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DEVELOPMENT OF PROPOSALS FOR LONG-TERM ENERGY POLICY OBJECTIVES AND MEASURES TO ACHIEVE THE RELEVANT OBJECTIVES, INCLUDING TAKING INTO ACCOUNT THE CONDITIONS FOR THE DEVELOPMENT OF THE NATIONAL ENERGY AND CLIMATE PLAN FOR YEAR 2030

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ABBREVIATIONS

CCFI – Climate Change Financial Instrument
CFCA – Central Finance and Contracting Agency
CSB – Central Statistics Bureau
DH – District Heating
EC – European Commission
$EF_{supply.}$ – Efficiency of energy supply
EI – Energy intensity
$EI_{agricalture}$– Energy intensity in the agricultural sector
$EI_{houslholds}$ – Energy intensity in the household sector
$EI_{industry}$ – Energy intensity in the industrial sector
E_{imp} – Share of imported energy
$EI_{public.commercial}$ – Energy intensity in the public and commercial sector
$EIt_{ransport}$ – Energy intensity in the transport sector
E_{mix} - Diversification of energy resources
EPA – US Environmental Protection Agency
ETS – Emissions trading system
EU – European Union
GDP – Gross domestic product
GHG – Greenhouse Gases
IDAL - Investment and Development Agency of Latvia
IEA - International Energy Agency
NECP - National Energy and Climate Plan
OECD – Organisation for Economic Cooperation and Development
RES – Renewable energy sources
UAE – United Arab Emirates

1. EXPLORING LONG-TERM ENERGY POLICY OBJECTIVES IN EUROPE AND THE WORLD

The Intergovernmental Panel on Climate Change issued its special report on the impact of global warming in October 2018. (IPCC, 2018) The report concludes that global warming caused by humans has already reached 1 °C above pre-industrial levels and is rising at around 0.2 °C every ten years. Without promoting international climate action, the average global temperature rise could soon reach 2 °C after 2060 and continue to grow further thereafter. The report warns of the consequences of global warming at 1.5 ° C. Jacobson et al., on the other hand, carried out a study summarising the guidelines for 139 countries to move to 100% climate-neutral energy by 2050 and to prevent global warming reaching 1.5 °C.

On the future of the energy sector, there is a consensus that global energy consumption will continue to grow. (Nyquist, 2016) The way it will be produced and used will therefore have a significant impact on achieving the objectives of the Paris Agreement and on the future of the population. As the volume of information and the popularity of climate change issues increases, more and more countries are developing long-term climate change mitigation strategies for the energy sector, both within and outside the EU. The size of this strategy and the intended targets varies by country. The study looks at available data on national energy strategies for 2050, as well as other available sources for the long-term energy strategy and mitigation measures. The following is a brief description of the long-term energy strategies of individual World and EU countries, as well as an overview of the European Union's common objectives and the European Green Deal setting the EU as one of the most ambitious goals for climate change mitigation in the world.

1.1. Long-term energy policy in the world

1.1.1. USA

The US, in its first document on nationally identified contributions to the Paris Agreement, shows that it intends to achieve a 26%-28% reduction in greenhouse gas (GHG) emissions compared to 2005 levels in 2025. (United States of America, 2020) In general, much more than in other countries' sources, a specific policy on energy and climate change is linked to the President in power. The current US President has announced a withdrawal from the Paris Agreement, but due to the terms of the agreement (the country cannot start withdrawal earlier than 3 years after the agreement) the US withdrawal procedure can be completed just one day after the next presidential election. There is therefore a possibility that political changes will lead to a change in the US position in the context of the Paris Agreement. (Wallach, 2019) A US study on the impact of environmental policy on the economy concludes that the exit from the Paris Agreement could increase gross domestic product (GDP) by around 1% over the medium term, but in the long term the US cannot achieve sustainable long-term development without additional initiatives in the development of environment-friendly technologies and policies (Nong & Siriwardana, 2018).

Despite the country's total “indecision”, different states of the USA have different conditions for GHG emissions. California has set a long-term target of reducing GHG emissions by 80% by 2050 compared with 1990 levels (the Global Warming Solutions Act) (McCollum et al., 2012). Such act was also adopted in Massachusetts (*Conservation Law Foundation*, n.d.). But the US Environmental Protection Agency (EPA) decided to deprive the state of California of the right to impose stricter conditions on vehicles for which another organization, the Defense Law Foundation, sued the presidential administration in November this year. The EPA has developed emission calculation formulas and factors that also calculate in Latvia and offer private individuals and companies tools to calculate their carbon footprint.

1.1.2. China

To explore low-carbon development capabilities in line with existing conditions, China has launched carbon trading trials in 7 provinces and cities, as well as low-carbon development pilot projects in 42 provinces and cities. The following has been achieved by 2014 (China, n.d.):

- Carbon dioxide emissions per GDP unit are 33,8% below 2005 levels;
- The share of non-fossil fuels in primary energy consumption is 11.2%;
- Forest area and forest stocks have been increased by 21.6 million ha and 2,188 billion m^3 respectively compared to 2005 levels;
- The capacity installed by the hydroelectric power plant is 300 GW (2.57 times the 2005 level);
- Wind energy installed capacity is 95,81 GW (90 times higher compared to 2005);
- Solar power installed capacity of 28,05 GW (400 times as compared to 2005);
- The installed nuclear power capacity is 19,88 GW (2.9 times the 2005 level).

China's target for 2030 is to reach a "peak" of CO_2 emissions (in addition to making efforts to achieve it more quickly), reduce CO_2 emissions per unit of GDP by 60% - 65% from 2005 levels, increase the share of non-fossil fuels in primary energy consumption to 20% and increase forest volumes by 4.5 billion m^3 above 2005 levels.

The main scenario of the report published by the Chinese Institute for Economic and Technology Studies on "China's Energy Perspectives 2050" foresees that the share of renewable resources in China will reach 35% of primary energy consumption by 2050. CO_2 emissions from China's energy sector will reach their highest point before 2035 and will drop by 82% in a graduated manner compared to 2010 levels by 2050. The reduction in carbon intensity will be based on a fall in the energy intensity of the Chinese economy (energy consumption per unit GDP). China's energy-related emissions are projected to start declining between 2025 and 2030. Given that China's number of private vehicles per 1,000 residents is lower than in other major countries in the world, we expect the number of such vehicles to rise. The energy sector, like industry and the private sector, has pledged in China to increase the use of natural gas as a cleaner alternative to other fossil resources. (CNPC ETRI, 2017)

The study concluded that a rapid increase in electricity consumption is expected in China, with an increase in the living standards of the population. Neither the share of fossil resources in electricity generation is projected to rise to 86.4% in the development of renewable energy technologies.

As possible alternative scenarios were mentioned:

- A ban on the sale of fossil fuel vehicles from 2040, which would provide cuts for increased consumption of petrol and diesel fuel and encourage the use of alternative fuels;
- Increased policy focus on building ecological civilisation (increased restrictions on existing producers, energy efficiency as a priority, development of energy-intensive industries, green production and promotion of green lifestyles), which would result in a reduction in energy consumption in industry and household sectors after 2025, while the energy consumption of transport would not exceed 400 Mtoe (100 Mtoe less than in the baseline scenario).

A pilot programme was launched in China in 2010, the "Low-Carbon City and Province", currently involving around 100 cities and provinces. In 2017, two cities - Dunhuang and Chengde

- have offered to provide 100% of the electricity city's needs by 2025 only with renewable resources. (He et al., 2019)

1.1.3. South Korea

South Korea generates about 1.4% of the world's greenhouse gas emissions. As part of its nationally identified contribution, it has set a 37% GHG reduction for 2030 compared to the baseline scenario, which is forecast to be unchanged. And 40%-70% GHG reductions compared to 2010 by 2050. (Republic of Korea, n.d.).

The South Korean scientists' study (Hong et al., 2019) modeled three long-term energy development scenarios focusing on the 3 aspects most discussed in South Korea: energy security, jobs and GHG emissions. The authors conclude that many other areas need to be studied: energy redeployment costs, air pollution and the health impact of the energy system, economic impact, new industry and job creation, etc., but the high dependency on energy imports (around 95% of energy is imported) should be taken into account. Modeled scenarios reach GHG emissions reductions in 2050 (against 2014 levels) ranging from 20.8% in the baseline scenario to 90.9% in the sustainable development scenario (RES only), without nuclear and coal).

1.1.4. Middle East and African Countries

The main source of climate change emissions in the Middle East and Africa is the energy sector, which accounts for around 38% of CO_2 emissions, followed by a transport sector of 25%. There are sources that conclude that emissions control programs and technologies in the region are more efficient when sponsored and implemented by the private sector; one such example is the success of Saudi Arabia in supporting the country's emissions monitoring. (Abbass et al., 2018)

In 2017, the United Arab Emirates (UAE) published an Energy Strategy 2050. The strategy aims to increase the amount of clean energy in total energy consumption from 25% to 50% by 2050 and to reduce the carbon footprint of energy production by 70%. It also aims to increase the energy efficiency of consumption, households and the industrial sector by 40%.

The strategy focuses on the use of different types of energy combining renewable, nuclear and clean energy sources to meet the economic requirements of the UAE and the environmental objectives of creating a mix of energy sources comprising: 44% clean energy; 38% gas; 12% coal; 6% nuclear energy. (Al Naqbi et al., 2019; *UAE Energy Strategy 2050*, 2017) The UAE government aims to invest $600 billion by 2050 to meet rising energy demand and ensure sustainable growth in the country's economy..

An important issue on the African continent is access to energy and tackling energy poverty, so the RES are supported when it makes it possible to improve energy access or is cheaper than conventional fossil resources. The national plus is the great potential for solar power (Ouedraogo, 2017).

Scientific recommendations for the 100% transition to renewable energy in Mauritius (Khoodaruth et al., 2017) provide that the creation of smart grids is a prerequisite for such a transition. Geothermal energy, solar photovoltaic, terrestrial and offshore wind stations, and the gasification of cane-pomace as a basic resource in combination with other less developed technologies would allow for a 100% share of RES in the Mauritian energy sector, but the current policy settings would only allow for partial decarburization.

