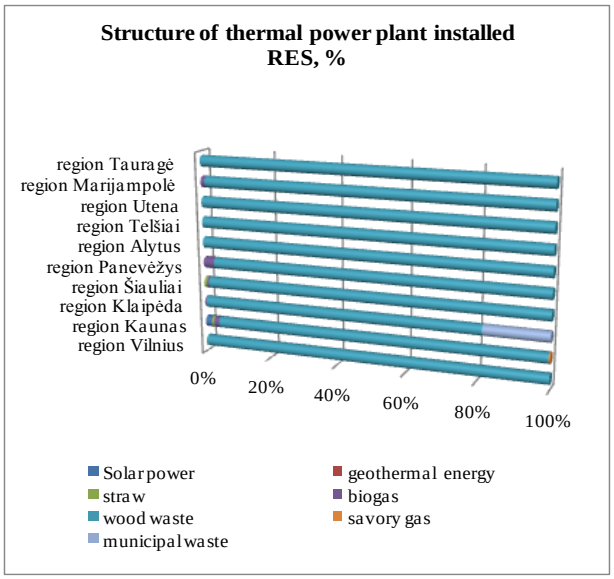

Figure 2. Percentage of technology utilization by Lithuanian region s in the heat sector.

It is shown in Figure 3, the situation in the electricity sector is better because different types of RES-E are used in a proportionate manner. This proves that it is possible to maintain a certain proportion of utilization of RES, with proper selection of economic and financial support measures.

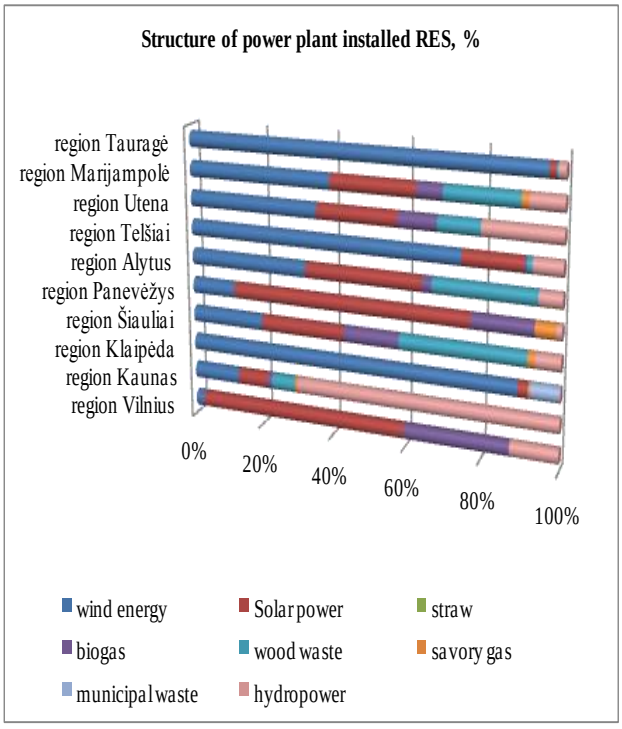

Figure 3. Percentage of technology utilization by Lithuanian regions in the power sector.

The stimulation of energy producers and consumers to use RES is one of the major goals of energy policy in Lithuania. Policies and measures that aim to enhance the use of RES are mainly driven by EU policy. Unstable state energy policy and changes of incentive measures destabilize the investment initiatives. The lack of economic evaluation on both demand and supply sides is the main challenge to achieve the expected goal.

The scientific problem is evaluation of social utility of RES that can show the advantages, which are underestimated in the investment decisions [16]. The most important benefits of RES are inexhaustibility and possibility to ensure sufficiency of energy resources for future generations. Also, utilization of particular RES technologies, such as solar energy, solves environmental issues. Therefore, RES may be additionally financed from other sources. The main issue is the diversity of RES utilization opportunities and incentives. The energy phenomenon is inexhaustibility of RES that could change exhaustible types of fossil fuel, such as oil and natural gas, and could be replaced with few different types of energy. This could be solar, wind, and geothermal energy. On the other hand, social utility of RES differs from the social utility of oil and natural gas, because RES guarantees the supply of energy resources for future generations.

