IK “eBIOpower”

PRELIMINARY

ON THE POSSIBILITIES OF IMPROVEMENT OF ENERGY EFFICIENCY AND USE OF RENEWABLE ENERGY RESOURCES IN MĀRUPE DISTRICT.

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SUMMARY

The aim of the present study is to identify the solutions for improvement of energy efficiency and the use of renewable energy applied and economically feasible in Latvia. The assessment of the feasibility of such solutions and their conformity with the development requirements of Mārupe district and the identification of the feasibility of the implementation of reviewed solutions within the framework of the pilot energy project of communities in Mārupe district.

The first chapter of the study provides the general description of the progress of the European Union (hereinafter referred to as the EU) and Latvia towards less carbon intense economy and the expected changes in the national policy and requirements regarding the energy supply of the municipal sector and the residential sector. The assessment of the energy efficiency of the housing stock and public buildings of Mārupe district and the assessment of their development is provided. The Second Chapter of the study provides the assessment regarding possible technical solutions for the use of renewable energy resources, the evaluation of the strengths and weaknesses of Mārupe municipality in the area of the introduction of RER and energy efficiency is performed. The Third Chapter defines the priorities of development of the energy sector in Mārupe district, summarises the preconditions for the development of the area and reviews the possible financial instruments. The Fourth Chapter of the study assesses the possibilities of creating communities in Mārupe district to ensure that the community would jointly implement a project for power generation and/ or heat production by using renewable energy resources, assessed the possible solutions within existing defined communities of residents.

The study on energy efficiency and the use of renewable energy in Mārupe district was performed by IK “eBIOpower” by involving the industry experts. The representatives of Riga Planning Region and the local government of Mārupe, the residents of Mārupe, the representatives of the Solar Energy association, the industry experts and the researchers of Riga Technical University. In addition to the above, during the development of the study two meetings of experts and one meeting with residents was organised in order to discuss and to promote the use of various solutions of renewable energy resources in Mārupe district and Latvia as a whole.

Conclusions: In Mārupe district there is a high potential for the introduction of new RER's and the replacement of the existing fossil fuels. The fossil fuel natural gas is currently widely used, however, the use of fire wood is also widespread and in the territory of the municipality several new RER technologies have been installed and serve as the best practice examples.

Due to the high population density, in the territory of Mārupe there is a high potential for creating energy efficiency and energy independence communities. There are legislative obstacles for the broader use of RER by households and the implementation of community projects and also the negative historical experience of forced collectivization has been maintained. The introduction of RER technologies and the improvement of energy efficiency in the communities of residents is not sufficiently widespread and promoted in Latvia, however, this can be changed. The

creation of energy communities should be encouraged at the municipal and national level.

It is recommended to use solar panels and solar collectors as the most appropriate solution for the implementation of the community pilot energy project at Mārupe district. It is recommended to implement several pilot projects by utilising various technologies in order to provide a broader best practice example for the potential implementers of community projects.

INTRODUCTION

The present report has been prepared within the framework of the project “Co-producing and co-financing renewable community energy projects” (Co2mmunity) (http://rpr.gov.lv/project/co2mmunity/).

The present report has been prepared in compliance with the contract "Performance of the preliminary study regarding the current situation in the area of energy efficiency and the use of renewable energy resources within the framework of development of the community energy pilot project in Mārupe distric" signed on 28 June 2019 between Riga Planning Region and the individual merchant“eBIOpower” (ID T/RPR/2019/Co2mmunity-2).

On 15 December 2011 the European Commission approved the European roadmap about how the greenhouse gas emissions in Europe should be reduced to 80-95% below 1990 levels by 2050 (Energy Roadmap/ *COM2011/0885). In 2019 the plan of development of low carbon economy of Latvia was developed under the supervision of the Ministry of Economics of Latvia, in particular, the "National Energy and Climate Plan 2021-2030" (hereinafter referred to as NECP 2030) aimed at moving towards the low carbon economy in Latvia in compliance with the guidelines defined by the EC.

In order to attain the goal of reducing greenhouse gas emissions in Europe to 80-95% below 1990 levels, the use of RER in power generation and heat production should be considerably increased, the improvement of energy efficiency, the use of various smart technologies on daily basis should be encouraged and various electrical means of transportation should be selected. In addition to the above, legislative amendments, more efficient possibilities of combining the RER systems with the common grid, the introduction of energy efficiency requirements and other solutions are needed, which would jointly contribute to the movement of Latvia towards the low carbon economy.

Broader production and more active use of RER at the household level today faces a few practical drawbacks, like non-conformity between the production and consumption, the lack of production capacities in case of unfavourable weather conditions and other details. Many of identified deficiencies can be solved by the creation of communities in the area of the use of RER.

In Mārupe district there are good preconditions for creating energy efficient communities, for example, there are restricted land areas, as the land is expensive and cooperation is necessary, there are active associations at some apartment houses, the level of paying capacity and education of residents is above the mean level in Latvia which indicates better awareness of the investment of financial resources in the equipment of energy efficient technologies.

DEFINITIONS

Community - a group of people living at the same place or united by common origin, affiliation, interests, etc. A group of countries involved in a certain union (for example, the European Community).[1]

Energy efficiency community – a community joining a group of people with a common interest in the introduction of energy efficiency measures.[2]

Energy independence community - a community joining a group of people with a common interest to introduce alternative (most often, renewable) energy resources for complete or partial satisfaction of their energy consumption.[2]

Energy Roadmap - the action plan approved by the EC on 15 December 2011 for the action of the EU Member States for reducing the greenhouse gas emission to 80-95% below 1990 levels by 2050.

National Energy and Climate Plan 2021-2030 (NECP[3]) - the policy planning document defining the goals of Latvia and the measures for their attainment in the following fields or actions: the reduction of greenhouse gas emissions and the increase of carbon dioxide capture, the increase of the proportional share of renewable energy resources, improvement of energy efficiency, provision of energy security, maintenance and improvement of the infrastructure of energy markets, as well as the improvement of innovation, research and competition.

Nearly zero energy building - the total consumption of primary energy for space heating, hot water production, mechanical ventilation, cooling, lighting amounts to maximum 95 kWh per square meter per year.[4]

Micro network - a micro network is a set of mutually connected smart energy consumers, controllable loads, decentralised energy sources and energy accumulators limited by the boundaries of the low voltage power network. The set operates as the independent, controllable environment and is able to operate both in a synchronous mode with the network of the distribution system operator and in an independent "island" type mode.[5]

Renewable energy resources (RER) - renewable sources of energy (wind power, solar power, hydroelectric power, ocean energy, geothermal energy, biomass and biofuels) are alternatives to fossil fuels that contribute to reducing greenhouse gas emissions, diversifying energy supply and reducing dependence on unreliable and volatile fossil fuel markets, in particular oil and gas[6]

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[1] Ekonomikas skaidrojošā vārdnīca. [Dictionary of Economics] R.: Zinātne, 2000.
[2] The definition proposed by the authors.
[3] https://em.gov.lv/lv/nozares_politika/nacionalais_energetikas_un_klimata_plans/
[4] https://likumi.lv/doc.php?id=258322 (17.pants)
[5] The definition by the IEEE organisation (https://smartgrid.ieee.org/images/files/pdf/IEEE_QER_Microgrids_October_3_2014.pdf)
[6] http://www.europarl.europa.eu/factsheets/lv/sheet/70/atjaunojamie-energoresursi

1. DESCRIPTION OF THE CURRENT SITUATION IN THE AREA OF IMPROVEMENT OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

1.1. Changes in the policy of the European Union and Latvia in the area of the improvement of energy efficiency and renewable energy

On 15 December 2011 the European Commission approved the European roadmap about how the greenhouse gas emissions in Europe should be reduced to 80-95% below 1990 levels by 2050 (Energy Roadmap/ *COM2011/0885). According to the roadmap and the actions defined therein, during the time period until 2050 the European energy policy will change regarding energy production, efficient energy consumption, the use of renewable energy resources and other areas which affect or cause greenhouse gases. The European future development goals are directed towards energy decarbonisation (the minimum use of energy production resources producing greenhouse gases), the increase of the role of electricity in the consumption, the introduction of energy saving, combining of decentralised and centralised energy production systems. The above list of the directions of action is not exhaustive, however, these are the major ones defining the energy areas and the change of the use of energy in Latvia in the near future.