1.2. Long-term energy policy in Europe

On 28 November 2018, the European Commission (EC) presented its strategic vision for moving towards a modern, competitive and climate-neutral economy in 2050. Already in 2009, the EU set an 80-95% reduction target by 2050. The modernisation of the European economy is based on the transition to clean energy. Efforts to reach the 2020 energy and climate targets have contributed to the development of new industries, innovation, creating new jobs and contributing to a drop in technology prices neutral to climate change. (European Commission, 2018)

The strategy gives energy a key role in the transition to an emissions-neutral economy, as energy currently accounts for more than 75% of EU greenhouse gas emissions. In all the options analysed, the energy system is moving towards zero greenhouse gas emissions. It is based on a secure and sustainable energy supply based on a market and a Pan-European approach. The future energy system will integrate electricity, gas, heating/cooling and mobility systems and the markets through smart grids will become the center of the system for citizens. Given that existing policies and strategic targets can only deliver a 60% long-term GHG reduction for 2030, a number of scenarios for post-2030 policy change were modeled. It is concluded that increasing energy efficiency, promoting the circular economy and individual solutions for transport (electrification, hydrogen, alternative fuels, a new approach to mobility) are not sufficient to reach zero emissions by 2050. These scenarios allow only 80% of emissions reductions compared to 1990 levels, a combination of all these options of 90%. In order to move further, it is necessary to develop CO_2 collection and storage options, such as forestry or agriculture. Towards a carbon neutral economy in 2050, 7 key "components" are identified. (Finnish Ministry of Employment and Economy, 2014):

- Energy efficiency, including zero emission buildings;
- Fuel and fuel consumption;
- Clean, safe and uniform transport system;
- A competitive economy and a circular economy as a key to reducing emissions in the industrial sector;
- Development of smart network infrastructure;
- Improving the benefits of the bio-economy and creating carbon "dipper" capabilities;
- Fighting with the remaining CO_2 emissions by removing and storing carbon.

The International Energy Agency (IEA) shall publish reports on the state of the energy policy, targets and forecasts of the Member States, as well as recommendations for the successful development of national energy. In 2015, Latvia presented the first deliverable on the planned contribution to the achievement of the objectives of the Paris Treaty on behalf of all EU Member States in the context of nationally determined contributions to the Paris Agreement. This deliverable shows that the EU and its Member States have committed themselves to a binding target of reducing greenhouse gas emissions by at least 40% by 2030 compared to 1990, to be jointly met as set out in the conclusions of the October 2014 European Council.

2019. On 11 December 2019, a new EU paper entitled "The European Green Deal" was adopted, aimed at: "*transforming the EU into a fair and prosperous society with a modern, resource efficient and competitive economy in which net greenhouse gas emissions would fall to zero in 2050 and economic growth would be decoupled from resource consumption. […] maintaining and strengthening the EU's natural capital and protecting the health and wellbeing of citizens from environmental hazards and impacts".* (European Commision, 2019) The elements of the European Green deal are illustrated graphically. Figure 1.1.

This report is the first roadmap covering the main areas of force application and the measures to be taken to achieve the objectives of the European Green Deal. The transition to a zero-carbon economy in the EU should be implemented through all available policy instruments: regulation and standardisation, investment and innovation, national reforms, dialogues with the social partners and international cooperation; it is also planned to increase efforts to effectively implement existing legislation and policies.

While the EU has already demonstrated results in the decoupling of GHG and economic growth: EU GHG emissions have fallen by 23% between 1990 and 2018, while economic growth rates have improved by 61%, the policies currently in force cannot meet the conditions of the Paris Agreement and the EU's objectives. Without more ambitious climate action, EU greenhouse gas emissions will fall by only 60% in 2050. The European Green Deal provides for the setting-up and implementation of more ambitious objectives in all the sectors included:

- Reinforcing the 2030 and 2050 climate targets;
- providing clean and safe energy at affordable prices;
- the transition of industry and the clean circular economy;
- energy efficient and resource efficient construction and renovation of existing buildings;
- zero pollution and toxic-free environment;
- the preservation of biodiversity and ecosystems;
- a fair, healthy and environmentally friendly food system;
- transition to sustainable and smart mobility.

Figure 1.1 European Green Deal (European Commission, 2019)

Timetable for launching the European Green Deal in the energy, energy efficiency and climate change sectors summarised in Table 1.1.

The EU is aware that the implementation of such an ambitious course of action requires resources and will have a different impact on each of the Member States, so the EU is committed to a fair reshuffle. To implement this commitment, the Sustainable Europe Investment Plan will be developed and new funds will be raised in the EU budget for revenues generated from auctioning under the EU Emissions Trading Scheme. Revenue streams based on non-discriminatory used plastic packaging and channeling 30% of the InvestEU fund to combat climate change have also been exhausted. The private sector is expected to play a key role.

A Fair Reformation Fund will be set up to ensure that no one is left behind. The implementation of the Green Deal is expected to lead to significant changes in business models, skills demand and relative prices. The impact of these changes on citizens depends on their geographical and social circumstances. The regions and sectors whose economies are based on carbon-intensive processes and fossil resources will be hardest hit, so they will be the main target groups for fair redeployment.

Table 1.1 European green start in energy, energy efficiency and climate change sectors.

Term	Task
by the end of 2019	Member States shall submit their revised energy and climate plans.
by summer 2020	The European Commission (EC) is presenting a plan for a responsible increase in the EU's 2030 greenhouse gas emission reduction target to 50%, to 55%, compared to 1990 levels.
by mid-2020	The EC will propose measures for the smart integration of renewable energy sources, energy efficiency and other sustainable solutions in different sectors. In parallel, the decarburization of the gas sector will be promoted.
In 2020	The EC draws up guidelines to tackle energy poverty. The EC is strongly evaluating Member States' national long-term renovation strategies and will start examining the possibility of including emissions from buildings in the European Emissions Trading Scheme. The Construction Product Regulation is being revised. (European Parliament and Council of the European Union, 2011) The EC also proposes to cooperate with stakeholders in developing a new initiative on building renovation. Cooperation will take the form of an open platform and will also include innovative financing schemes under InvestEU. Offshore wind energy strategy..
by June 2021	The EC looks into and, if necessary, proposes a review of climate change policy instruments (ETS and non-ETS sectors, land use, land use change and forestry regulation) with a view to achieving effective carbon prices across the economy. The EC shall review the revised energy and climate plans submitted by the Member States.
In 2023	Member States are starting to update their national energy and climate plans with the ambition of new climate objectives.

A significant risk to the EU economy may arise if the EU implements the Green Deal, but individual countries do not take climate change mitigation measures. Carbon intensive products imported from foreign countries can compete produced by locals on the basis of the Green Deal principles. The EU economy would thus suffer, but GHG emissions would not only be "moved" to countries outside the EU. In order to avoid this, it is planned to use a carbon tax.

Without all the involvement of the World countries in climate change mitigation, it is not possible to achieve this essential objective, the role of which so many still do not want to be recognised. The European Green Deal will make the EU a leader and pioneer on the path to a climate-neutral society. The EU is committed to promoting and implementing a more planet-friendly environment, climate and energy policy. To this end, it is necessary to show a credible example and to act accordingly in the fields of diplomacy, trade policy, development aid and other foreign policy. The international carbon market is developed as a key instrument for creating an economic incentive to mitigate climate change. Firstly, EU support will be provided to neighboring countries: a green programme for the Western Balkans is being developed, as well as a strong climate partnership for the environment, energy and climate with the Southern Neighborhood and the Eastern Partnership. It is stressed that cooperation with third countries on cross-cutting climate and environmental issues should be pursued. In this context, the report on the "European Green Deal" states: *"It may be necessary, in line with the G20 commitment, to end global subsidies for fossil fuels and fossil fuels, to phase out the financing of fossil fuel and fossil fuel infrastructure by multilateral authorities, to strengthen sustainable financing, to phase out any new coal-fired power plants and to carry out measures to reduce methane emissions*." (European Commission, 2019) In this case, the words "may be" may appear to be misplaced because the direction towards carbon neutrality and subsidies for fossil resources seems to be uncombined, but it should be noted that the rules of the European Green Deal include a requirement not to neglect anyone and to provide citizens with safe energy at affordable prices. The EU also intends to cooperate with other countries in mitigating the effects of climate change and promoting resilience to them in order to prevent these problems from becoming a cause of food insecurity, conflict and forced migration of the population.

The European Green Deal is certainly a revolutionary policy and, as such, the involvement of citizens is a fundamental condition for its implementation. It is necessary to involve citizens already in policy development and to carry out educational campaigns, as citizens are the driving force for change. In order to maintain citizens' involvement and commitment, the transition to a carbon-neutral economy needs to be done in cooperation with people and in such a way that citizens have no reason to worry about job losses, whether they will be warm at home and can maintain or improve their existing standards of living. By March 2020, the European Commission is expected to launch a European Climate Pact focusing on three forms of cooperation on public involvement in climate action:

1. Promoting the circulation and understanding of information on threats and challenges posed by climate change and environmental degradation, as well as ways of preventing them;
2. Creating a real and virtual space for individual and collective disclosure of ideas and creativity and sharing ambitious action;
3. Promoting local initiatives in the field of climate change and environmental protection.

The European Commission itself, as an institution, is also developing a strategy to mitigate its environmental impact. In the event of a successful European Green Deal, the EU would become a "*fair and prosperous society that responds to the challenges of climate change and environmental degradation, thereby improving the quality of life of current and future generations"*. (European Commission, 2019)

A closer look at the long-term energy strategies developed by Northern Europe and the Baltic States to analyse their progress towards the overall EU goals.

1.2.1. Finland

The Finnish Energy and Climate Roadmap 2050 (Finnish Ministry of Employment and Economy, 2014) states that Finland's long-term objective is to reduce GHG emissions by 80%-95%. The Roadmap also stresses that commercialization of carbon capture and disposal technologies will play an important role on the way to the stated targets. Finland's new government announced in June 2019 that it would become CO_2 neutral by 2035. (Morgan, 2019)

1.2.2. Norway

The Sustainable Energy Centre modelled three scenarios for Norway's development by 2050 (Korsnes & Sørensen, 2017). The latest oil scenario, in which Norway is ramping up oil extraction and economic growth is taking place until 2030, the oil industry collapses, resulting in increased unemployment and a threat to the pension fund by 2040. In the Green Tax scenario, which introduces a global carbon tax and oil extraction gradually becomes more expensive, at the same time its demand is declining. Following this scenario, Norway exports mainly hydroresources for energy production in 2030, but lacks a source of national income, resulting in increased inequality and rapid urbanisation by 2050. A collective participation scenario is being modeled in which a 6 h working day is introduced in Norway and “Statoil” is becoming “StatWind” (transition to wind resources) from 2020 to 2030. Around 2030, petrol-powered machines are banned and collective farming and urban gardening are being developed. Instead of cost efficiency, energy efficiency is set as a priority. The study concludes that, in democratic circumstances, one policy direction is unlikely to be started and maintained, so the future is likely to be a mix of all three scenarios.