Renewable energy policy is a complex system, where a balance among three aspects of sustainability – environment, economy, and social life – is needed. A good performance and well-balanced RES policy requires efforts from different stakeholders. Although each country has different starting conditions, namely, developed technical infrastructure and own energy resources, development of energy from RES should be shaped on the basis of long-term macroeconomic policy [17]. This means that a good and scientifically-based theoretical background is needed as well as indicators reflecting economic development and a method for assessing the impact of certain type of energy from RES on these indicators are required. In other words, this is a reliable energy supply at an affordable price, which causes as positive environmental impact as possible.

Support for RES is required to promote wider use of renewable energy. What is more, energy market failure is a serious obstacle to promote the development of RES. External positive benefits of using RES, such as public interest, are not evaluated here. This benefit is related to introduction of new technologies, their development, and positive impact on the environment [18][19]. Subsidies for RES must be based on a positive external utility. Therefore, one of the most effective methods could be integration of RES technologies into regional energy development [20]. Regional programs may be appropriate tools for subordinating market mechanisms (reducing renewable energy adaptation costs, increasing competitiveness in the market and promoting the development), which are required to overcome market barriers [21][22].

As a rule, the impact of RES-technologies on economic and social indicators is supported by statistical correlation analysis based on historical trends in RES development and their impact on macroeconomic indicators. However, the

anonymity of this method and the probability of a certain error cannot provide a clear understanding of the actual impact of specific parameters when analysing specific projects under individual RES-technologies [23]. Also, this method does not provide tools or ways to optimize the development of the RES-Sector or to put in place support measures to maximize macroeconomic benefits with minimal resources. Therefore, valuation is inseparable from the microeconomic analysis of the project chosen by the individual investor (taking into account the economic benefits to the developer), using external parameters for macroeconomic indicators [24]. Results obtained in one project may be interpolated to assess the potential impact of the support scheme at the urban level.

Levelized Cost Of Energy (LCOE) is one of the most popular approaches for comparison of different energy generation options on equal basis – present value of total life-cycle cost. The modificated LCOE approach, which was applied in a paper of V. Bobinaite and D. Tarvydas [25] gives an opportunity to quantitatively assess the influence of certain RES support measures on the cost of energy production. Also, it provides the investors a tool which could be used to compare different RES investment projects concerning external benefit to society.

This method with a broad interpretation was adapted to assess the use of wind energy in the macroeconomic framework [3].

III. SPATIAL ASPECT FOR THE ASSESSMENT OF BENEFIT FROM USING RES TECHNOLOGIES IN URBAN AREAS

There is no consensus among scientists in the debate on who should take initiative and responsibility in addressing the issues of the dissemination of innovation as a precondition for economic development: the state, the city or private structures. The basic idea of the problem above has expressed prominent environmentalist: "Global must move towards a local one, because localities exist within the boundaries of nature, where global exists only in the offices of the World Bank and the ICF and in multinational offices. Global ecological space is the local integration of everything" [26]. More and more scientists say that decisions are needed in this area by territorial units. The key issue is, in the long term, to achieve the possibility that different types of RES would find a niche in the long run, which basically means the stability of energy prices and the assurance of all elements related to sustainable development. In essence, this means consolidating the knowledge system into an effective set of practical implementation. Reproduction of good practice in this regard is an increase in the competitiveness of the whole economy, since it eliminates many negative factors associated with fossil fuel combustion. Also, burning biofuels causes not only the air pollution problem in cities, but also the degradation of forests despite the alleged reforestation of the forests.

The use of renewable energy in rural as well as urban areas became the significant development thus adding to mitigation of climate change, reducing differences between rural and urban dwelling options [27], bringing new RES options for diversifying energy supply [28]. The role of local governance for energy and urban development appears highly important here [29].

Policies and measures that aim at enhancing the use of RES are mainly driven by EU policy. The scientific problem is evaluation of social utility of RES that can show the advantages, which are underestimated in the investment decisions [30][31]. Moreover, it is transfer of their economic interpretations on uniform rules and economic laws into specified dimension, in this case trying to reduce different opinions as much as possible [32].

The main indicators of external benefit are considered to be the use of domestic capital; taxes paid to the state budget and newly created job positions. Combination of different types of RES may create a large external effect and make a significant impact not only on individual consumers of RES, but also on the society. Therefore, the benefit from using RES, especially in urban areas, should be evaluated during the decision making process.