The European Commission recommendations to Latvia strictly advise to increase the RER contribution of Latvia to minimum 50% of the final consumption. The EU legislation does not define a separate goal in the electricity sector. Latvia plans to increase the share of RER in electricity up to minimum 60% during the period until 2030.

In the heat supply and cooling supply sector Latvia plans to secure the annual mean increase stipulated by Article 23.2 c) of Directive 2018/2001 by 2030, i.e. to increase the share of RER in heat supply and cooling supply by minimum 0.55% every year.

In the transportation sector Latvia envisages the increase of the share of RER of minimum 7% in 2030 by securing this both by the use of modern biofuel and biogas[7], and also by encouraging the use of electricity in transportation.

Table 1.1

Goals of the Latvian policy of RER use and their result indices

Policy result in the subdimension of the RER energy of the decarbonisation dimension	**Actual value**	**Target value**[8]				
	2017	**2020**	**2022**	**2025**	**2027**	**2030**
Share of RER in the energy end consumption (%)[9]	39.01	40	**41.8**	**44.3**	**46.5**	**50**[10]

[7] Modern biofuels produced from the raw materials referred to in Annex IX to Directive 2018/2001, for example, algae, straw, manure or waste water sludge, glycerine, etc.

[8] The current goals defined by the mandatory EU legislation, other policy planning documents or legislation of Latvia are presented by the normal font and the mandatory goals to be defined are presented in bold.

[9] The indicative values of target indices of 2022, 2025 and 2027 are defined in compliance with the conditions contained by Article 4(a) of Regulation 2018/1999.

Taking into account the European energy roadmap 2050, Latvia has developed its program and strategy for low carbon development up to year 2050[11]. The strategy has been developed in compliance with the European roadmap by setting tasks for successful attainment of the targets. The strategy defines the interim targets to be attained by 2030 and 2030 as well as solutions for securing low carbon development.

Considering the Latvian National Strategy for Development of Low Carbon Economy until 2050, the Latvian plan of development of low carbon economy, in particular, the "National Energy and Climate Plan 2021 - 2030" (hereinafter referred to as the NECP 2030) was developed by the Ministry of Economics in 2019. This is the medium term policy planning document defining the goals to be attained by Latvia and the directions of actions: the reduction of greenhouse gas emissions and the increase of carbon dioxide capture, the increase of the proportional share of renewable energy resources, improvement of energy efficiency, provision of energy security, maintenance and improvement of the infrastructure of energy markets, as well as the improvement of innovation, research and competition.[12]

The action direction Energy Security and Internal Energy Market defines the following priority actions:

1) Improvement of energy efficiency in buildings. Improved energy efficiency in buildings will reduce energy consumption and also energy dependence caused by energy import resulting from the energy demand;

2) Improvement of energy efficiency and promotion of the use of RER technologies in heat supply, cooling supply and industry. The decrease of the energy consumption resulting from the improvement of the efficiency of district heating systems will contribute to energy independence;

4) Promotion of economically reasonable self-production and self-consumption of energy. The promotion of self-production and self-consumption is possible by means of using smart energy meters which, in turn, provide the opportunity for aggregators to join the market;

5) Improvement of energy efficiency, promotion of the use of alternative fuels and RER technologies in transportation. The fuel used for transportation is currently being imported, therefore the reduction of consumption improves the energy independence of the country.

The above referred actions are reviewed as priorities for the solutions proposed by the present study for improvement of energy efficiency and the use of renewable energy sources in Mārupe district, including in community projects.

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[10] The strictly advised target value by the EC recommendations (https://em.gov.lv/files/attachments/lv_rec_lv.pdf).

[11] http://www.varam.gov.lv/in_site/tools/download.php?file=files/text/Likumd/_projekti/KLIMATS//OMA_2050_15122017.pdf

[12] https://em.gov.lv/lv/nozares_politika/nacionalais_energetikas_un_klimata_plans/

1.2. Description of the residential and public fund at Mārupe district.

In 1990 there were ~5000 residents in Mārupe district and in 2018 their number has increased to ~22 000 residents. In 1990 there were four small densely populated territories and also several farmsteads in Mārupe district. The densely populated areas had both formed historically in residential areas close to Riga (Tīraine, Mārupe), created artificially for providing for the operation of the collective farm (Jaunmārupe) and created artificially as a new residential area for the technical personnel and flight personnel for providing for the operation of the international airport "Riga". These are the centres forming the basis for the development of current Mārupe district. In these centres there are the only apartment houses in Mārupe district built according to the building standards of the Soviet Union and the construction materials available there when there were no energy efficiency requirements. Therefore the 53 apartment houses in these settlements should be considered the ones where the implementation of energy efficiency measures would be possible with high efficiency, thus reducing the total energy consumption of these houses. Energy efficiency measures have been implemented in some houses (7 apartment houses).

The time period from 1990 to 1995 was the period of major change and inclarity when there was no considerable development of the housing stock. The houses built after year 2000 are characterised by considerable better energy efficiency. In addition it should be mentioned that during the time period from year 2000 more than 40 new apartment houses have been built in Mārupe district, and the number of newly built detached houses (including terraced houses) has increased by more than 4000 houses. The construction materials and energy efficiency of all these houses differs, however, it is much better than that of the houses built before 1990.

In Mārupe district the housing stock accounts for a major share of the total energy consumption, therefore it is necessary to consider or to set particular requirements to ensure that the reconstruction and renovation of houses would comply with the requirements of zero energy or nearly zero energy houses[13]. According to regulatory enactments, all the residential houses and other non-residential houses built in Latvia after 1 January 2021 will have to comply to the requirements of nearly zero energy houses.[14]

Public buildings (state or state administration authorities) have to comply with the requirements of zero energy houses as from 1 January 2019. The concept of a nearly zero energy house has been incorporated in the requirements of Council Directive 2010/31/EUR on energy efficiency of buildings.

It can be expected that Mārupe will not lose its attractive properties for choosing it as the place for living and the number of population and houses will continue growing as a result. Considering the development of the territory planning documents of Mārupe district, further development of Mārupe district both horizontally (by expansion of the current construction territories on the account of not constructed territories) and

[13] Strategy for the Latvian low carbon development, page 27
http://www.varam.gov.lv/in_site/tools/download.php?file=files/text/Likumd/_projekti/KLIMATS//OMA_2050_15122017.pdf

[14] Cabinet Regulations No. 383 (9 July 2013) “Regulations on the Energy Certification of Buildings"

vertically (by maintaining the current not constructed territories and at the increased demand for housing, the number of apartment houses will increase) is possible. Irrespective of which scenario of the housing development prevails, the energy efficiency demands for the construction materials of apartment houses and detached houses will be high and will conform to the requirements of nearly zero energy houses.

Also companies and manufacturing premises are important heat energy consumers in Mārupe district. Favourable working conditions are also ensured in the buildings of this type and these are related to the adjustment of the micro climate and the consumption of energy resources for providing it. The office buildings and the actions performed there for securing the necessary comfort level can be considered similar to the above described segment of apartment houses, however, the manufacturing premises are different due to the scope of manufacturing there. In the course of designing manufacturing premises, the heat produced during the manufacturing process is taken into account, resulting in possibly different requirements for the control of the micro climate in each manufacturing building. It would be important to achieve that also in the course of constructing such buildings the heat capacity of the building is considered and funds are not saved on the account of using appropriate energy efficient materials.

1.3. Evaluation of the currently utilised energy sources in Mārupe

The local governments in Latvia are not obliged to create and to maintain common data about the energy resources used in the territory of the municipality, their origin and distribution. On the national level the energy balance data (information about the production, import, export and consumption of energy resources in the country) are collected by the Central Statistics Bureau[15]. It can be assumed that the split of the consumption of energy resources in Mārupe district is approximately similar to the split of the consumption of energy resources in the country, see Figure 1.1.