1.2.3. Sweden

Swedish scientists model two scenarios for the transport sector – electrification and biomethane scenarios (Bramstoft & Skytte, 2017). In their study on decarburization of the energy and transport sector by 2050. The studies found that electrification scenarios were more cost-effective. However, the sensitivity analysis showed that changes in the price of biofuels have a very significant impact on the outcome. It was concluded that Swedish biofuel resources would not be sufficient to provide the entire transport sector, so it would be necessary to import resources from abroad.

Sweden's 2050 energy scenario, based on renewable resources, foresees a significant reduction in energy consumption (more than 100 TWh) between 2020 and 2040, as well as a gradual increase in solar and wind energy, which will result in no longer needing or replacing the energy currently produced from oil and using nuclear energy from wind and solar energy. (Gustavsson et al., 2011). No changes are forecast in the use of bioenergy and other energy resources currently used (waste, hydro).

1.2.4. Estonia

Estonia is one of the fastest-growing economies in the Organization for Economic Cooperation and Development. The local energy resource – the oil shale – accounts for nearly 70% of Estonia's energy demand. It gives the country energy security, but it is carbon intensive. Despite modernising technology, Estonia has succeeded in achieving most of its energy targets for 2020. The main priorities for Estonia by 2030 are the strengthening of the Baltic electricity market and its timely integration into the Northern Energy Market. (IEA, 2013)

On 3 October 2019, Estonia endorsed the objective of achieving climate neutrality by 2050. For Estonia, this has been a difficult decision, since a large part of the country's economy is based on the extraction and use of shale. The transition to renewable resources would mean an end to this activity, a loss of employment for a significant number of people and a potential reduction in the stability of the energy sector. Despite this, Estonia has joined the objective of climate neutrality and has given priority to energy efficiency. The support for the natural gas infrastructure and the accession of the Estonian politician Kadri Simpson, who is currently the EU Energy Commissioner, to the EU's responsibilities in the framework of the Paris Accord, leads to the conclusion that the political environment is facing obstacles to climate objectives. (Morgan, 2019)

The main document for setting the long-term energy strategy in Estonia is the Estonian low-carbon development plan for 2050, issued and developed by the Estonian Ministry of Environment. The strategy states that Estonia's long-term target is a reduction of 80% of CO_2 emissions compared to 1990 levels. What's unusual is that the plan foresees a 70% reduction in emissions to 2030 and 72% to 2040. On the basis of this plan, a National Climate Change Adaptation Strategy has been developed, including measures such as the establishment of a maritime surveillance and warning system for coastal cities. Energy is intended to maximise the efficiency of the use of shale, to use gas by-products of fuel shale for electricity and heat production and to replace liquid fossil fuels and natural gas in the long term. The development of renewable energy generation technologies and the use of knowledge-based, ecological and sustainable biomass will be promoted. It is also noted that it is important to develop technologies that reduce the carbon intensity and network-related technologies of the current industry. (Estonia Ministry of the Environment, 2017)

Currently in the field of energy, funding is allocated (Meelis, 2017):

- In energy efficiency measures for apartment buildings;
- Alternative transport fuel (biogas);
- Energy efficiency and renewable energy for public buildings.

1.2.5. Lithuania

The Lithuanian Seimas adopted the National Energy Independence Strategy in June 2018 (Ministry of Energy of the Republic of Lithuania, 2018). The strategy was supported not only by law-makers but also by the majority of stakeholders. The strategy foresees that by 2030 70% of electricity consumption will be covered by electricity produced in Lithuania and 45% of electricity will be produced from the RES, while in 2050 all electricity consumed in the country will be produced on-site and from the RES. This will be helped by the development of renewable energy production, which will not only contribute to energy security in Lithuania but also contribute to the achievement of the EU and global climate goals. The energy sector as a whole is targeting an 80% share of RES in final energy consumption by 2050. The promotion of the productive consumer phenomenon is particularly important. By 2030, it is planned that there should be at least 500 000 producing consumers in the country – people who have decided to produce their own energy from renewable sources on their own. In addition to the planned development of the gas pipeline connection with Poland.

1.2.6. Local authorities' support for local energy initiatives. Example of Germany, the Netherlands and Denmark

In Western European countries, local energy initiatives – a localised approach to sustainable development – are a response to a slow transition of the system to sustainable innovation. Since 2007, 300 local energy initiatives have been set up in the Netherlands. Local energy initiatives can be described as “do yourself” initiatives in the context of the transition to low-carbon energy. These are local, non-commercial, small-size initiatives that rely heavily on the involvement and action of highly motivated people.

In Germany, local energy initiatives are being implemented, for example, as a change in the form of the management of local heating companies from the municipality and the local energy initiative group. Other solutions include solar PV systems and public building roofs, biomass heating systems, biogas production, etc.

Saerbeck (CitiNvest project report, 2009) a town with 7 thousand inhabitants, which has been implementing various local energy initiatives since 2008 to provide 100% renewable energy supply. A number of energy projects were implemented in the city: installed solar panels on public building roofs, switched the central heating system to biomass boilers, wind turbines and a biogas station were installed. Of the 7 wind turbines (3MW each), one belongs to local residents, who once allowed a change in public opinion against setting up a wind park. Solar panels (total capacity around 10000 kW_{el}) are displayed on the roofs of many private houses. Saerback is an example which shows that various stakeholders in society (businesses, municipalities, citizens, planning region and farmers) work with the municipality, focusing on traditional municipal competences such as education, tourism, support from local associations, public finances and management in building local energy initiatives.

In the Netherlands, local energy initiatives are primarily linked to wind energy projects where the energy produced is delivered to the local population. Solar projects in the urban environment and rural environment are popular solutions for the mid-energy initiative in the Netherlands. The overall objective of these initiatives is to strengthen the local economy through energy savings and revenues from joint projects and to ensure a sustainable environment for their citizens.

Lochem (Hoppe et al., 2015) in a city with 33 thousand inhabitants, a local energy cooperative supplies solar-powered energy to local residents. The municipality supports local energy initiatives that have allowed several energy projects to be carried out: support for households to install solar panels on rooftops, setting up a collective solar park on the roof of a municipal building (110 panels with a total capacity of 1 MW), renting out electric vehicles, etc.

Sonderborg (Smartencity project homepage, n.d.) the municipality in Denmark committed to achieving CO_2 neutrality in 2029 by replacing gas-powered turbines and boilers with wind turbines, heat pumps, biomass boilers and solar collectors and replacing natural gas supply with local biogas. The municipality is very active and uses the European and Danish funds to achieve energy objectives.

Summary

The development of sustainable energy system strategies has become one of the top priorities in global policy. The decision-making process and the stages that decision-makers have to pass through to agree stable long-term alternatives to the sustainable development of existing national and local government energy systems is a difficult task, taking into account economic/financial, technical, social and environmental criteria. Energy strategies are needed not only at global and national level but also at regional/local level. Sustainability is essentially a concept of multi-criteria, so scientists (Neves et al., 2018) offer a multi-criteria analysis method as a tool to improve decision-making for the development of long-term objectives and strategies in municipalities. The EU launched the Covenant of Mayors Programme, with over 6,000 European municipalities already voluntarily committed to reducing CO_2 emissions by 40% by 2030. Cities from 60 countries with a total population of more than 300 million are participating in this pact. (García & Khandke, 2019) The energy strategy is also a matter of concern at company level. The introduction of international standards (e.g. ISO 50001) within the company requires the implementation of energy policy and the related energy strategy. In this context, energy policy is a dossier on the organisation's long-term vision, justification and commitment to improving environmental performance through the EM, while the energy strategy is a systematic approach and a roadmap for achieving the objectives of energy policy (Finnerty et al., 2018).

At national level, the most important initiative for the development and implementation of sustainable energy strategies is the Paris Agreement, which agreed to reduce GHG emissions by 80-90% by 2050. As part of this, each participating country shall draw up its own national plan on its individual contribution to the overall climate change mitigation target. These individual targets have to be ambitious, but the United Nations report entitled "The Emissions Gap Report 2019" stresses that the objectives set out in existing national contributions are not sufficient to halt global temperature growth in time and are on the verge of reducing global warming by 1.5 °C (United Nations Environment Programme, 2019).

In this chapter, we looked at the long-term strategies of the energy sector of individual countries, which allowed an insight into the diversity of this sector. Even the energy strategies of our immediate neighbors Lithuania and Estonia have significant differences: Lithuania has set up its objective of full energy independence, while Estonia's most important issue is to make the energy sector more environmentally friendly without losing the economic and societal benefits of extracting and exploiting the indigenous carbon-intensive fuel shale. Other countries, such as Ukraine and the US, are dependent on global or domestic political change. Developing countries are also involved in the fight against climate change under the Paris Agreement. The International Environmental Community and many donor countries are urging developing countries to adopt a renewable energy policy that will contribute to the development of low-carbon energy. Many developing countries have identified the development of clean energy rather than absolute reductions in GHG emissions as a key component in their individually nationally identified contribution to global efforts to combat climate change.

Sustainable development of the energy sector and increasing the share of renewable energy cannot be seen as merely an altruistic activity on behalf of the common good, with the increase in the share of RES in the energy sector attributable tangible benefits to the country concerned. The implementation of RES support policies is a promising response to a number of challenges facing many countries and regions around the world, including challenges related to energy diversification, energy security and economic diversification of oil-producing countries (Kahia et al., 2017).

Long-term energy strategies are an important commitment to the future, but without consistent use of real policy instruments, it can also remain at a level of beautiful commitment. European countries and the US are the initial innovators of RES policy, experimenting with a series of renewable resource-support policies since the 1990 s. Two specific RES policy methods – the mandatory procurement tariff and the quota system – have been shown to be particularly successful. (Baldwin, 2019) The EU has also now set the objective of becoming a global leader in climate change by taking the European Green Deal to reach a zero carbon economy by 2050, the EU intends to use all available policy instruments: regulation and standardisation, investment and innovation, national reforms, dialogues with social partners and international cooperation. And to comply more closely with existing legislation and policies.

2. ANALYSIS OF LONG-TERM ENERGY POLICY OBJECTIVES AND DEVELOPMENT OF PROPOSALS

2.1. Methods used in policy assessment

Different methods can be used to assess national energy and climate policies. Each of the methods deals with different aspects of energy and climate policy: the rigidity of environmental policy, the effectiveness of renewable energy policies, the overall national climate plan, the sustainable development of the energy sector.