At the moment, a very important scientific problem emerges, namely the performance of non-profit organizations, such as municipality in the context of a knowledge-based economy. The main feature is that knowledge, for example, related to the sustainable development of energy, in particular the widespread use of renewable energy sources, as vital for global climate change mitigation, is becoming less an expression of the desire for competitiveness as an object of implementation and dissemination of good practice. In the current new economic situation, the main emphasis is on knowledge dissemination. On the other hand, they become an effective tool in the non-dispersed, random, but organized way to achieve a particularly important goal - massive absorption of RES technologies, which covers many positive additional effects – reducing environmental pollution, energy, in particular heat price stability, social issues, etc.

Each RES has different value in terms of external benefit, thus respective promotion schemes can and must differ significantly. This depends on the environmental situation in certain area. External conditions and current infrastructure for RES technologies differ, thus spatial planning, such as urban energy development plans, is the most appropriate tool for the benefit assessment. All countries pay little attention to the support of RES technologies on the demand side. Support for the consumers is the most appropriate via support programs (and not by supporting scattered consumers), as it enables to achieve actual effect. The external benefit analysis for small wind power plants, geothermal heat pumps, and solar collectors was performed to find their niche in urban and rural areas. The external effect indicators for different scenario cases are shown in Table I. Data in Table I show the comparison of external benefit using different types and scale of RES technologies. The main indicators of external benefits are considered to be the use of domestic capital; taxes paid to the state budget and newly created job places. Avoiding air pollution is also one of the key factors that determine the external utility of RES-technologies.

TABLE I. EXTERNAL BENEFIT OF USING SOLAR, WIND AND GEOTHERMAL ENERGY TECHNOLOGIES (CASE OF LITHUANIA)

Indicators	Wind power plants		Geothermal heat pump and solar collectors in multifamily building	Solar collectors in district heating system
	4 kW	*10kW*	*126kW*	*7000kW*
Production, MWh	6,8	17,5	185	4500
Domestic capital, 1000 EUR	8.02	21.08	25.01	1380.88
Social insurance, 1000 EUR	0.81	1.51	9.27	119.23
Personal income taxes, 1000 EUR	0.29	0.55	3.46	44.46
New jobs (man months)	2.3	4.2	31.9	409.4

Combination of different types of RES may create a large external effect and make significant impact not only on individual consumers of RES, but on the society as well. Therefore, the benefit from using RES, especially in urban areas, should be evaluated during the decision making process. If direct support is applied for RES or environmental technologies, the impact will depend on the volume of support and the source of funding. For example, if the direct assistance is financed from the state budget, the promotion measures would increase the budget deficit in addition to the positive aspects mentioned above. Therefore, it is essential that the promotion would be cost-effective: the benefits should exceed the negative effects. Inexhaustible types of RES (wind, solar, and geothermal energy) enable greater benefit than the subsidies it might require, while penetration into the market is growing.

Therefore, in the world and especially in the EU countries, many cities are taking initiatives to replace RES fossil fuels with RES technologies and thus greatly improve the living conditions of society cities that are committed over a period of time reaching 100 percent supply of energy from RES. There was a number of attempts to move in this direction. It seems that it requires billions of funds. However, the circular economy theory and facts that are supporting this theory shows that enhanced support and funds are necessary for the initial stage, especially during formation process of information systems. However respect for the environment is rarely considered the unconditional value of business relations. Educational activities are necessary, which would show the connection between human activity and eternal laws of nature. A special role in this process is attributed to smaller cities and rural or suburban communities. It will be a long process of transformation, but this is one of two alternatives: the continued destruction of the natural environment or the circular economy based on the above principles.

The key elements are: the strategic goal set before 2050 to achieve 100% supply of RES. (Lithuania has to provide 23% of final energy consumption by 2020). This means that all RES and energy saving tools find their niche in the overall energy development. The tax policy, which is the main economic element, is characterized by the fact that significant energy taxes on fossil fuels are applied. This makes it possible to compare the competitive capabilities of fossil fuels and RES technologies by eliminating external costs that do not appreciate the use of fossil fuels in financial accounting. One of the key points is that infrastructure is optimally used, for example, centralized heating systems, which ensures a high level of utilization of RES-technologies.