[15] https://www.csb.gov.lv/lv/statistika/statistikas-temas/vide-energetika/energetika/tabulas/metadati-energobilance

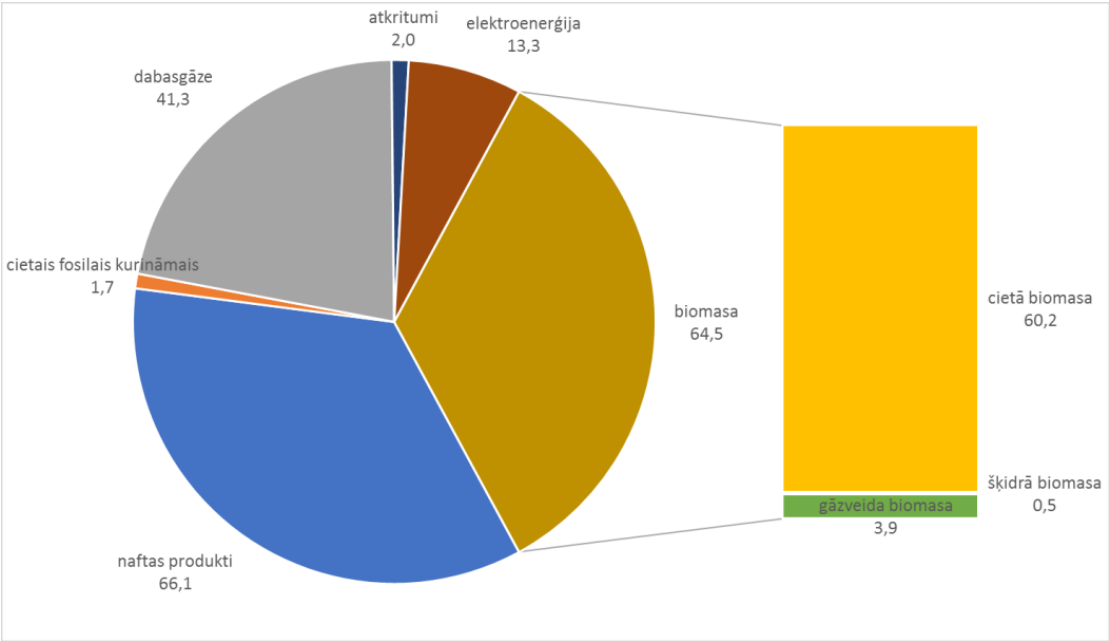

Figure 1.1 - Consumption of primary energy resources in Latvia, 2017

[pie attēla: electricity; biomass – solid biomass; liquid biomass; oil products; solid fossil fuel; natural gas; waste]

It can be seen that fossil energy resources, in particular, oil products, natural gas and solid fossil fuel, prevail in the consumption of energy resources. It can be considered that the distribution of the consumption of primary energy resources is even.

In Mārupe district there are some heat producers related to the above described historical construction in Mārupe district. The biggest volume of heat in Mārupe district is produced by SIA "Mārupes komunālie pakalpojumi" [Mārupe utility services] (three independent systems in Tīraine, Mārupe and Skulte) and SIA "Sabiedrība Mārupe" (apartment houses and greenhouses in Jaunmārupe). Natural gas is used for operating three systems and it provides heat and hot water production for 32 apartment houses. Wood shavings, which is a renewable energy resource, and peat, which is a fossil energy resource, are used for heat production for 12 apartment houses in Tīraine. In order to provide continuous and economic operation of the boiler house of Mārupe settlement, a new gas-fired heating boiler was purchased for its upgrade in 2018 and its connection to the system is envisaged in 2019.[16]

In apartment houses built after year 2000 there are different technical solutions for providing heat supply, however, all of them are related to the use of natural gas for heat production. Considering the common trend for providing heat supply to newly constructed houses in Mārupe, it can be concluded that a large part of the necessary heat is produced by burning natural gas.

In Mārupe district there is the infrastructure of natural gas and its maintenance is provided by SIA „GASO". In the territory of Mārupe district and in the operational area of Riga district of SIA „GASO" there are:

[16] AS "Mārupes komunālie pakalpojumi", Medium term operational strategy 2015 - 2020. Version: 15 November 2018

• high pressure (P<1.6MPa, P<1.2MPa P<0.6MPa) distribution gas pipelines and the related equipment;

• medium pressure (P<0.4MPa) distribution gas pipelines and the related equipment;

• GRP-105 and GRP-96.[17]

Unfortunately, it is not possible to receive the accurate data about the natural gas consumption in Mārupe district from SIA "GASO". However, taking into account the above provided information about the gas networks, it can be concluded that a large amount of the produced heat in Mārupe district is produced by burning fossil fuels creating greenhouse gases. The plans of development of heat supply systems in Mārupe also provide for the development of the technologies using fossil fuels. This approach does not conform with the environment policy goals defined by the European Union and Latvia. In order to achieve the goal of discontinuing the use of fossil energy sources by households set by the EU, all the households in Mārupe district will have to give up using natural gas during the time period until 2050. The way of implementing this and covering the costs of transformation of the energy supply system is the question for the state policy of the near future. The use of alternative types of gas (biogas, biomethane, hydrogen) for providing fuel is one of the feasible solutions for using the existing gas supply system to be considered.

1.4. Assessment of the energy efficiency of the municipal buildings in Mārupe

In Mārupe district there are 20 different public buildings, in particular, kindergartens, day centres and public buildings. Some of them have been constructed or reconstructed recently. According to the information provided by the administration of Mārupe district regarding the energy capacity or energy consumption of public buildings their energy consumption (space heating, electricity, hot water) ranges from 51.0 to 237 kWh/m2/year. In compliance with the requirements of the EU Directive, the buildings constructed after 31 December 2018 where state authorities are located and which are owned by state authorities should conform with the requirements of nearly zero energy buildings (Directive of European Parliament and Council 2010/31/ES (19 May 2010) on energy efficiency, Article 9). The requirements of the Directive are incorporated in the legislation of the Republic of Latvia in Cabinet Regulations No. 383 (9 July 2013) "Regulations on Energy Certification of Buildings".

In compliance with the Law on Energy Efficiency of Buildings the energy efficiency of a building is a relative amount of energy describing the consumption of energy needed for space heating, ventilation, cooling, lighting and hot water supply of the particular building under the operating conditions characteristic for the type of the building. The energy efficiency of a building is expressed as kilowatt hours per square meter per year (kWh/m2/year). A building can be classified as a nearly zero energy building if its consumption of heat amounts to 40 kWh.m2/year and the total

[17] Development of guidelines for further development of Riga city engineering infrastructure (Volume 7 - Gas supply), SIA „Aqua-Brambis", 2009

consumption of primary energy for space heating, hot water production, mechanical ventilation, cooling and lighting amounts to maximum 95 kWh/m2/year.

Cabinet Regulations No. 383 (9 July 2013) "Regulations on Energy Certification of Buildings" define the comparative evaluation scale of energy efficiency comprising five energy efficiency categories of residential buildings, namely, A, B, C, D, E and F, see Figure 1.2.

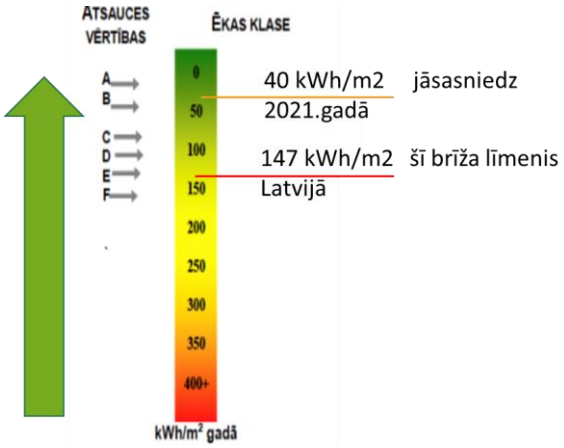

Figure 1.2 - Attainable energy efficiency indices defined for residential buildings[18]

[pie attēla: atsauces vērtība – reference value; ēkas klase – building category; jāsasniedz 2021. gadā – to be attained in 2021; šī brīža līmenis Latvijā – current level in Latvia]

The Cabinet Regulations define the minimum permissible energy efficiency level of buildings for the buildings to be reconstructed or renovated:

1) for apartment houses - the energy efficiency index for space heating does not exceed 90 kWh per square meter per year;

2) for residential houses consisting of one or two apartments - the energy efficiency index for space heating does not exceed 100 kWh per square meter per year.