2.1.1. Method for evaluating the rigidity of environmental policy

There are a number of challenges to assess the rigidity of environmental policy. Firstly, in order to address climate and energy challenges, countries can choose different policy instruments. Each of these instruments is characterised by a different level of effectiveness, dynamic efficiency and political acceptability. Thus, the "multi-dimensionality" of the national policy portfolio must be confronted when setting policy indicators. Secondly, countries with a more significant pollution problem could impose stricter environmental requirements. Without this, a biased indicator of the rigidity of environmental policy would be provided. Thirdly, some "initial conditions" or time-changing indicators, such as the sectoral breakdown of industry, the level of energy efficiency or the age of capital, may have a significant impact on the ability of countries to implement certain (lower cost) options. Despite these barriers, a number of indicators have been identified in the analysis of environmental policies. (International Renewable Energy Agency, 2012; Nicholls et al., 2014)

Table 2.1 Overview of the categories and indicators used to assess the rigidity of environmental policy (Botta & Koźluk, 2014; Galeotti et al., 2020)

Categories analyzed	Indicators used
Pollution reduction efforts	Share of pollution reduction costs and costs in GDP
	Government expenditure on energy research and development relative to GDP
	Indirect tax rate on energy
	Share of income from environmental and energy taxes in total GDP
Composite policy indicators	Single CO_2 quota price for participants in the Emissions Trading Scheme
	Share of renewable electricity to be achieved annually under the renewable energy certificate trading scheme
	Share of the electricity savings to be achieved annually in the emissions trading scheme for energy certificates
	Price of one SO_2 quota in the SO_2 Emission Trading Scheme
	CO_2, NO_x, SO_x tax rates, EUR/t
	Minimum procurement tariff and premium for wind and solar energy, EUR/kWh
	Emission limit values for PM, SO_x and NO_x for coal-fired installations, mg/m^3
	Diesel tax in the industrial sector, EUR/l
	Packaging deposit system
	Maximum Sulphur content in diesel fuel

Emission indicators	Ratio of estimated CO_2 emission intensity to actual intensity	
	Analysis of major components	

The method proposed by the Organisation for Economic Cooperation and Development (OECD) is designed to assess the rigidity of environmental policy through quantitative indicators. The methodology evaluates various environmental policy instruments, mainly related to climate and air pollution. Although the impact of environmental policy is multidimensional and complex, the indicators selected allow a simplified description of the various aspects of environmental policy. This methodology defines policy rigor for both individual policy instruments and general environmental policy as higher direct or indirect costs associated with polluting or environmentally harmful behavior. It's just appreciated for instruments like taxes - if higher tax value means more rigidity. For subsidy instruments, such as compulsory procurement tariffs or R & D subsidies, a higher subsidy is also interpreted as a more stringent environmental policy. Such subsidies increase the potential costs of pollution, and they can be assumed to be paid by the majority of taxpayers or consumers, thereby benefiting from a “cleaner” operation.

The indicators analysed in this methodology are looked in three categories: pollution reduction efforts, composite policy indicators and emissions indicators. The method mainly uses quantitative indicators (excluding the assessment of the introduction of the packaging deposit system). Table 2.1 summarises all indicators included in the methodology. The instruments included in the analysis have been chosen to cover, as widely as possible, both market and non-market access to environmental policy. All the variables taken in the analysis reflect the legislative elements of the rules (e.g. the emission limit value for a given substance, the tax rate for emissions). The exception is the indicator of the CO_2 and SO_x emissions trading scheme, which uses the average annual price of allowances and government R & D expenditure as a percentage of GDP expenditure allocated to research and development of renewable technologies. Indicators are calculated for different countries and normalized so that they can be compared with each other.

2.1.2. Method for evaluating renewable energy policy

The use of renewable energy technologies for energy production has become increasingly popular in recent years. Some technologies have become cost-competitive with conventional energy production, such as hydro and biomass, and wind and geothermal energy in suitable places. However, in many cases aid policy remains the main driver of implementation. Given the importance of promoting the deployment of renewable technologies and the high financial costs often associated with support, it is important for policy makers to know how policies work in the context. The evaluation can help identify possible adjustments and allocate scarce financial resources as effectively as possible.

The main objective of the RES deployment policy is to increase renewable energy technology installed capacity and renewable energy production. This could lead to a number of other benefits, such as cutting technology costs, safer energy systems, increased public awareness and social recognition of renewable energy, job creation, sustainable local production and increased market share of renewable energy technologies. Such policies generally involve substantial financial support and should therefore be regularly assessed. Ongoing evaluation can help to identify options for policy adaptation and improvement. This is particularly important in the area of long-term aid policy, since different circumstances may change unexpectedly over time. (International Renewable Energy Agency, 2012)

The method uses four well-established criteria: implementation efficiency, cost efficiency, equity and institutional fitness. For each of the criteria, it is important to identify measurable indicators that can be used for performance assessment. Table 2.2 shows an overview of all indicators used. This method applies only to policy enforcement, not to the wider impact of renewable energy technologies, such as the environment, the economy, energy security or technological impacts. The nature and complexity of the analysis depends on purpose and context. The method can be used to compare the different countries with each other, or to assess the situation before and after the policies implemented.

Table 2.2 Overview of the categories and indicators used to assess the rigidity of environmental policy (Nicholls et al., 2014)

Criteria	Indicator
Efficiency of implementation	Additional RES capacity installed
	Electricity produced from RES
	Level of achievement of the stated national objectives
	European Commission Performance Indicator
	Policy impact indicator
	Implementation Status Indicator
Cost efficiency	Specific costs of installed capacity (EUR/MWh)
	Energy production costs (EUR/MWh)
	Revenue Level Indicator
	Potential earnings indicator
	Revenue adequacy indicator
	Total cost indicator
Equality	Changes in energy consumption (or expenditure) as absolute values
	The benefit ratio obtained for the target group against the share of that group among the population.
	Energy Accessibility Indicators
	Potential for stakeholders to participate in policy implementation
Institutional suitability	Support and stability, impact of stakeholders
	Credibility of the policy
	Political appropriateness and admissibility of new development
	Resources available to staff
	Human capital
	Investor interest
	Policy implementation potential
	Credibility of the policy concept
	Resource adequacy

In order to assess the effectiveness of the implementation of RES policies, the simplest indicators measure the installed capacity or energy produced and its growth in absolute units or percentages. These performance indicators can be determined by a minimum amount of information required. The determination of energy produced has an advantage compared to the assessment of capacity growth, since this indicator cannot determine how productive renewable energy plants are, for example, as a result of efficient deployment, maintenance and integration. However, simplified indicators have a number of limitations. They do not show any progress in relation to economic or technical potential or in relation to wider policy objectives. They also lack expected value, because little is indicative of future prospects and can't explain the causation.

By comparing the different policies of the EU Member States, the EC defines the efficiency of energy delivered (with a specific renewable energy technology) in GWh compared to the national potential for each technology. The related efficiency indicator *E* measures the additional energy output achieved by technology i in a given year *n*, as a percentage of the total additional "realizable potential" considered achievable between this year and 2020. It is calculated as follows:

$$E_n^i = \frac{G_n^i - G_{n-1}^i}{POT_{2020}^i - G_{n-1}^i}$$

where

G_{n-1}^i- Energy produced with specific renewable technology *i* in year *n;*

POT_{2020}^i- Total potential for the production of specific renewable technologies *I* by 2020

The policy outcome is considered to be effective if more than 7% is achieved for well-known technologies such as wind and hydropower, above 3% for biogas and other medium-developed technologies and above 0.5% for solar photovoltaic energy and similar less developed technologies. However, the calculated values reflect only a snapshot of effectiveness over a specified period, which may not be consistent with the overall impact of the policy over its lifetime.

The International Energy Agency (IEA) (International Energy Agency, 2018) defines the "realisable potential" of the RES as the maximum potential, assuming that all existing barriers can be overcome and all development actors are active. It takes into account medium-term restrictions on the implementation of changes, such as market growth rates and planning constraints, which vary annually in pursuit of the long-term technical potential. The percentage of realisable potential achieved is considered to be a more equitable indicator for international policy comparison than absolute or percentage changes in production and capacity, as it takes into account different national or regional sizes, starting points in the deployment of renewable energy and achieving renewable energy policies and targets. However, the complexity of the modelling method and significant data requirements may limit its usefulness, unless indicators can be estimated from current international studies.

The policy impact indicator is the adaptation of the IEA's performance indicator. Instead of assessing progress in real potential estimates in 2020, using the current year as a benchmark, this indicator measures progress towards the IEA's 2010 world energy outlook (WEO) forecasts for 2030, taking 2005 into account as the base year.

The "Intelligent Energy Europe" programme has developed an implementing status indicator aimed at identifying the share achieved by the national renewable energy market for individual technologies. This is intended to raise awareness of the results of the performance indicator, which, as noted above, has an impact on market development. In addition, it makes it possible to better differentiate between general policy recommendations. The indicator consists of three weighted sub-indicators representing different aspects of the deployment of RES:

- the quantity produced by the RES as part of the total consumption of the sector;
- RES production as part of the realisable potential of 2030.
- RES capacity installed.

Cost efficiency is defined as the ratio of the outcome achieved to investments, such as renewable energy targets achieved with spent economic resources, mostly measured at a given time (static efficiency). Dynamic efficiency increases the future dimension of time, including the amount of innovation to improve the ratio of results and investments.

Static efficiency can be measured simply by using EUR/MW or EUR/MWh. As discussed in the context of efficiency, the determination of the energy produced is generally more informative than the installed capacity, since it takes into account the efficiency of use. In order to compare the impact of policies on a multilateral basis, it is necessary to clearly define the input costs for both the capital investments included (e.g. production plant, improvements in transmission and distribution networks, related construction work) and the financial sources taken into account (full cost or government subsidy).

The main factor in assessing the effectiveness of the RES policy is the amount of financial support paid to the energy producer. It must provide a sufficient and predictable return on investment to stimulate capacity growth, but it must also be moderate to avoid unexpected gains resulting if aid levels exceed requirements. The revenue-level indicator was further developed by creating a revenue-adequacy indicator.

Policy fairness is defined as the occurrence of policies and the consequences of dissemination, including dimensions such as the rule of law and respect for citizens' rights. Policy fairness can be assessed in the light of the impact sharing between different groups and the extent to which different stakeholders can participate in its development.