The idea of eco-villages has been analysed since the last decades of the XX century all over the world. Modelling methods were used for resources management and sustainability assessment [33]. The most recent research concentrates on eco-innovations, eco-efficiency and eco-effectiveness, cultivations of eco-sustainability on various social-economic-environmental levels. The investigations also involve the role of eco-cultural diversity, renewable energy in eco-communities and understanding the eco-complexity and ecosystem approach [34].

The principle of ecological movement can be expressed by the quote "think globally, act locally". Progress in solving environmental problems can be achieved more quickly if the principles of our activities and the functions of natural laws system are harmonized. This was the main principle of the development of green settlements. The energy sector of green settlements duplicates the processes in the nature, which is a perfect example of waste-free technology. The volume of waste generated in energy sector can be reduced by increasing the usage efficiency of primary energy sources and promoting the use of RES. The negative impact to the environment can be mitigated through more efficient use of RES in energy sector developed under the circular economy model and bioregional development principles. The use of RES in the regions can create unique environment for resource utilization. The exploitation of energy resources must not exceed the nature's resilience limits otherwise RES can be treated as non-renewable resources. The development of regional energy sector, according to the principles of circular economy, is encouraging the use of a wide range of local and renewable resources.

IV. BALANCING OF RES SUPPORT FORMS BY USING SPATIAL PLANNING METHOD

In the legal system of Lithuania, self-government has been given fairly broad opportunities to participate in the development of energy efficiency and the use of renewable energy resources. The Law on Local Self-Government of the Republic of Lithuania distinguishes between independent functions of municipalities, including the preparation and implementation of municipal planning documents and planning documents implementing them. Thus, municipalities are required to prepare and implement their territorial planning documents and have the opportunity to include in them measures for the development of energy efficiency and renewable energy sources (on the other hand, they also have a delegated function delegated by the Ministry of Renewable Energy

Act to develop renewable energy the resources of the development plan. Municipalities also administer the implementation of the measures of the rural development program in the form of a state-delegated function. However, these documents may only become a routine accumulation of unrelated obligations. Only an organized set of knowledge permits the conversion of these program documents into what their initiators motivate a special purpose - the massive use of RES reclamation.

Exactly the municipalities, according to their responsibilities and functional structure, there are those organizations that could implement RES technologies on a large scale. However, it needs to be understood that the RES project will be one of many parallel programs and will only be figures if the benefits to other related programs at the state and municipal levels are not assessed. One of the major problems with the knowledge economy is the creation of separate programs with different goals and sources of funding.

Different types of RES have a very broad and distinctive scale of use therefore, each renewable requires its own specific support. This topic has been focussed on the potential analysis of wind, solar, and geothermal energy for small scale applications. Every renewable has a wide developing scale of technologies, which is becoming cheaper due to the growth of supply. What is more, every renewable has different significance level in terms of external benefit, thus support schemes can differ significantly. This depends on the environmental situation in various areas. External conditions and current infrastructure, where RES technologies could be applied, differ as well; therefore, spatial planning via urban energy development plans is the most appropriate tool for benefit assessment.

Most countries support RES technologies mainly on the supply side, while existing opportunities to use solar energy at the consumers' side, such as small systems of solar collectors in multi-apartment buildings, are significant as well. Support for the consumers is the most appropriate via support programs (and not by supporting scattered consumers), as it enables achieving actual effect. Renovation of buildings by districts enables planned actions, which could solve technical and financial problems for district heating companies due to reduced consumption.

Application of the schemes mentioned above for small producers increases administration costs and is often not acceptable due to high complexity level. Therefore, territorial administration is needed. The main problem is that the programs for implementation of legally delegated functions have no consolidating unity. This might lead to serious problems: renovation of multi-apartment residential houses would reduce the heat consumption significantly. As a result, the district heating tariffs would increase due to growing fixed heat generation and supply costs.

Although the EU directives and national laws provide for the functions of the municipalities of the Republic of Lithuania in developing software documents for the energy sector in general and for RES-technologies are rather precise, in practice, plans are just beginning to be formed. Having analysed the current laws of the Republic of Lithuania, it is clear that they regulate in a sufficiently detailed manner the responsibilities of municipalities and the development of the use of RES. But the main problem is that separate programs are being developed for the implementation of individual EU directives, which do not have a consolidated unity. Meanwhile, functions such as the Special Needs Planning Development Plan, as well as future Environmental Protection Plans, which are already beginning to plan for the implementation of commitments made under the Paris Agreement, are directly linked to the development of RES, are formed separately. In this way, the financial resources and modest forces of specialists working in municipalities are dispersed. A stable and balanced program with carefully selected subsidizing, enabling the interaction between consumers and heat suppliers, is necessary for solving these problems, as proposed in Figure 4.