During the development of the study information was received about the consumption of energy resources by 20 different public buildings in Mārupe district. In the result of the assessment of the above data it can be concluded that the total consumption of energy resources ranges from 51 kWh/m2 per year up to 300 kWh/m2 per year. The lowest energy consumption refers to a single-storey houses built or reconstructed during the last years. The highest energy consumption refers to old buildings which have not been reconstructed and to the sports complex. See the detailed analysis of energy consumption in Annex 2.

Considering the set energy efficiency targets in relation to the construction of new buildings, it should be recommended to Mārupe District Council to define internal goals regarding the attainment of the energy efficiency targets of existing buildings. It

[18] https://www.em.gov.lv/lv/nozares_politika/majokli/eku_energoefektivitate/

would be expensive to attain the nearly zero energy level in the existing buildings, therefore different attainable targets need to be defined. The attainment of the minimum energy consumption of apartment houses amounting to 90 kWh/m2/year as defined by Cabinet Regulations No. 383 (9 July 2013) "Regulations on Energy Certification of Buildings" could serve as one of such goals. If attraction of co-financing for renovation of buildings is successful, a more ambitious goal could be set, for example, attaining the energy efficiency of buildings equal to 75 kWh/m2/year. If the buildings of this type are combined with alternative energy production solutions (for example, solar panels) this would bring them closer to the status of nearly zero energy buildings. In compliance with the information provided by Annex 2, the mean energy consumption exceeds 75 kWh/m2/year in 17 buildings out of 20 in Mārupe district. According to the expected savings over a period of 10 years, it is possible to estimate the economically efficient investment amount for each of the buildings.

2. USE OF RENEWBLE ENERGY RESOURCES

2.1. Assessment of the current situation of the use of renewable energy resources

Fire wood (fire wood, timber waste, wood chips, wood briquettes, wood pellets) and hydro resources are the main types of RER in Latvia. The share of RER in the total consumption of energy resources amounted to 35.2% in 2018. Fire wood is the most used RER in Latvia and accounts for 80% of the RER consumption.[19] See the distribution of RER consumption per types of energy resources during the period from 2010 to 2018 in Figure 2.1.

From the above Figure it can be seen that fire wood is the prevailing RER in this country. According to experts' assessment the distribution is similar also in the territories with no gas supply in Mārupe district. The share of the RER in the form of fire wood is essential, however, a major impact on the use of fire wood is caused by the fact that gas supply is provided in the territory of Mārupe district and residents use gas heating for the sake of convenience.

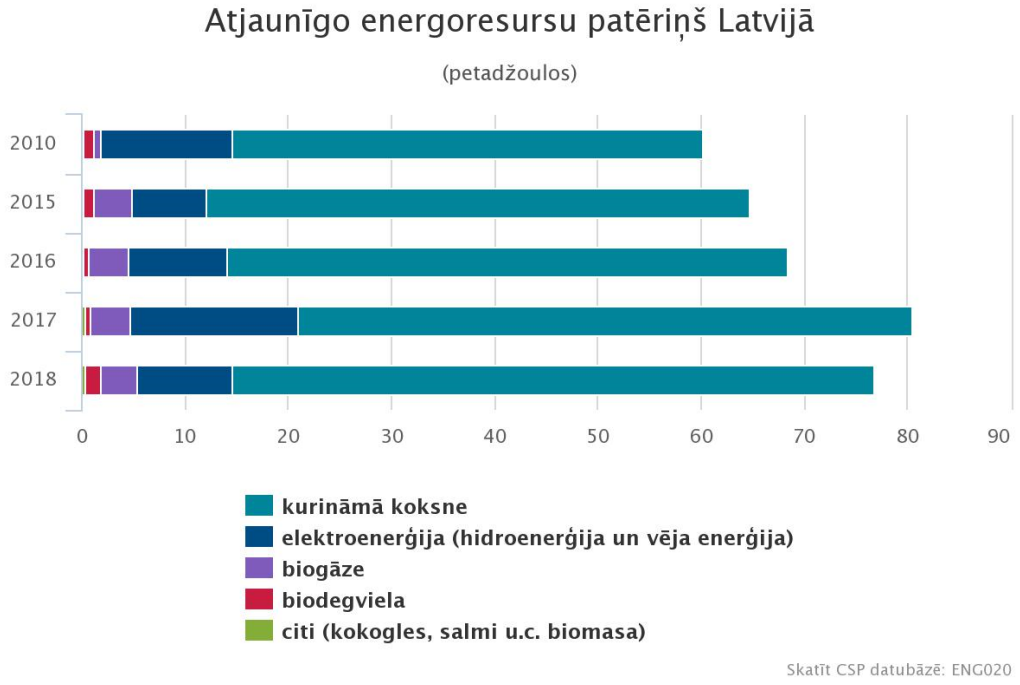

Figure 2.1 - Distribution of the consumption of renewable energy resources per types of energy resources

[pie attēla: Consumption of renewable energy resources in Latvia; fire wood; electricity (hydro energy and wind energy); biogas; bio fuel; other (charcoal, straw and other biomass)]

[19] https://www.csb.gov.lv/lv/statistika/statistikas-temas/vide-energetika/energetika/meklet-tema/2485-atjaunigo-energoresursu-paterins-2018-gada

The space heating projects of houses by using RER (not including fire wood, wood chips and pellets) are viewed as technically complicated and requiring high initial investment by consumers. In order to promote broader use of RER in space heating and electricity supply of houses, state authorities and local governments should encourage implementation of various pilot projects on the basis of which such systems could be verified by everybody. This would reduce fear and improve awareness of the operation of such systems. The Ministry of Environmental Protection and Regional Development (MoEPRD) in 2010 – 2012 has implemented the project of the open tender "Use of renewable energy resources in the household sector" within the framework of the Climate Change Financial Instrument. Within the project 2444 projects of households for transition to the use of RER for heat supply of houses were approved in Latvia, and 57 RER based installations were done in Mārupe (see the data in Annex No. 1) totally securing the annual reduction of CO2 emissions in the amount of 364.04 tons. Considering that the implementation of the project was completed in 2012, the total reduction of CO2 emissions amounts to 2,548.28 tons by the end of 2019. The residents of Mārupe have most often selected the solution based on heat pumps (42%) and solar collectors (37%) for the implementation of the CCFI projects (see Figure 2.2).

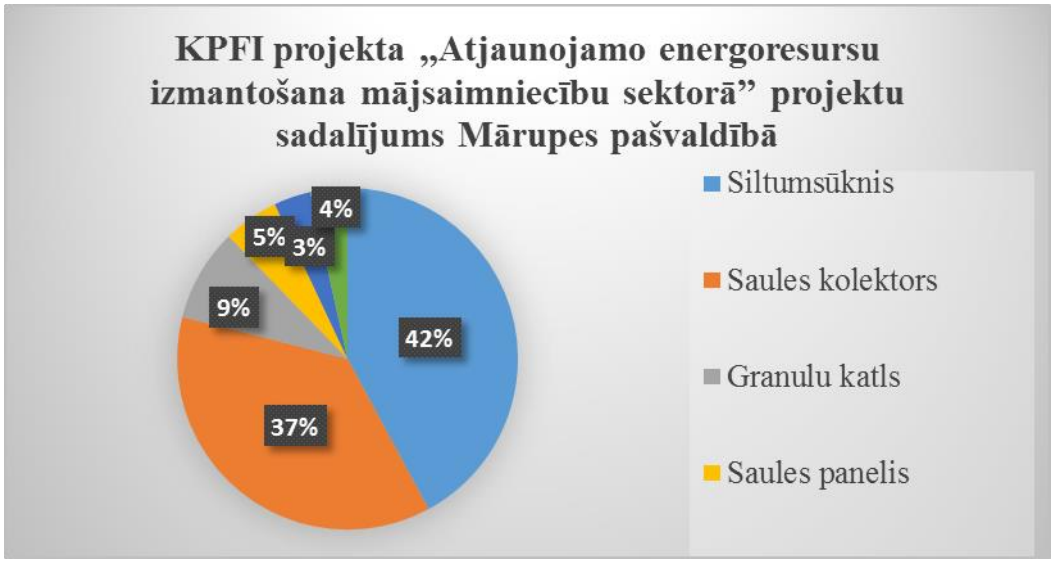

Figure 2.2 - Distribution of RER technologies implemented by households in Mārupe within the CCFI tender by the MoEPRD

[pie attēla: Distribution of projects of the CCFI "Use of renewable energy resources by households" in Mārupe district; Heat pump; Solar collector; Pellet-fired boiler; Solar panel]

From the results of approved projects it can be seen that the technologies using solar energy and heat pumps prevail in the selection of households in the field of RER. Totally they account for 84% of all the solutions.