One way to assess the fairness of the policy impact breakdown is to compare the relative importance of policy-driven energy consumption and spending changes in different social or income groups. These data are the most readily available as absolute values that can be used either to track progress or to compare policy impacts with specific capital benchmarks. However, assessing changes can be difficult if the deployment of renewable technologies means the deployment of modern energy services, since the cost change equity analysis should take into account the fuel they replace. This may require an assessment of the undervalued energy (e.g. wood) and the associated non-monetary costs (e.g. time spent collecting fuels, health effects). Indirect effects can also be difficult to quantify, even though they have the potential to be equally significant. Policies supporting RES can affect costs in other areas of the energy system by requiring upgrading existing transmission and distribution networks or taking measures to manage recurring production.

Another approach to policy fairness is how effectively subsidies are for the poor. The assessment of subsidies that protect consumers from increased energy prices (caused by renewable energy sources) is analogous to the assessment of subsidies for the poor, since the poor are disproportionately affected by the increase in energy prices. In addition, in some situations, rather than supporting only the poorest with benefits or tax breaks, policy makers could contribute to the integration of RES.

The participation of stakeholders in decision-making processes is internationally recognised as a defined public right. The impact of participation processes is usually measured using scales such as Arnstein ladders (Videira et al., 2006), which assess the actual level of influence of participants on the decision-making process. Such an assessment shows that stakeholder consultation is not always effective or sufficiently inclusive. In terms of fairness, there are concerns that poor communities are generally under-represented in policy-making processes, because they have little access to high-level social processes and lack the internal capacity to otherwise influence policy-making processes. This raises particular concerns, since the most deprived social groups may also be most marginalised and thus subject to a disproportionate share of policy risks. Therefore, the clear representation of all stakeholder groups in decision-making processes is considered to be an important means of promoting the interests of the various groups.

Studies have identified a large number of qualitative indicators used to assess institutional potential, usually used in complex ways to create a multi-faceted understanding of the institutional environment and its interaction with policies. They are composed of different sets of indicators and grouped according to the specific institutional issues they are intended to represent. The set of indicators selected for a specific assessment varies significantly depending on the objectives of the evaluation, the resources available for it, the nature of the review policy and all perceptions of the institutional environment. Four types of categorization of indicators in sets have been identified:

- Political viability and organisational capacity. Indicators shall be divided according to whether they reflect the viability of the policy, i.e. its public acceptability and the issues affecting it, whether there is sufficient potential organisational capacity for its implementation and implementation.
- Endogenic and exogenous indicators are divided according to whether they are endogenous to policy (relating to its complexity, such as transparency and predictability) or are exogenous (conditions required for the policy to function well).
- Rules, management structures, characteristics of participants and business characteristics. Indicators are broken down according to whether they represent "rules" (e.g. incentives and legislation); governance structures (their existence, structural fitness and functional capabilities); characteristics of participants (beliefs and values, resources, skills and knowledge, including cooperation between participants).
- Capacity levels and spheres of observation. Indicators are divided into many "observation spheres" for each of the four hierarchical "capacity levels" (i.e. system, organisation, individual or network).

2.1.3. Method for evaluating national climate plans

National energy and climate plans (NECP) are an opportunity for EU Member States to plan their next steps towards a climate-friendly future and to benefit from the economic and social benefits associated with it. Clearly and strongly NECP can serve as a justification for large and small investors and the involvement of stakeholders, and to identify where additional resources will be needed. The methodology proposed by *the Ecology Institute* and *the European Climate Foundation* is used to assess the state-of-the-art version of "National Energy and Climate". The method offers a qualitative analysis of NECP from 28 Member States and evaluates the appropriateness of their national targets (in the context of zero emissions), the completeness of policy descriptions, detail and the quality of the development process. It does not assess the potential effectiveness of the policy submitted.

This method uses an indicator-based evaluation tool developed in consultation with representatives of NGOs and civil society organisations, advanced business associations and research centres to assess and compare NECP projects. The development of the method was based on the need for NECP to be conducive to change and based on a transparent preparation process. NECP can be seen as contributing to change if it sets far-reaching objectives in a sustainable decarburization path, in line with the long-term objectives of the Paris Agreement, and sets out a coherent and credible policy mix to achieve them. The plan shall be transparent if it continuously facilitates timely and efficient investment by all stakeholders. These key aspects are assessed in three main dimensions:

- The adequacy of objectives;
- Information on planned policies;
- Quality of process.

A number of considerations and challenges were taken into account when developing the evaluation method. First and foremost, many important elements of the NECP should not be used in quantitative assessment and should therefore be assigned a numerical indicator. In order to reduce subjectivity and increase the reliability of the assessment, the evaluation shall be based on predefined criteria and possible responses. Secondly, despite the uniform model provided for in the management regulation, NECP projects have different levels of detail and completion. The methodology reflects the different phases of completing the NECP, marking where the information is missing and using scales to take into account different levels of detail.

Table 2.3 Overview of the categories and indicators used to assess the current version of the NECP (Duwe et al., 2019)

Category	**Criteria**	**Maximum possible score (points)**
Objective adequacy	Non-ETS sector GHG emissions targets for 2030	15
	National GHG emissions targets for 2030	1
	RES targets for 2030	12,5
	2030 Energy Efficiency Goals	12,5
	National targets for 2050	4
Policy information	Policies to achieve the objectives of the non-ETS sector	10
	Policies to achieve the RES objectives	10
	Policies to achieve energy efficiency objectives	10
	Coal use	5
	Exclusion of the subsidy of fossil energy sources	2
	Funding	8
Quality of processes	Effective involvement of stakeholders	7,5
	Compliance	2,5

The target adequacy dimension consists of five key indicators assessing climate and energy targets for greenhouse gas emissions, non-ETS sector emissions, renewable energy sources and energy efficiency. Checking the relevance of each 2030 target to the current EU targets. This assessment is mainly quantitative. The proposed targets are assessed as inconsistent, in line with EU objectives, medium-ambitious and ambitious to achieve net zero emissions by 2050. Target numeric values per rating category are shown in Table 2.4.

Table 2.4 Target assessment levels

	Minimum match	**Average match**	**Zero level by 2050**	**Conformity of the Paris Agreement**
GHG emissions *(% decrease compared to 1990)*	-40% to -46%	-46% to -55%	-55% to -65%	Above -65%
Energy efficiency *(%increase compared to reference year)*	-32,5% to -33%	-33% to -40%	-40% to -47,3%	n/a
RES *(%share in final consumption)*	32% to 33%	33 % to 45%	45% to 53,2%	n/a

The information dimension of the policy plan consists of six key indicators assessing the information provided on policies and measures to reduce greenhouse gas emissions, renewable energy and energy efficiency. It is assessed whether this policy is sufficient to achieve national objectives. The dimension also examines the information provided on investment needs and on measures preventing the transition to a zero emissions system (e.g. subsidies for fossil fuels).

The assessment is based on a qualitative approach for most indicators, mainly by examining the level of detail. This does not include a full impact assessment and does not assess the likely effectiveness of the current or additional policies or the accuracy of the information provided.

The quality dimension of the process consists of two key indicators assessing how Member States coordinate the NECP development process. In order to assess the level and quality of stakeholder involvement, the method shall examine whether a public consultation has taken place, its time and format. The second indicator checks the overall consistency and timely submission of the plan.

The total possible score that states can reach is 100. Since the dimensions of target adequacy and policy information are given more weight, their criteria together represent 90 points, while the maximum score of the process quality criteria is 10 points (see Table 2.3). Some individual responses have potential negative indicators, such as the lack of information available in the draft plans on particularly important aspects to point to a "penalty" for bad practices.

2.1.4. Energy Indicators for Sustainable Development Assessment

In selecting energy resources and related technologies for the production, supply and use of energy services, it is important to take into account the economic, social and environmental consequences. Policy makers need methods to measure and assess the current and future impacts of energy consumption on human health, human society, air, soil and water. The method used aims to determine whether the current use of energy is sustainable and, if not, how to change it. To identify this, a series of indicators focusing on key issues in the three main dimensions of sustainable development are defined: economic, social and environmental.

The indicators used are quantitative, but they are not merely data analysis; rather they go beyond basic statistics in order to give a deeper understanding of key issues and highlight important relationships which, using basic statistics, are not obvious. They are important instruments for informing policy makers and the public on energy issues related to sustainable development. Each set of indicators shall express the aspects or effects of the production and use of energy. Overall, the indicators give a clear picture of the whole system, including interlinks and compromises between the different dimensions of sustainable development as well as long-term prospects. The change in the values of the indicator over time indicates progress or lack of progress towards sustainable development. Changes in the value of each indicator over time will help determine the progress of each country. Instead of relying on abstract analysis, a simple set of figures are available to policy makers to drive decisions and monitor the results of policies introduced.

The indicators defined in the methodology, summarised in Table 2.5, constitute a set of sustainable development energy indicators that are useful for policy makers, energy analysts and statisticians. Some indicators focus on providing essential energy services for poverty reduction and improving living conditions, while other indicators focus on environmental impacts. When deciding on policies, it is important to take into account not only economic but also social and environmental issues. The objective of the analyst is to select, evaluate and submit suitable indicators to policy makers to assess the situation in their country and to promote development in a sustainable way.

Energy availability has a direct impact on poverty, employment opportunities, education, demographic transition, indoor pollution and health. In developed countries, energy for lighting, heating and cooking is available by switching on the switch. Energy production is relatively clean, safe, reliable and accessible. In poor countries, the collection of energy resources for cooking and heat production requires up to six hours a day and is usually carried out by women who might otherwise be involved in more productive duties. Where coal, charcoal and/or paraffin are commercially available, these energy resources represent a large part of the household's monthly expenditure. Insufficient equipment and ventilation means that this fuel burned in housing causes a lot of illnesses and deaths from air pollution and fires. This example is intended to illustrate two topics of the social dimension: justice and health. Social justice is one of the main values underlying sustainable development. Energy should be available to everyone at a fair price.