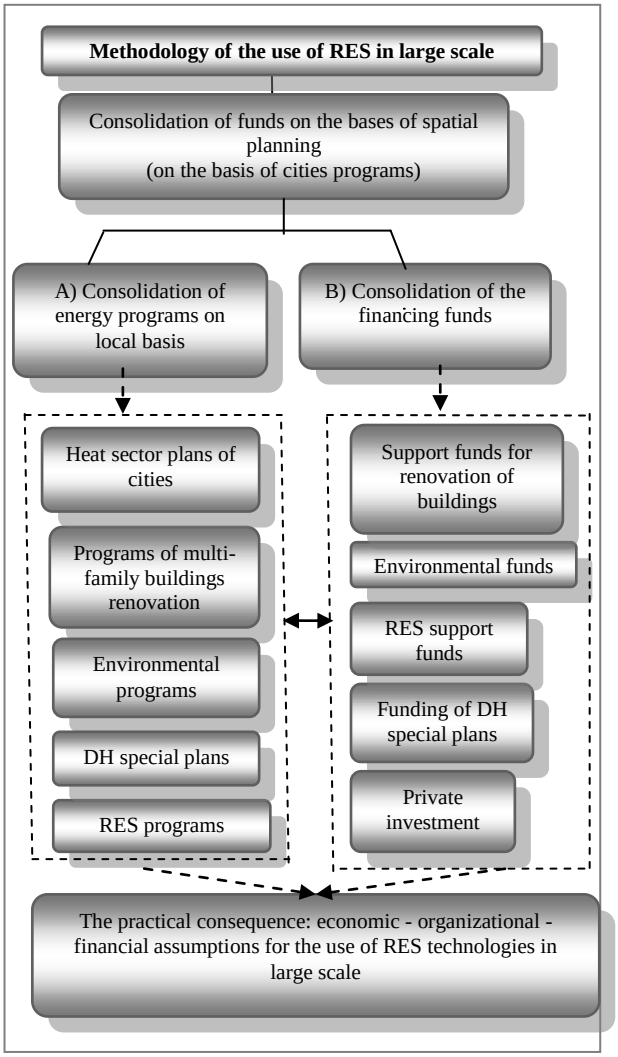

Figure 4. Methodology of the use of RES in large scale.

Periodization of economic age and assessment of various RES support forms, with regard to the specifics, has

different goals and tasks from the macroeconomic perspective.

There are two blocks of local programs and financing sources, which are to be described: A) and B).

A. Consolidation of cities energy programs on the uniform basis of knowledge economy

Lithuanian legal system of self-government has granted fairly broad opportunities to participate in increasing energy efficiency and development of renewable energy. Law on Local Self-Government in Lithuania distinguishes independent functions of municipalities, such as preparation and implementation of municipal strategic planning documents and planning documents implementing them. Law on Energy from Renewable Sources initiates preparing local RES development plans. Municipalities also administer the implementation of measures of Rural Development program such as carrying out the delegated function of the State. Law on Local Self-Government establishes that municipalities organize the heat supply within their territory. Law on Heat Sector regulates the special planning of heat, which is one of the implementation mechanisms of those obligations. In addition to broad responsibilities for the preparation of planning documents, the role of municipalities has been reinforced for renovation (modernization) of multi-family buildings in recent years.

The need for single energy policy formation with an economic support system for RES (as one of the compounds) has been notified for several years already.

Through the INTERREG RUSE project, we had the opportunity to get acquainted with examples of dozens of countries in the field of good practice in RES-industry. Particularly noteworthy is that the best results are achieved when municipalities play an active role in the field of implementation of RES projects. Several key moments are typical and characteristic: (a) the adoption of RES-technologies is a key element of all environmental programs; b) state-owned funds can use cities for environmental protection according to the extent to which they plan to acquire RES-technologies: c) households are one of the most important objects in the installation of low-power RES-equipment.