2.2. Review and assessment of feasible RER technologies

Besides wood products (fire wood, wood chips and wood pellets) there are several other important RER technologies which can be used and integrated with heat supply systems or power generation systems. Annex No. 3 provides a detailed technical description of the most popular RER solutions which are used in private and municipal projects. Annex No. 3 presents the best practice examples based on the operation of which the efficiency and usefulness of these technologies can be analysed. By promoting and encouraging the spread of such systems in Mārupe district, they could be used in the community projects of residents in order to increase the share of RER in the total consumption of energy resources.

it is recommended to transform the boiler houses of Mārupe, Jaunmārupe and Skulte from the use of natural gas to biofuel and solar energy over time, as it is demonstrated by the best practice example regarding the implementation of the project at Salaspils municipality. It is recommended to get more involved in the production of biogas and its transmission to the gas network.

2.3. Description of strengths and weaknesses of the use of RER in Mārupe municipality

Strengths	Weaknesses
• **In the territory of detached houses in Mārupe district there are vast possibilities for using solar panels and solar collectors for additional energy production;** • **In the territory of detached houses in Mārupe district there are vast possibilities for using heat pumps for providing the space heating for houses;** • **As micro generators become more widespread, there is the energy supply infrastructure for connecting renewable energy resources to the public grids;** • **Existing system of district heating and district gas supply with a potential to transform it for RER based operation;** • **Implemented RER projects serving as the best practice examples;** • **Good energy efficiency indices of municipal buildings and residential buildings;** • **On average higher paying capacity and a higher education level of residents;**	• There is an established infrastructure based on fossil energy resources not encouraging its replacement with RER; • Deficiencies of the NET electricity metering system on the national level not encouraging self-generation of electricity by households and communities of residents; • Restricted possibilities for placement of wind generators, including wind micro generators (up to 11 kW); • As regards detached houses, the use of wood products for space heating may not be the most appropriate solution because the combustion of wood causes smoke, CO2 and ash. In case of intense construction, when every house uses this system the air quality may deteriorate considerably; • There is no infrastructure for the use of electric vehicles;
Opportunities	**Threats**
• **The housing stock in Mārupe is developing fast and is created anew. This provides good opportunities for providing various technologies related to energy efficiency**	• Low interest and awareness of residents; • Comparatively high initial investment in the introduction of RER technologies; • Restrictions for involvement of the local

and the use of RER at the planning and design stages; • The dense population of Mārupe district creates a lot of potential for implementation of RER projects in residential communities, including the opportunities for creating micro networks; • Vast possibilities for installation of solar panels on the roofs and walls of detached houses and apartment houses, in backyards; • **Improvement of energy efficiency in public buildings and residential houses built before 2000;** • **Technically simple and proven solutions for the supplementation or replacement of fossil fuel-based heating equipment of apartment houses with RER heating equipment;** • Electrification of space heating, the use of bio and solar energy in heat supply (heat pumps, solar collectors, biofuel fired boilers); • Co-financing to RER projects from the EU funds; • Availability of technologies for electrification of transportation;	government in RER projects imposed by the EU and the national policies; • Selection and use of inappropriate RER technologies, thus creating a bad impression of their compliance; • Potentially insufficient capacity of the infrastructure of AS "Sadales tīkls" [Distribution Network] for electrification of heat supply and transportation; • Lack (insufficiency) of co-financing and subsidies;

3. PRIORITIES OF THE DEVELOPMENT OF ENERGY IN MĀRUPE DISTRICT

3.1. Priorities of the development of energy in Mārupe municipality

Taking into account the results of the previously performed study of the energy field and the potential of Mārupe district, the main actions regarding the improvement of energy efficiency may be proposed in the household and service sectors which are both broadly represented in Mārupe district. The feasible actions in the use of RER can be easier incorporated in the construction of new buildings when the infrastructure for the use of RER is envisaged at the design stage. However, it is also important to find solutions for improvement of energy efficiency of existing systems and their transition to RER technologies. The following most efficient actions for the development of low carbon economy have been identified in Mārupe district:

Improvement of energy efficiency of buildings. Although the improvement of the energy efficiency of buildings does not provide a direct positive effect for low carbon energy production, if the total energy consumption of buildings is reduced, it is easier to satisfy the demand by using only RER. Therefore high energy efficiency requirements can be set for new buildings by defining very low permitted energy consumption per square meter per year.

For apartment houses and also municipal buildings which have been commissioned, attainable targets should be set providing that the energy efficiency index for space heating conforms with category A in newly constructed buildings and the total energy capacity of the building does not exceed 95 kWh/m2/year. By providing the above encouragement, actions for improvement of energy efficiency should be planned and implemented. Slightly lower requirements should be set for buildings to be reconstructed because often materials and architecture solutions used for the construction of these buildings will not allow securing conformity with higher requirements.

In addition to the above, as regards design and construction of new buildings in Mārupe district, the requirement to produce a part of the energy necessary for the building by the building on the basis of RER could be imposed. Additional energy can be produced in a variety of ways:

Use of solar panels and solar collectors. Mārupe district has developed on vast territories of meadows which ensure that there is very little shadow which would reduce the efficiency of operation of solar panels and solar collectors. Water heated by solar collectors may be used for providing hot water supply at houses or for performing partial pre-heating of the space heating system prior to using another type of space heating, which is most often based on fossil fuel. Energy produced by solar panels may also be used for heating water, operating electrical heating or electrical devices. In a standard situation solar panels and collectors installed at Mārupe district

would be able to perform their function with the maximum possible efficiency at this latitude and reduce the amount of energy necessary for the house by 50%. Installation of solar panels for power generation is justified from the economic point of view now and the pay-back time of the investment is on average 10 years (see Table 3.1) upon the condition that all the generated electricity is consumed. Below there is the estimation of the economic efficiency of a solar panel based on the actual operational indices regarding the generated electricity. This solar panel is installed in Brenguļi.

Table 3.1.