Table 2.5 (International Atomic Energy Agency, 2005) *Overview of the categories and indicators used to assess energy sustainability*

Category	Indicator
Social dimension	Share of households (or residents) without electricity or commercial energy or heavily dependent on non-commercial energy
	Share of household income spent on energy spending
	Household energy consumption for each income group and corresponding distribution of fuels
Economic dimension	Per capita energy consumption
	Energy intensity per GDP indicator
	Efficiency of energy supply
	Energy intensity of the industrial sector
	Energy intensity of the agricultural sector
	Energy intensity of commercial sector
	Energy intensity of the household sector
	Energy intensity of transport
	Distribution of energy sources
	Share of renewable energy sources
	Share of energy imports
Environmental Dimension	CO_2 emissions per capita
	CO_2 emissions per GDP indicator
	Ambient concentrations of air pollutants in urban areas
	Emissions of air pollutants from energy generation
	Areas of soil where acidification exceeds critical norms
	Level of deforestation related to energy use
	Ratio of generation of solid waste to energy units produced

Limited income (limited availability) can force households to use traditional fuels and inefficient technologies, and the time needed to find and collect firewood is time that cannot be spent cultivating fields or otherwise working. Poor people generally have to spend a large share of their income on essential energy resources needed for services such as cooking and heating.

There may be different opportunities or availability between regions and between income groups in the region. National or national differences may arise from a very uneven distribution of income, insufficient energy transport and distribution networks and large geographical differences between regions. Accessibility and accessibility indicators are clear indicators of progress.

Energy use should not harm human health; it should rather be improved by improving living conditions. However, energy production has the potential to cause injuries or diseases, causing pollution or accidents. The social objective is to reduce or eliminate these negative effects. Health indicators have sub-design safety covering accidents caused by energy extraction, transformation, transmission/distribution and use. Oil platforms and, in particular, coal mines are prone to accidents that injure or kill people. Refineries and power plants can release emissions into the air that cause lung or respiratory diseases. Households where coal, wood and kerosene are burned in traditional fireplaces and ovens to cook food and heat spaces have high levels of respiratory diseases, especially for children.

Energy consumption per GDP unit is a marker of total energy intensity. In determining the sustainability of consumption trends, high attention is paid to efficiency and aggregated and distributed intensity. However, caution should be exercised in the interpretation of these indicators. A country whose economy relies on banking activity and trading will consume less energy per unit of GDP than the one whose economy relies on steel production and ore processing. In view of the structure of the economy, these indicators allow the assessment of changes in energy efficiency, which may in turn be linked to changes in technology, a combination of energy types or consumer expectations or behavior.

The efficiency of energy transformation and distribution supervises energy efficiency in transformation processes such as power plants. Production indicators look at the energy used compared to local energy resources.

Energy intensity indicators may be identified in individual sectors. As they are specific to the sector, they can be good for assessing energy efficiency, economic structure, and depreciation of equipment and equipment. However, changes measured with added value are subject to world commodity prices and currency fluctuations in trade-dependent industries. This can dramatically change indicators that have nothing to do with real efficiency changes.

The share of different energy sources in the overall energy mix and the proportion of energy produced, provides a useful picture of the supply of primary energy and shows the degree of diversification of energy. Energy end-use prices by energy and industry play an obvious economic role. Efficient energy pricing is the key to efficient energy supply and use and socially efficient pollution mitigation. Energy prices and related subsidies and taxes can contribute to energy efficiency or to improving access levels, or they can create efficiency in the supply, distribution and use of energy. While relatively high prices of commercial energy sources can be seen as a barrier to their use, prices that cover supply costs are needed to attract investment in a safe and reliable energy supply market.

The issue of energy security is one of the main objectives of the sustainable development criteria of many countries. Energy supply interruptions can lead to serious financial and economic losses. In order to support sustainable development objectives, energy should always be available in sufficient quantities and at reasonable prices. Safe energy supply is essential for maintaining economic activity and providing reliable energy services to the public. For the assessment of energy security, it is important to monitor trends in net energy imports and the availability of adequate critical energy stocks.

For the assessment of the environmental dimension, priority issues are emissions of acidification, ozone-depleting substances of the tropospheric and other pollutants affecting urban air quality. Greenhouse Gas (GHG) emissions are important in the debate on whether humanity is adversely affecting the climate. The air pollutants that cause the greatest concern are Sulphur oxides, nitrogen oxides, carbon monoxide and particulate matter (the last two are particularly important for indoor air pollution). These pollutants can harm human health by causing respiratory problems, cancer, etc.

Water and land quality are other important environmental dimensions. Land is more than just a topography of physical space and surface; it is in itself an important natural resource consisting of soil and water, which is essential for food cultivation and for the provision of life for the various communities of plants and animals. Energy activities can lead to land degradation and acidification, affecting water quality and agricultural productivity. The use of wood as a (non-commercial) energy resource can lead to deforestation, which has led to erosion and soil losses in some countries. Some countries have a long history of smooth deforestation. Although environmental legislation is now in force in many countries to avoid further land degradation, the damage still affects significant areas. Energy transformation processes, which often produce solid waste, including radioactive waste, which must be disposed of accordingly, also have a low impact. Water quality is affected by the release of pollutants into liquid wastewater from energy systems, in particular from the extraction of energy resources.

2.2. Assessment of Latvian energy policy

2.2.1. Evaluation of renewable energy sources

In recent years, the share of renewable energy resources has increased in Latvia's energy balance. The use of biomass and wind energy has increased in electricity generation. The National Energy and Climate Plan (Ministry of Economy, 2020) (NECP) projects that by 2030, RES electricity will reach 62% of total electricity produced and will provide it with electricity produced by HES, all types of biomass in cogeneration and wind power plants. Under the relevant policies, a small proportion of electricity will also be produced by solar power plants.

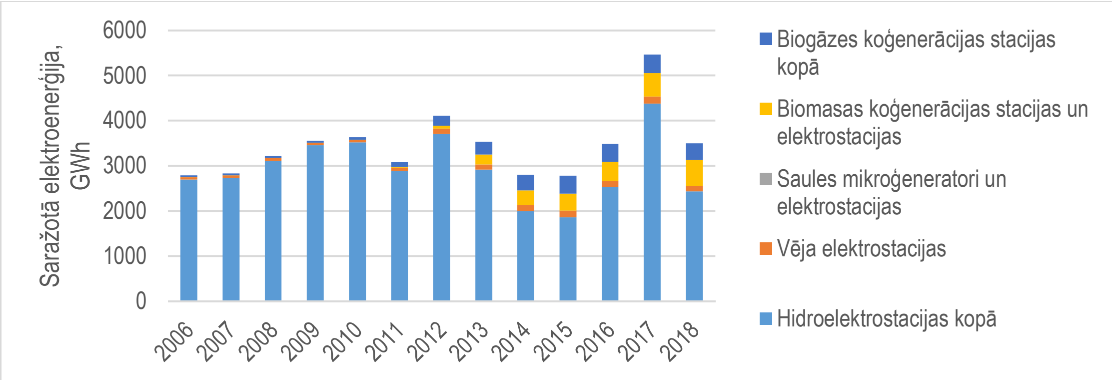

Figure 2.1 Historical changes in the distribution of electricity produced by RES

On the basis of the methodology described in Chapter 2.1.2, an implementing status indicator for the various RES was established, assessing the share of the total technological potential of three different categories, RES technology installed capacity, as defined in the NECP and the share of total electricity consumption. The Implementation Status Indicator allows an indirect assessment of the effectiveness of the implementation of the policies implemented.

Table 2.6 Assessment of the implementation status indicator

Category	Assessment
Share of total electricity consumption	A maximum of 40 points if the proportion is above 10% of total sector consumption.
Share of technological potential	Maximum 40 points if the proportion is above 60% of the amount of electricity produced by the NECP
Installed capacity	A maximum of 20 points if the capacity installed by the technology is above 100 MW.

In order to determine the status indicator for deployment, each of the RES technologies used for electricity generation is assigned an appropriate number of points (see Table 2.6). The calculation uses available information from the Central Statistical Bureau (CSB) on capacity installed in 2018, electricity produced and technological potential modeled by the NECP for a specific RES technology.

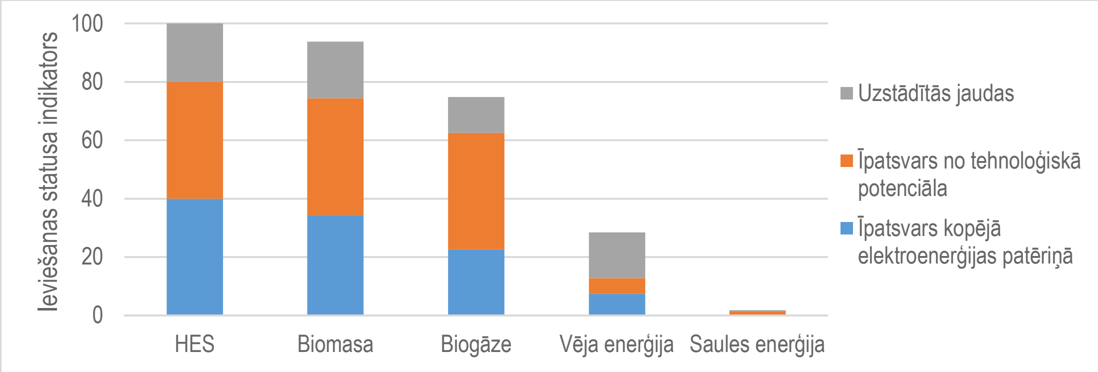

Figure 2.2 Status indicator for the deployment of different RES in electricity generation

Implementation status indicators are shown in Figure 2.2, indicating the low deployment status for wind energy and solar power. The highest rate has been reached for HES and biomass stations. However, this indicator does not provide information on the cost-effectiveness of implementation policies.

In order to assess the cost-effectiveness results of RES policies, a number of policies implemented to increase RES technology capacity in different sectors were analysed in households, municipal buildings, district heating and transport. Although a number of policies have been implemented, there is currently a lack of information on the indicators achieved - the total installed RES capacity, the estimated amount of energy produced and the actual amount of energy produced. The specific costs of installing RES for the two programmes implemented, as summarised in Table 2.7., were calculated from publicly available information and project descriptions implemented.

Table 2.7 Analysis of the results of RES policies

Energy efficiency programmes	**Promoting energy efficiency and the use of local RES in district heating**	**Technology transition from fossil to renewable energy; complex solutions to reduce greenhouse gas emissions**
Aid applicants	District heating plants	Local authorities
Implementation period	2018-2020	2010-2012
Administrative body	CFLA	Environmental Investment Fund
Number of projects analysed	18[1]	39[2]
Installed RES capacities, MW	136[3]	26
Specific costs of installing RES, in thousands EUR/MW	143	202
Specific costs per energy produced, **EUR/MWh**	No information	7,3
Specific GHG emission reduction costs, **EUR/t CO_2**	No information	443

In Round 1, the Central Finance and Contracting Agency (CFCA) coordinated project competition “Promote energy efficiency and the use of local RES in district heating” identified 18 projects that would replace fossil energy sources (mainly natural gas) with RES (mainly

[1] Analysis of projects to replace fossil fuels with RES technologies.
[2] Analysis of projects planning only the installation of RES technologies
[3] Taking into account capacity of flue-gas capacitors

biomass). The total installed capacity in these projects amounts to 136 MW. Total funding for these projects amounts to 71 million EUR, of which almost 2 million The EUR was allocated as EU co-financing. Consequently, the specific costs of the co-financing granted on the installed RES capacity MW amounts to 143 thousand EUR. According to the information available, it is not possible to determine the expected amount of energy produced as well as the amount of GHG emissions avoided in these projects.