This process has been going on for a long time and is not just a declaration and not just declarations. In parallel, in the world, and especially in Europe, long-term programs are being developed and implemented in order to ensure that cities and regions receive energy from purely RES-technologies. There are about 40 such cities in Germany. It is worth noting that all cities that have announced these ambitious plans are focusing on a wide variety of R & D and the development of smart grid technologies. It would seem that this requires billions of EUR, but the theory of circular economics and the evidence of this theory show that more support and resources are needed at an early stage. Consolidation of programs according example presented in Figure 5 would be a good solution as RES have a significant impact on various aspects and especially in the formation of consolidated financing fund program.

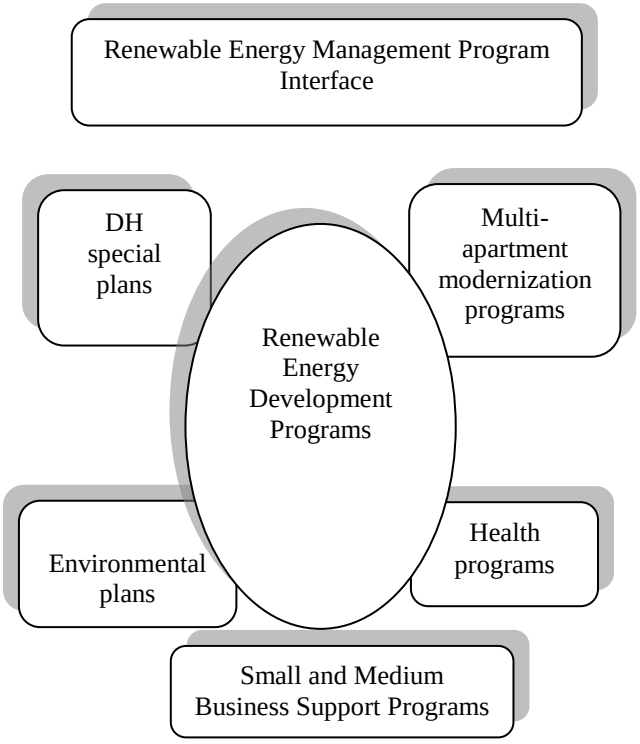

Figure 5. Renewable Energy Management Program Interface.

Such program consolidation might be organizational and the integration of RES technologies could be financed using Structural Funds simultaneously solving the tasks of other related programs.

They continue to become a normal business, except that respect for nature is rarely seen as an unconditional value in business relationships. Educational activities are needed that would demonstrate that the link between human activity and the eternal laws of natural evolution, which supports human viability, is interrupted. Particular role in this process is attributable to cities and smaller rural or suburban communities. And although this will be a long process of transformation, it is one of two alternatives - either further destruction of natural environment or the adoption of economy that would operate in circular economies.

B. The second block shows consolidation of the financing funds program for sustainable development.

It is necessary not only to foresee the results that are expected in the use of RES but also to form the best prerequisites and financial resources that it would be possible to realize positive external effects. However, considering the possibility of incorporating efficient use of resources and RES into planning documents of municipalities, there is an issue of financing. Independent functions of municipalities, including implementation of the program documents, are funded from local budgets. These funds are limited; therefore, it is difficult to expect a decision of allocating funds to these areas on a larger scale.

Therefore, the main role of municipalities is organizational, which would allow mobilizing larger resources. A special issue is lack of energy specialists who could prepare complex programs.

Scattered generation character and the fact that most of these installations can be implemented on demand side are left for private initiative. In order to involve hardly competing energy sources, the institution for investment management is required. Municipalities could act as institutions seeking for the development of wide scale RES technologies. Actual legislation in Lithuania shows that municipal powers and responsibilities regarding RES are regulated in detail. There are no barriers, except financing issues for the actions of municipalities. Some of them have signed the Covenant of Mayors; some have adopted RES development action plans, however, only a few of them are actually acting.

The promotion of RES on wider scale was implemented in EU by creating green settlements or the so-called eco villages [35]. For example, the state funded project Climate Menu in Netherlands, which enabled towns to select sectors which needed exceptional attention in order to meet national obligations. Environmental policy is implemented by towns, where the best possibilities are concentrated and problems are the most visible.