Estimation of the pay-back indices of solar panels

Saražotās elektroenerģija un ieņēmumi		gads											
		Janvāris	Februāris	Marts	Aprīlis	Maijs	Jūnijs	Jūlijs	Augusts	Septembris	Oktobris	Novembris	Decembris
Saražotās enerģijas daudzums	kWh	49	289	636	966	1617	1421	1360	1166	704	391	121	45
Ieguvums (pieņemot cenu 0,1548 EUR/kWh)	EUR	7,59	44,74	98,45	149,54	250,31	219,97	210,53	180,50	108,98	60,53	18,73	6,97
Investīcijas un uzturēšana													
Iekārtu iegādes un uzstādīšanas izmaksas	EUR	11000	0	0	0	0	0	0	0	0	0	0	0
Iekārtu uzturēšanas izmaksas	EUR	0		0	0	0	0	0	0	0	0	0	0
Bilance	EUR	-10992,41	-10947,68	-10849,22	-10699,69	#######	-10229,41	#######	-9838,38	-9729,40	-9668,87	-9650,14	-9643,18

Generated electricity and revenue; Generated electricity; Gain (by assuming the price is 0.1548 EUR/ kWh); Investment and maintenance; Costs of purchase and installation of equipment; Costs of maintenance of equipment; Balance

Saražotās elektroenerģija un ieņēmumi		1.gads kopā	2.gads	3.gads	4.gads	5.gads	6.gads	7.gads	8.gads	9.gads	10.gads	Kopā 10 gados
Saražotās enerģijas daudzums	kWh	8 765	8 765	8 765	8 765	8 765	8 765	8 765	8 765	8 765	8 765	87 650
Ieguvums (pieņemot cenu 0,1548 EUR/kWh)	EUR	1356,82	1356,82	1356,82	1356,82	1356,82	1356,82	1356,82	1356,82	1356,82	1356,82	13 568,22
Investīcijas un uzturēšana												
Iekārtu iegādes un uzstādīšanas izmaksas	EUR	11000	0	0	0	0	0	0	0	0	0	11000
Iekārtu uzturēšanas izmaksas	EUR	0	0	0	0	0	0	0	0	0	0	0
Bilance	EUR	-9643,18	-8286,36	-6929,53	-5572,71	-4215,89	-2859,07	-1502,25	-145,42	1211,40	2568,22	2568,22

Use of air or earth heat pumps. The use of air or earth heat pumps is an alternative to the use of solar energy. The highest operational efficiency of heat pumps is attained at higher ambient air temperature. Space heating in detached houses can be switched on at any time, however, the best indices of the use of heat pumps are achieved at higher ambient air temperature when the reagent can easily reach sufficiently high temperature and has higher efficiency indices. The resulting heat production can exceed the electricity consumption for production three-fold to four-fold. By performing careful research work and selecting the most appropriate solution of the heat pump for the particular situation, investments in the construction of heat pumps would pay back within 7 to 12 years on average.

The broader use of either solar panels and collectors or air or earth heat pumps would reduce the prices of both their sale and installation. In the result, when such RER solutions are used more by individual households, each of them can produce a part of the necessary energy by itself.

3.2. Definition of preconditions for development of the energy area at Mārupe district

In order to promote energy efficiency of the existing buildings of new buildings, it is possible to make relevant amendments to the legislation, if these are the goals of the state, as well as to develop the mandatory regulations of Mārupe district if these are the goals of Mārupe district. The same applies to the use of RER by households. As regards the use of RER by households, it is important to achieve that the costs of the energy produced by using RER are comparable to the costs of the energy purchased at

market prices. Considering only the costs of technologies, it is hard to attain such comparable costs indices between fossil and RER technologies. The price of electricity competitive with the price of electricity generated by power plants using fossil energy resources can only be provided by wind farms which technology is not feasible for use in Mārupe district. In order for the costs of the technologies of fossil energy resources and RER technologies to be comparable, political "tools" are needed.

The simplest way for ensuring broader use of RER would be the increase of taxes for fossil fuels, in particular, natural gas, coal, peat, oil products used for space heating. At the same time, this would provide additional resources to the state budget. In the result, the production of energy from these raw materials would become more expensive and the costs of the energy produced from RER would be equal or lower. However, the increase of taxes for fossil fuels is not a solution for today, as this would reduce the paying capacity of population and the competitiveness of companies using fossil energy raw materials. Both residents and companies can choose their residence in another country if resources are cheaper there. However, at the moment when the production costs of RER energy is equal to the production costs of fossil energy, amendments for increasing the tax rates for fossil fuel would be desirable, as this would encourage faster transition to RER energy. At present there are several solutions for power generation from RER whose price is equal to the price of energy produced by burning of fossil fuel[20].

It is important to implement various actions for encouraging the introduction of energy efficiency measures and the use of energy produced from RER by households and for provision of services. If such actions were encouraged, the RER production costs would decrease, as they are dependent on the prices of the equipment manufacturers, the costs of the distribution of equipment, the profit margin of sales companies, as well as the installation costs. The costs of distribution, installation and start-up of RER equipment can account for up to 50% of the total costs of RER equipment. Upon the increase of the demand for the use of RER equipment both in Latvia and in Mārupe, the know-how and the experience of buyers would improve and the competition among sales and installation companies would increase, resulting in the eventual reduction of the costs of RER technologies.

3.3. Tools for implementation of energy management measures

It is possible that not all the consumers have necessary financial resources for improving energy efficiency of buildings or installing RER production equipment in households. In the result, the available financial resources or other aid solutions for securing the above actions should be assessed.

At present there are several financial resources available in Latvia for improving energy efficiency of existing buildings.

[20] https://www.lsm.lv/raksts/zinas/ekonomika/par-aptuveni-250-miljoniem-eiro-buves-latvija-lielako-veja-parku.a292231/

• A loan for improvement of buildings. This is a loan issued by a commercial bank for investment in the improvement of the technical condition of buildings, including the improvement of energy efficiency.

• The offer of energy service (ESCO) companies - these are companies specialising in the implementation of energy efficiency measures in apartment houses (in some cases, also production buildings). Within ESCO a comprehensive network of experts has been established in Latvia who perform actions for improving energy efficiency of buildings in a coordinated manner and by providing the guarantee of the results to be attained. The risk for the results to be attained is assumed by the main (ESCO) company, who also provides the financial resources needed for renovation, which are often provided at more favourable terms than the loans issued by commercial entities.

• ALTUM[21] - the state development financial institution providing financing in the areas set as important and eligible for support by the state and where sufficient funding from credit institutions is not available. At present ALTUM administers the specific support target measure 4.2.1.1 "To promote increasing of energy efficiency in residential buildings", within the framework of which it is possible to receive funding of up to 50% in the form of a grant for the measures of improving energy efficiency of apartment houses.

The following financial resources are available for the purchase and the installation of RER equipment:

• "Green energy credit" - the initiative for small scale projects created by a commercial bank in Latvia. This is the initiative of one of the credit institutions in Latvia. The credit may be used for buying an electrical vehicle, an electrical scooter, an electrical bicycle, for installing solar panels or collectors. The amount of the credit is from 500 to 25,000 EUR.

• Purchase of equipment by paying in instalments - the initiative of the companies distributing RER equipment for promoting the use of this equipment. By signing a contract with the company which sells and installs relevant equipment, an agreement is reached on installing the particular equipment at a household and the payment for the installation is done over a period of several months. In the result, the monthly payment can be equal to monthly savings.

In addition to the above, Mārupe District Council can implement various actions for encouraging the improvement of energy efficiency of apartment houses, replacement of fossil energy and promotion of various RER solutions. During the experts meeting of the development of the present study, a proposal was presented for praising and awarding the most energy efficient house or zero energy demand houses in Mārupe district. In order to provide encouragement to residents it would be useful to arrange various competitions among houses in various categories (apartment houses, detached houses, terraced houses, semi-detached houses).

[21] https://www.altum.lv/lv/pakalpojumi/maju-energoefektivitate/daudzdzivoklu-maju-energoefektivitate-pamatinformacija/par-programmu/

4. POTENTIAL FOR CREATING ENERGY EFFICIENCY/ ENERGY INDEPENDENCE COMMUNITIES IN MĀRUPE DISTRICT

4.1. Conditions for the creation of energy efficiency/ energy independence communities

A community is a group of people united by something, for example, the place of residence, interests, language, religion, standards, the origin, needs. At present communities are created in social networks where people sharing the same interest unite in network magazines and forums.[22] Communities can be both very big and influential, like the European Union or the Roman Catholic Church, and also very small, like a handicraft club or a family. In the Republic of Latvia the communities who want their operations to be recognised as legal entities may establish associations or foundations.

The increasing RER production volume promotes major changes in electricity generation and supply. The system is transforming from centralised to decentralised. The consumers change from being passive energy consumers to flexible consumers by using various functions of postponed consumption. The systems of a single network get transformed into the systems of multiple networks. All the above encourages the creation of new energy communities[23].

The above described indicates that at present there are favourable conditions for creating various new energy communities. There are very few restrictions for creating communities, including energy communities. The major restrictions include the common place, common interests and the willingness to create a community. Then the decision may be taken on the official registration of the community if this is necessary in compliance with the legislative requirements.