During the period 2010-2012, various project contests were launched for the acquisition of funding of Climate Change Financial Instrument (CCFI). In order to assess the results achieved in the capacity building of the RES, the projects implemented by municipalities in the competition “Complex solutions to reduce greenhouse gas emissions” in various layers and “Technology transition from fossil to renewable energy sources”, with new boilers, heat pumps, solar collectors and other local technologies installed. The total RES capacity of the projects analysed amounts to 26 MW. Total funding for these projects amounted to almost 7 million EUR, but co-financing by CCFI of 5.2 million EUR. Specific costs per installed RES capacity – 202 thousand EUR, which is a higher rate than in the tendering procedure for district heating projects. This is explained by a number of aspects: DH installs more power plants with lower specific costs, with a higher share of the CCFI project competition for the deployment of comparatively more expensive RES technologies (solar collectors, heat pumps).

For most of the CCFI projects carried out, the indicative amount of energy produced was also indicated, so that the specific co-financing costs on the amount of energy produced could be determined. For the various projects, these costs range from EUR 1.3 to EUR 55.8/MWh to the co-financing provided. The overall figure for this programme is EUR 7,3/MWh, assuming the duration of the systems is 20 years. Figure 2.3 shows that the higher costs on the amount of energy produced are for solar collector systems and for the installed capacity for heat pumps.

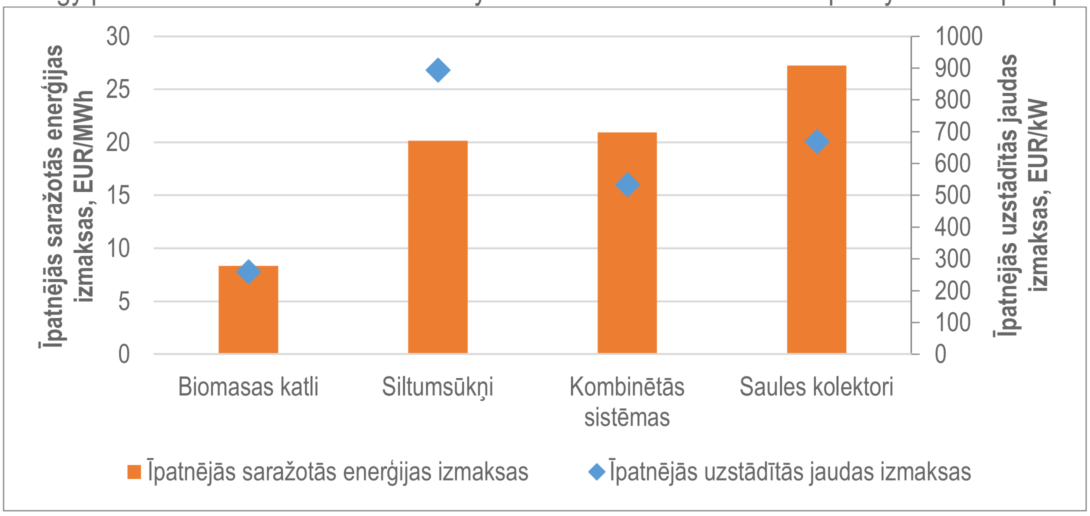

Figure 2.3 CCFI cost-effectiveness indicators for municipal projects on the co-financing of different technologies

In the projects analysed by CCFI, the total amount of GHG emissions avoided is nearly 12 thousand tonnes of CO_2 emissions per year. The specific cost of co-financing allocated per tonne of CO_2 emissions avoided is EUR 443.

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2.2.2. Evaluation of the Energy and Climate Plan

The report by the Ecology Institute and the European Climate Fund, based on the developed methodology described in Chapter 2.1.3, assessed THE non-version submitted by all Member States of the European Union. The resulting country ratings are shown in Figure 2.4.

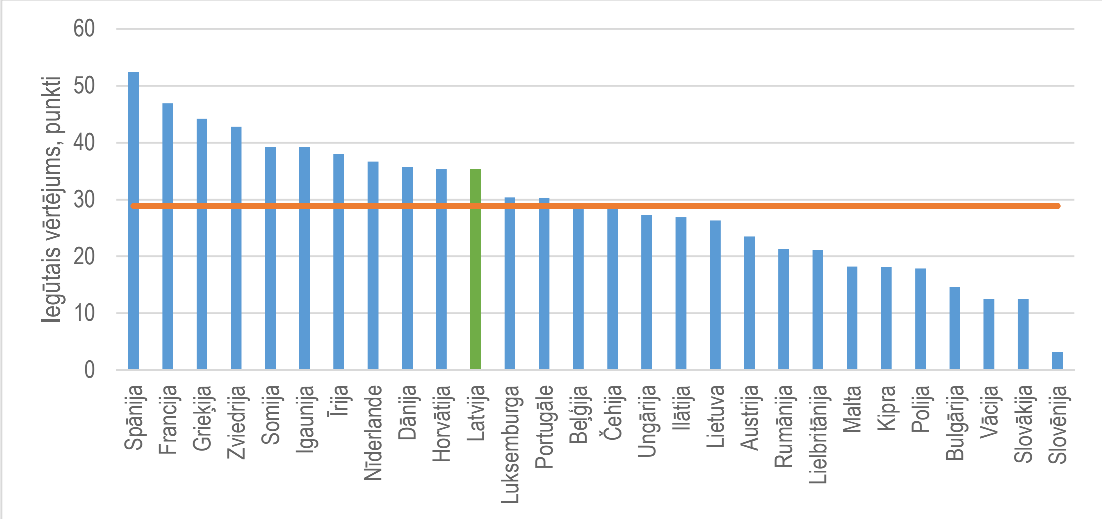

Figure 2.4 Results of the evaluation of the first version of the National Energy and Klimt Plans of the EU Member States

The NECP assessment received 35.3 points from the maximum 100 points submitted by Latvia. The assessment provides a higher assessment because Latvia has launched a consultation process with stakeholders, including social partners, and involvement of civil society. The evaluation developers have welcomed the fact that the plan contains detailed information on existing and planned policies as well as on investment needs and financing measures, part information on sectoral funding.

Latvia has a good overall GHG emissions target of -55% by 2030 (compared to 1990). Unfortunately, no higher target for non-ETS sector GHG emissions (-6%) has been set, noting that a higher target will only be set in 2020 after the adoption of the EC implementing act.

It is noted that Latvia NECP does not only provide general information on energy subsidies, but not those concerning fossil fuels, as well as policies for phasing out fossil fuels.

Table 2.8 Overview of the assessment provided by LATVIA NECP

Category	**Criterion**	**Acquired score**	**Maximum probable rating**
Target adequacy	No-ETS sector GHG emissions targets for 2030	**1,5**	15
	National GHG emissions targets for 2030	**1**	1
	RES targets for 2030	**0**	12,5
	Energy Efficiency Goals for 2030	**2,8**	12,5
	National targets for 2050	**3,6**	4
Policy Information	Policies to achieve non-ETS sector objectives	**2,3**	10
	Policies to achieve the RES targets of	**3,5**	10
	Policies to achieve energy efficiency targets	**2,8**	10
	Coal use	**5**	5
	Exclusion of subsidies for fossil fuels	**0,4**	2
	Funding	**4,7**	8
Quality of processes	Effective involvement of stakeholders	**5,6**	7,5
	Match	**2,2**	2,5

Table 2.8 summarises the resulting points in each of the categories. Although the number of points assessed in the target adequacy category is small (8.9 points), Latvia's indicator exceeds the EU average (7.3 points) in this category. Member States should aim for more ambitious GHG reduction targets in the non-ETS sector in order to achieve at least the lower "Neto zero emissions by 2050" scenario. This would demonstrate commitment and coherence with the signing of the Paris Agreement.

In the information category of the policy plan, Latvia NECP received a lower assessment of the defined policies in order to achieve the objectives of the non-ETS sector and energy efficiency. However, the overall assessment achieved in this category is increased by the fact that the reduction in coal use is highlighted in particular, but there is a very small percentage of coal in Latvia as an energy resource. Latvia has received the fourth highest ranking among all EU Member States.

2.2.3.Assessment of the sustainability of the energy sector

On the basis of the methodology described in Chapter 2.1.4, different indicators for sustainable national development have been identified. In the light of the information available, indicators are identified in the economic and environmental dimensions. Figure 2.5 shows changes in energy intensity by extending total energy consumption to GDP indicator in thousands EUR and per capita. The calculation uses available CSP data on total energy (GJ) (Central Statistical Bureau, n.d.), the total value of gross domestic product at actual prices (Central Statistical Bureau, n.d. - a), thousands EUR and total population (Central Statistical Office, n.a. - b). It can be seen that the specific total energy consumption per capita is increasing rapidly between 2016 and 2018, which is due to a decline in population and an increase in overall energy consumption. On the other hand, the energy intensity rate per GDP is declining from 2011. The energy intensity rate is higher between 2008 and 2010 as GDP declined as a result of the economic crisis.