However, when considering the possibility of including efficient resource use and RES in municipal planning documents, there is a question of financing. The implementation of autonomous functions of municipalities, including the implementation of program documents, is financed from municipal budgets. These funds are limited, so it is difficult to expect decisions to spend on these areas at a wider scale. The functions transferred by the state to municipalities are financed from the state budget or state funds and transferred to municipalities as a special targeted grant. In any case, financial resources can only be very modest and dispersed according to individual programs, which is why the central role of city authorities is organizational, which would allow mobilization of larger resources. A particular problem is the lack of energy specialists who can develop complex programs.

Therefore, the most important prerequisite for solving financing issues may be the public-private partnership - long-term cooperation between the public sector body and the private-sector partner in the implementation of the complex of activities (for example, the design, construction, reconstruction, repair and maintenance of the infrastructure). However, in our opinion, this concept needs to be extended to the justification for financing sustainable urban development programs, consolidating and managing the funds on this basis for implementation of the program. In the field of financing RES, it is possible to use examples of various regional and even global partnerships. They play an important role in financing the RES sector in developing countries (Figure 6). Financial resources of the private sector for RES projects implementation have become attractive in the last few decades.

This diagram shows how cities can form consolidated funds on a public-private partnership basis. For this, essential conditions are required - the formation of city information systems and programs that are required to be drawn up by law into a long-term integrated urban sustainable development program that synchronizes and duplicate individual short-term plans.

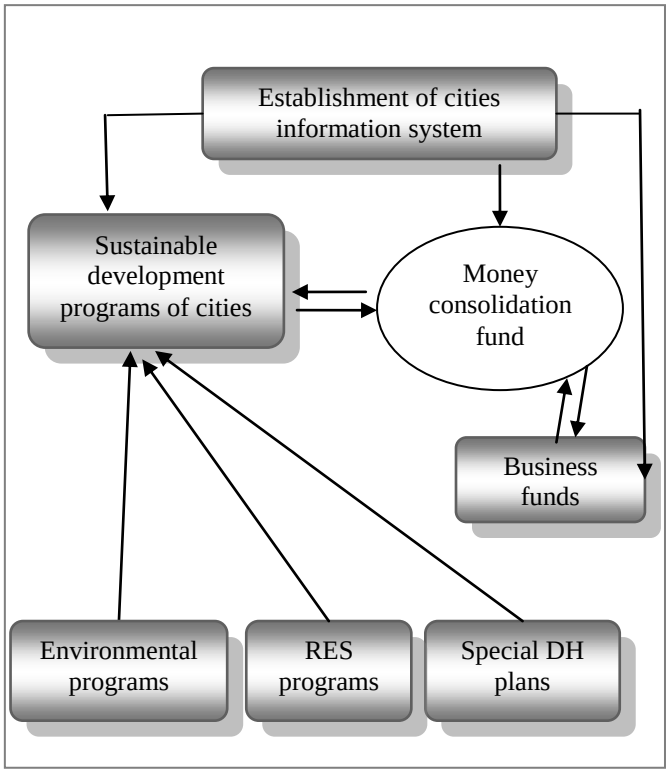

Figure 6. Financing opportunities system for RES technologies in Lithuania

In general, environmental programs in all parts of the world are based on wider use of RES, and the centralized heat supply plans could become the most rational instrument for combining various renewable energy projects into a coherent system, both on production and on the consumer side.

These financial resources are used in the public sector for infrastructure construction and maintenance purposes as well as for industrial equipment installation. However, examples of developing countries show that RES sector funding by using internal private financing channels are limited. Liming and Behrens distinguish several reasons why the involvement of the private sector is insufficient:

- investments in the RES sector have characteristics of public goods (i.e., costs and benefits are not always experienced by the same economic entity);
- developing countries do not have effective legal regulation of environmental sector;
- initial capital costs of RES technologies are high;
- there are additional risks caused by long payback period of technologies;

- higher than normal investment risks (such as market and currency risks) require a higher return on investment in developing countries;
- transaction costs of small and medium-sized projects are relatively high.

Therefore, the aforesaid reasons are due to the fact that RES sector is not always attractive to private investors in developing countries. In order to attract private sector investment, it is recommended establishing public-private partnerships. Moreover, the use of existing measures is recommended.

Figure 3 shows that cities can form consolidated funds on the principle of public-private partnerships. This requires fundamental conditions, such as forming cities' information systems and programs, which are mandatory by law, into the long-term unified urban sustainable development program that will synchronize and avoid duplication of individual short-term plans. Basically, environmental programs in all countries of the world are based on a wider use of RES, and special DH plans could become the most rational measure combining various RES projects into the unified system on both production and consumer sides.