The conditions for power generation by RER technologies and by using the NET [24] system for payment for electricity can be referred to as the major obstacle for the introduction of RER technologies in community projects. From the point of view of implementation of community projects, the current NET system has the following deficiencies:

- NET system may only be used by private individuals and if the community of residents is registered as an NGO it cannot use the NET system;
- The fee for the services of the distribution and transmission networks and the MPC [mandatory procurement component] payment needs to be paid for the electricity transmitted to the grid and consumed from the grid;

[22] https://lv.wikipedia.org/wiki/Kopiena
[23] https://www.compile-project.eu/wp-content/uploads/Explanatory-note-on-energy-community-definitions.pdf
[24] The conditions for the operation of the NET system are defined by Cabinet Regulations No. 50 "Regulations of the trade and use of electricity".

- Within the NET system payments for the electricity transmitted to the grid and consumed from the grid are not performed according to the hourly prices of electricity at the exchange, thus having a negative impact upon the pay-back indices of the RER system;
- Electricity has to be transmitted to the grid via a single defined commercial electricity metering point and the NET metering principle has to be applied to this metering point. If a community is not registered as a legal entity it may face problems for the installation of the above commercial electricity metering point for common use. Moreover, from the point of view of community projects, there should be a possibility to apply the electricity generated from RER to the electricity metering of each individual apartment at some point.

In order to promote energy efficiency and the implementation of RER technologies in the communities of residents, the state support is an important tool, including the support provided by the national policy and legislation improvements.

4.2. Assessment of the potential for creating energy efficiency/ energy independence communities in Mārupe district

In Mārupe district there is a high potential for creating energy efficient communities, considering the above described various energy efficiency solutions. The owners of apartment houses *de facto* exist within unified communities even if they are not aware of this and have not registered themselves by establishing an NGO. However, in order to implement major energy efficiency improvements in an apartment house, it will be necessary to agree on common actions requiring the involvement of all the owners of the house. The above applies to both improving the heat insulation of houses and the introduction of various RER solutions for the development of local power network systems. Communities can also be created by joining several nearby apartment houses, thus allowing the implementation of larger and more important common solutions for the use of RER.

Within the sector of detached houses energy communities can be created at locations where they are located close to each other, so that it is possible to construct own common system. The boundaries of creation of communities would be considerably expanded if there were solutions for using the existing centralised power supply system on economic basis. The systems of solar panels for generation of solar power have the highest potential for implementation of energy efficient solutions in detached houses. Unfortunately, the highest solar potential is at noon time and during summer when the instant energy consumption at households is lowest. However, the bigger the community, the higher the possibility that also in summer and at noon time there will be appropriate energy consumption for the installed production capacity. In order to balance the production cycle and the consumption cycle it is possible to use various energy storage technologies, however, this increases the total costs of the system. When electricity is generated by solar panels, the most available technology for

electricity storage is its storage in the public grid by using the electricity NET consumption system.

4.3. Selection of sites for implementation of the pilot project and their characteristics

In order to perform the assessment of energy efficient solutions in various existing or potential communities at Mārupe district, several house owners have been addressed and the technical solutions described by Annex No. 3 have been evaluated for the purpose of improving energy efficiency of buildings or the use of RER. An open discussion by involving local residents was held within the negotiations on creation of new energy communities at Mārupe district. Apartment houses at Krones iela 56 and Mazcenu aleja 15 where there is well-known active representation regarding the solving of matters related to the development of the house were individually addressed. Joint administration unions have been established for these houses and successful implementation of pilot projects is possible there including the possibility to demonstrate these examples to the owners or representatives of other apartment houses. In the sector of family houses the projects of semi-detached houses at Paleju street and Mazā Dravnieku street were addressed. Still, it should be pointed out that in Mārupe district there are many terraced houses where there is a high potential for creating own energy community.

The expert discussion taking place on 26 November 2019 at Mārupe District Council reviewed various theoretical solutions regarding complete or partial replacement of fossil energy with RER at apartment houses and terraced houses.

EXAMPLES OF VARIOUS RESIDENTIAL HOUSES AND THEIR DESCRIPTION

Apartment house at Krones iela 56, Mārupē

The house was commissioned in 2008. The total area of the house is 8427.70 m2, the useful area is 7799.50 m2 and the construction volume is 29618m3. There are

108 apartments in the house. The foundation of the house, the ceilings and the roof is constructed in reinforced concrete, and vertical structures are made of light concrete. The roof cover is metal. The primary space heating is provided by a gas-fired boiler located in a separate boiler house next to the apartment house. Power supply, water supply, sewage and gas supply is provided in a centralised manner.

In the separate room of boilers there are two gas-fired heating boilers “Viessmann" Vitoplex 100 PX1 with the capacity 500 kW. For hot water production heat exchangers with the capacity of 730 kW and two hot water accumulation boilers 2 x 1000 l are used. The operation of the boiler is automated without permanent

supervising personnel.
The total energy consumption for hot water production ~ 336 MWh/year. The mean gas consumption ~36,400 m3.

Apartment house at Mazcenu aleja 15, Jaunmārupe;

The house at Mazcenu aleja 15 is located in Jaunmārupe settlement, it has been built in 1980 is connected to the district heat supply system. Heat supply is provided by SIA "Sabiedrība Mārupe". The house has undergone full-scale renovation in 2018. There are 18 apartments in the house and the total energy consumption for hot water production is ~100 MWh/year.

Semi-detached house project at Paleju street

The semi-detached house at Paleju street was commissioned in 2015. The house has reinforced concrete band-type foundation, expanded concrete walls and bituminous shingle roof. The total living area of both sections of the house is 238 m2. The space heating of the house is provided by two local gas-fired heating boilers. The total gas consumption ~3000 m3/year. Considering the gas consumption, the energy efficiency of the building was estimated and it equals 117 kWh/m2/year. This energy efficiency index should be assessed as bad for a building of this type and this year of construction. The total annual electricity of the building of 5877 kWh/year should also be assessed as elevated. It is recommended to perform additional data analysis in cooperation with the residents of the house in order to identify the possible causes of the high consumption of gas and electricity.

Semi-detached house project at Mazā Dravnieku street

The semi-detached house at Mazā Dravnieku street was commissioned in 2016. The total living area of the house is 280 m2. The space heating of the house is provided by local natural gas-fired heating boilers and the mean total gas consumption amounts to 2200 m3/ year. The mean electricity consumption of the house is ~ 3000 kWh/year. Considering the natural gas consumption, the estimated energy efficiency of the building is 73 kWh/m2/year. This energy efficiency index

is much better than at the house at Paleju street, however, it should be assessed as average in comparison to the target of 30 kWh/m2/year set at the national level for year 2021.

The space heating of the houses based on the use of natural gas should be seen as a deficiency in the movement to zero emission economy as provided for by the EU; irrespective of various technical solutions, natural gas is a fossil fuel producing carbon dioxide gas emissions, therefore its consumption should be reduced considerably or fully replaced with the use of RER. The energy efficiency measures and the full-scale reconstruction of the house implemented at the house at Mazcenu aleja 15 should be viewed as a positive aspect. It will provide considerable contribution to the reduction of the consumption of energy resources, and the technical and visual condition of the house has also been improved. The other houses have been built after year 2000 by using modern construction materials. Irrespective of the above, the energy consumption in houses ranges from 70 to 120 kWh/m2/year.

In order to promote the implementation of the "green economy", the technical solutions described in Annex No. 3 to the report were reviewed by the meeting on 26 November 2019. The main thesis and conclusions of the expert discussion regarding the suitability of various technical solutions and the possibilities of using RER for power generation and/ or heat production for houses.

Implementation of heat pumps with the principle of operation air-water or earth-water will be inefficient from the economic point of view. In case of construction of heat pumps system the connection and the link with the heating system of the house present the position of high costs. Irrespective of whether it is intended to use heat pumps for satisfying the complete heat demand or a part thereof, the costs of investment will be high. In addition it should be taken into account that all the houses have existing heating systems in the construction of which considerable financial investments were made. When the additional system of heat pumps is constructed and a part of heat is produced by heat pumps, the amount of energy produced by gas becomes more expensive because it will still be necessary to provide the system maintenance. Introduction of heat pumps is perspective in new households where there is no existing infrastructure, including centralised gas supply networks. Due to potential high costs this technical solution is not further considered.

Implementation of the system of heat pumps with the principle of operation air-air. In case of apartment buildings this would require the construction of 1 - 2 heat pumps for every apartment depending on various technical solutions. The installation of such heat pumps would be financially cheaper than in the case of earth-water heat pumps. Owners of apartments could provide space heating of apartment by using the above referred air-air type heat pumps resulting in lower consumption of district heating. However, this solution has its drawbacks due to the below described reasons. There is no solution for hot water production. This would still be done by using the existing heat supply system and it would still be necessary to provide its operation and maintenance. In addition, this solution would damage the appearance of the building facade because many heat pumps would be installed on the facade.

Installation of solar panels for partial replacement of electricity consumption. Solar electricity panels can be installed on the roofs of all the reviewed houses from the technical point of view. In case of detached houses they can also be placed on the ground. Installation of solar panels is the simplest solution from the technical point of view and can be connected to the internal and external power network of the building. This is also the technical solution requiring the lowest investment among the reviewed solutions. This solution would be more efficient for apartment houses at present and this is related to the non-conformity of the power generation cycle and consumption cycle. In case of apartment houses there are more devices operating automatically also during the daytime (a refrigerator, a washing machine) and there are also more people who stay at home during the daytime due to various reasons and consume electricity (sickness, vacation, small children, retired people). Within the NET payment system spare electricity can be transmitted to the distribution network system, however, the costs of such stored electricity increase because additional payments for the distribution services provided by the network need to be made. According to the working group on the application of suitable electricity pricing policy for provision of power supply organised by the Ministry of Economics, a solution is proposed according to which it would no longer be necessary to pay the costs of the network transmission and the mandatory procurement component within the NET payment system for the exchange of the electricity generated by micro generators. If this solution was accepted, the installation of solar panels and the replacement of all the electricity consumed by the house would be an economically more profitable solution.

Installation of solar collectors for hot water production. This is a more complicated solution than installation of solar panels from the technical point of view, however, it is more economical than heat pumps. Solar collectors can provide hot water production. This means that it is possible to pre-heat the space heating system prior to its heating within the existing heating systems. During warm periods the use of this system can fully satisfy the demand for hot water, however, during cold period considerable additional heating by using fossil energy resources will be required.

In the result of assessing all the proposed solutions, the meeting of experts decided to recommend the system of solar collectors for equipping houses with it and partial energy production by using RER. The heat energy produced in this way would be fully used and fossil energy would be replaced.

The detailed selection of the solution to be used should be done in cooperation with the residents of houses and on the basis of technical-economic considerations.

4.4. The pilot project of the community energy efficiency and renewable energy resources for the selected best site

During the elaboration of the project "Energy efficiency and the use of renewable energy in Mārupe district" it was concluded that the solutions which are most compliant with the project goal and justified on technical and economic grounds in the area of implementation of community energy efficiency projects are feasible in apartment houses and various terraced houses.

Solutions comprising various solar panels or solar collectors are best justified on economic grounds and provide the highest energy efficiency. They can be comparatively easily integrated with the existing internal heat and electricity supply systems of houses by ensuring additional RER energy production at the site and reducing the use of fossil energy.

In case of apartment and terraced houses neighbours should agree on the integration of any of the selected systems because this will affect the common property. This type of agreement serves as the basis for the community agreement when several mutually related neighbours agree on common solutions in the area of use of RER energy.

The following steps need to be implemented for starting the introduction and the use of RER energy solutions in communities:

1. A majority decision on the introduction and integration of any of the RER energy production solutions with the community property needs to be taken. For example, the installation of solar panels for electricity generation;
2. An agreement should be achieved with a company providing installation of solar panels regarding performance of the works. It is important to perform detailed calculations jointly with the company representatives and to agree on the capacity of the equipment to be installed. It is recommended to select the capacity of the equipment to be installed in compliance with the maximum electricity consumption at the moment with the least number of consumers at home. If highest capacities are installed the costs of investment increase and the economic efficiency will be lost because the spare energy will be transmitted to the grid and recorded according to the NET metering principle. If NET metering principles change, it may become profitable to install solar panels with higher energy production capacity. It is important to remember that households in Latvia may install microgeneration equipment to be connected to the grid (in this case, solar panels) with the capacity up to 11 kW. This capacity can satisfy the demand of a single household, however this may not be sufficient for the consumption of an apartment house.
3. It is necessary to agree on technical solutions with the company representative who will install solar panels. This agreement includes the matters, like where solar panels will be placed, for the operation of which devices the generated electricity will be primarily used (lighting of staircase, lighting of basement, attic, consumption by apartments, etc.), how the metering of additionally generated electricity in the apartment house will be performed.
4. In an agreement on the installation of solar panels is reached, the company representative usually helps to perform necessary administrative work based on the regulation by the laws and regulations, as well as the regulation by AS "Sadales tīkls" regarding the connection of a micro generator (a solar panel) to the common energy supply system.
    1. A permit for the introduction of a new micro generator should be received from the Ministry of Economics;
    2. An application on the connection of a new micro generator has to be submitted to AS "Sadales tīkli"; AS “Sadales tīkli” will issue the technical terms of reference and the connection contract. In addition,

AS "Sadales tīkli" will replace the electricity meter with a meter of a suitable type free of charge if this is necessary.

3. The local construction authority needs to be notified regarding the intent to install micro generation equipment on the facade of the building or in the backyard. Also the construction authority may issue the technical terms of reference to be followed during the installation and operation of micro generators.

From the description of actions it can be concluded that the system has been created for the introduction of solar panels at individual households, however, in case of apartment houses where every apartment has its own contract and metering of power supply, it is more difficult to receive suitable technical terms of reference.

5. The solar panels are installed and connected for the purpose of satisfying the individual or common consumption of electricity by following the above described requirements.

Assessment of the installation of solar RER technologies at Mazcenu aleja 15

In order to estimate the necessary capacity of the solar collector, the data on heat consumption for hot water production were collected, see Table 4.1. The total heat consumption for hot water production in 2018 The annual consumption was 101.243 MWh.

It is recommended to install a system of solar collectors with the area of 20m^2 at Mazcenu aleja 15. The total annual production capacity of this system will be 20 MWh which will satisfy ~ 20% of energy demand. It should be taken into account that the system needes to be selected so that its summer maximum capacity does not exceed the consumption, therefore it is not recommended to install a bigger system.

The costs of the installation of this system are ~ 12,000 EUR including VAT, see the offer in Annex No. 4. Considering the heat price equal to 50 EUR/MWh the estimated pay-back time of this equipment would be ~ 10 years.

However, it is also important to consider the environment factor, as the introduction of the proposed solution with the solar collector will reduce the burning of the fossil energy resource, in particular, natural gas, by 2100 m3, resulting in the reduction of CO_2 emissions by 4000 kg/year.

Table 4.1

Consumption of heat for hot water production at the apartment house at Mazcenu aleja 15 in year 2018

Month	MWh	Month	MWh
January	8.008	July	8.965
February	7.650	August	8.698
March	8.083	September	9.700
April	7.725	October	8.625
May	8.525	November	8.150
June	8.214	December	8.900
TOTAL: 101.243 MWh			

In the case of the house at Mazcenu aleja 15 the installation of 20m^2 of solar panels for power generation could be considered as an alternative solution. The total capacity of such panels would be 3.3 kW and the power generation would amount to 3.3 MWh/year, and the installation costs of the system would amount to ~ 4,000 EUR. Considering the mean electricity price including all the components equal to 150 EUR/MWh the estimated pay-back time of this equipment would be ~ 8 years. For the development of the accurate solution using solar panels the data of the electricity consumption for common use would be needed, unfortunately, these data were not available during the study. Moreover, it is necessary to consider the deficiencies of the NET settlement system referred to in Chapter 4.1 if a union wants to perform power generation.