The role of Government in financing RES sector is ambiguous because the role of Government is highly dependent on economic, social, and political environment. Thus, the role of Government in financing RES sector could be both active and passive. The Government solves problems of energy security and access to energy, job creation, improving the competitiveness and economic growth; RES sector could greatly contribute to resolving such problems. Therefore, the Government in this case actively participates in financing RES sector. There are several reasons why the Government takes active role in RES sector. Firstly, the Government financial support allows filling in the gap between the private sector's supply of investment and demand for investment. Secondly, the Government understands that the social return of investments in the RES sector is significantly higher than the private (individual) return. As a consequence, the Government increases social returns by creating economic incentives for investors. Some authors emphasize that governmental funding remains the most important source of funding RES sector in developing countries. Active role of the Government starts during implementation of national programs, providing subsidies, soft loans, loan guarantees, and tax incentives. The Government assistance with a mobilizing investment of private sector into RES sector has been increasing in recent years.

Partnership advantages are that the risks of implemented project are distributed among partners, according to their abilities to manage risks. Moreover, public-private partnerships ensure necessary investments in the public sector;

- ensuring timely and better quality public services;
- in many cases, projects are implemented on time and does not require additional unforeseen public expenditures;
- private sector entity is given an opportunity to ensure long-term income;
- during implementation of projects, private sector skills and experience are used;
- proper allocation of risks allows reducing costs to control them.

  Of course, there may be disadvantages, such as developed infrastructure, or services could be more expensive;
- delaying public sector payments of the partnership project to the future it could be adversely affected subsequent periods of public sector fiscal indicators;
- purchase of services through partnership takes longer and is more expensive compared with traditional public procurement;
- partnership projects are long-term, complex and relatively inflexible contracts because it is difficult to predict and assess all factors which may affect the future performance of the envisaged activities.

V. CONCLUSION

A particular obstacle to the widespread use of RES is the lack of evaluation of the benefits to society (reduction of pollution, energy supply of the future for generations, huge and never-ending potential of energy resources such as solar, wind energy) when introducing RES-technologies. Therefore, when formally calculating, RES-technologies are not sufficiently competitive compared to fossil-fuel technologies. This work deals specifically with the problem of the impact of RES-technologies.

There are controversial phenomena, especially in the heat sector, where huge disproportion of used RES has appeared. Unreasonably huge role is assigned to biomass in usage projections of RES. Biomass is an energy resource that is the result of economic activity and depends on continuity of economic activity. Meanwhile, the use of an inexhaustible solar and geothermal energy potential is absolutely insufficient.

The analysis of positive and negative impact of the use of RES on research in Lithuania and other countries has shown that major part of the positive impact of the development of RES is related to GHG and other pollutant emissions, job creation and rural development, increase in employment in the regions, the reduction of heat prices and the lower emissions of some fossil fuels. Investigation has allowed the formation of a targeted, reliable methodology compatible with the status of existing statistical information.

Each RES has a different value in terms of external benefit, thus respective promotion schemes can and must differ significantly. This depends on the environmental situation in certain area. External conditions and current infrastructure for RES technologies differ, thus spatial planning, such as urban energy development plans, is the most appropriate tool for the benefit assessment.

More and more scientists say that decisions are needed in this area by territorial units. The key issue is, in the long term, to achieve the possibility that different types of RES would find a niche in the long run, which basically means

the stability of energy prices and the assurance of all elements related to sustainable development. In essence, this means consolidating the knowledge system into an effective set of practical implementation.

The methodology, which is based on spatial planning, identifies certain aspects that usually are not covered by routine investment evaluation techniques, namely, the existing problems in cities: high atmospheric pollution, unemployment, etc., may determine validity conditions that allow interpolating results to assess technology for spatial energy planning for solving problems mentioned above. Combination of different types of RES may create large external effect and make a significant impact not only on individual consumer of RES, but on the whole society as well. Therefore, the benefit from using RES, especially in urban areas, should be evaluated during the decision making process.

Urban programs should be the main form for consolidation of investment funds and promotion on the basis of possible rational use of investment as a complex macroeconomic effect can be measured and achieved on the territorial basis.

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