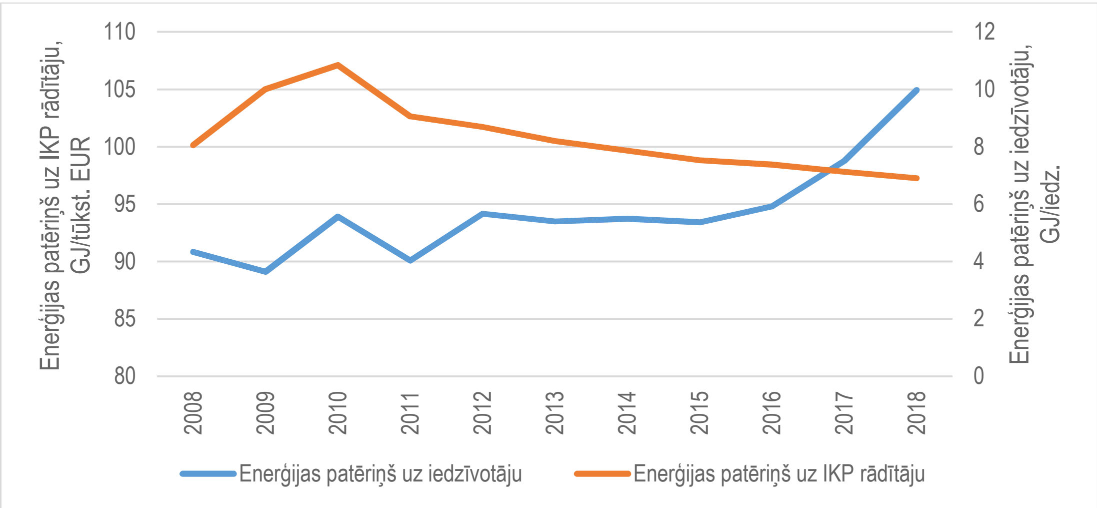

Figure 2.5 Changes in energy intensity per GDP indicator and population

A regression analysis has been carried out to analyse the relationship between total energy consumption and GDP value. Figure 2.6 shows the correlation between GDP at current prices, total energy consumption and energy intensity. The correlation factor for the overall energy consumption and GDP indicator is seen to be relatively low. In particular, the total consumption values of 2010, which are higher than other years and 2015 and 2016 values, are relatively lower (shown in red). These shifts are explained by both economic processes and meteorological conditions, since the average temperature of the winter months of 2010 was lower than in other years (see Figure 2.7).

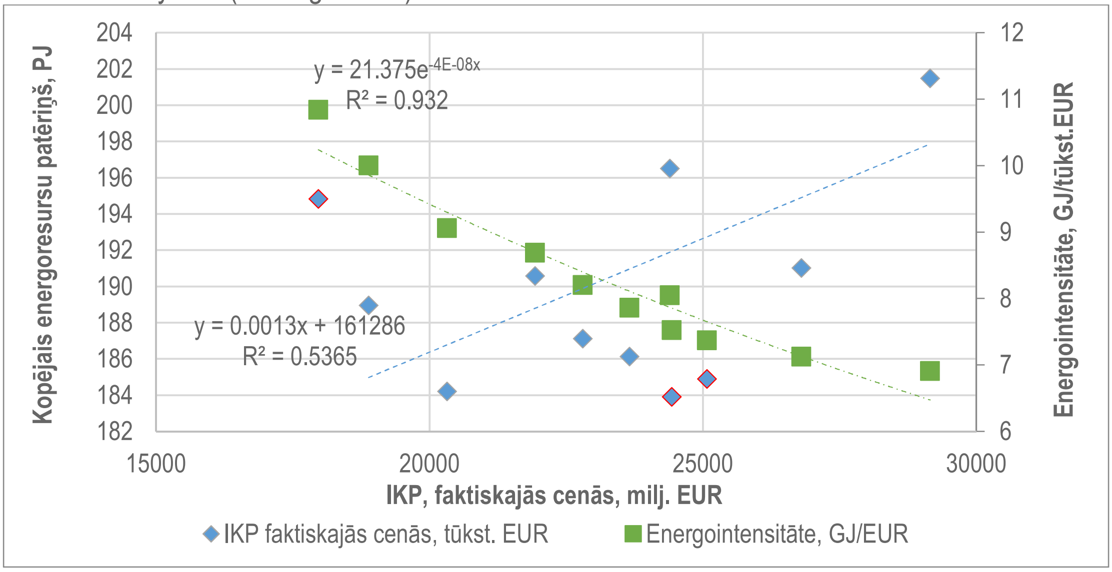

Figure 2.6 Regression analysis results for measuring the impact of GDP on total energy consumption.

Figure 2.6 shows well that the energy intensity rate is declining as the GDP indicator grows. Higher added value can be achieved in economically favorable conditions with a lower share of resources.

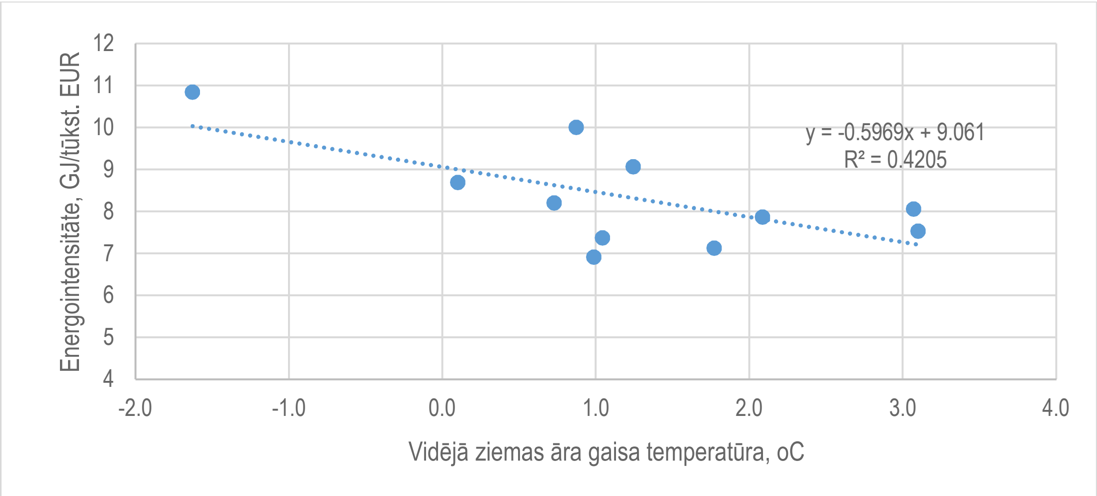

Figure 2.7 Average winter outdoor air temperature and energy intensity correlation

For an in-depth analysis of the overall energy intensity, the corresponding energy intensity indicators are identified in each of the sectors. The intensity of industry, agriculture and the public and commercial sector has been analysed against the total added value of a particular sector. On the other hand, the intensity of households and the transport sector is expressed as the sector's energy consumption to GDP per capita. The results are summarised in Figure 2.8. The energy intensity of industry and the agricultural sector appears to be similar. The commercial sector creates relatively higher added value with less energy consumption. There is a decrease in energy intensity in all sectors.

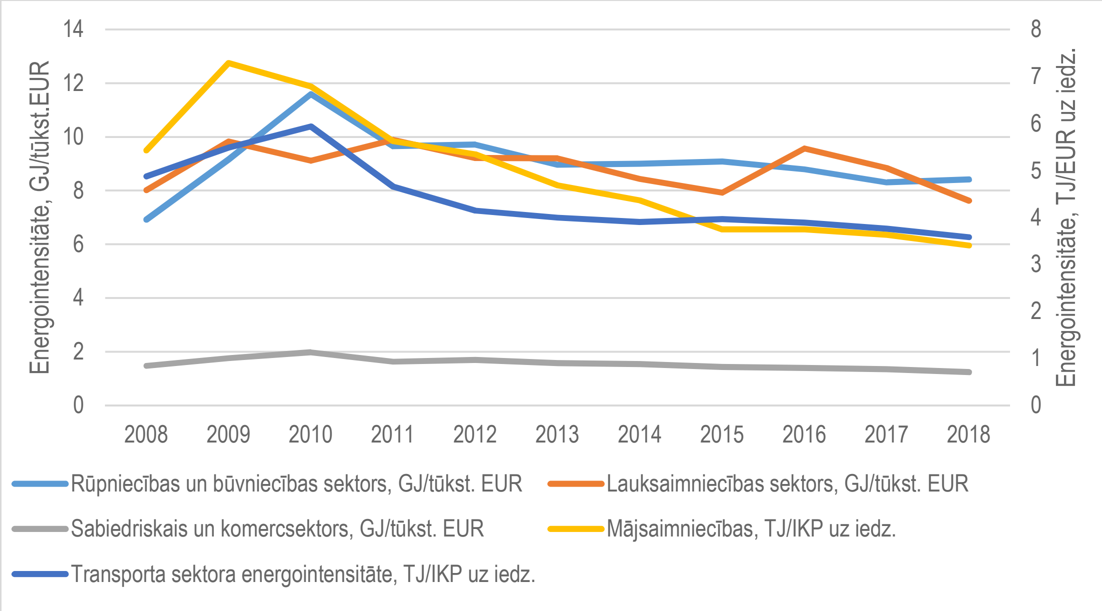

Figure 2.8 Comparison energy intensity of sectors

Figure 2.9 shows regression analysis for the agricultural sector. The correlation rates between total energy consumption and total added value in the sector are relatively high, indicating that total added value in the sector is one of the most significant factors influencing energy intensity. Energy intensity in the agricultural sector has decreased by 5% compared to 2008 and 2018 values.

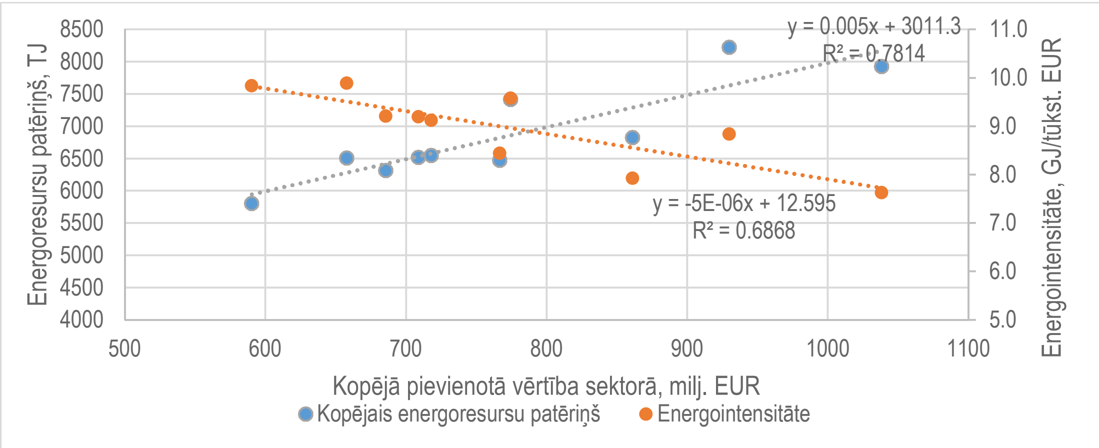

Figure 2.9 Regression analysis results for the agricultural sector

Figure 2.10 shows regression analysis for the industrial and construction sectors. Correlation ratios are relatively high. Energy intensity in this sector has decreased by 8% compared to 2009 and 2018 values.

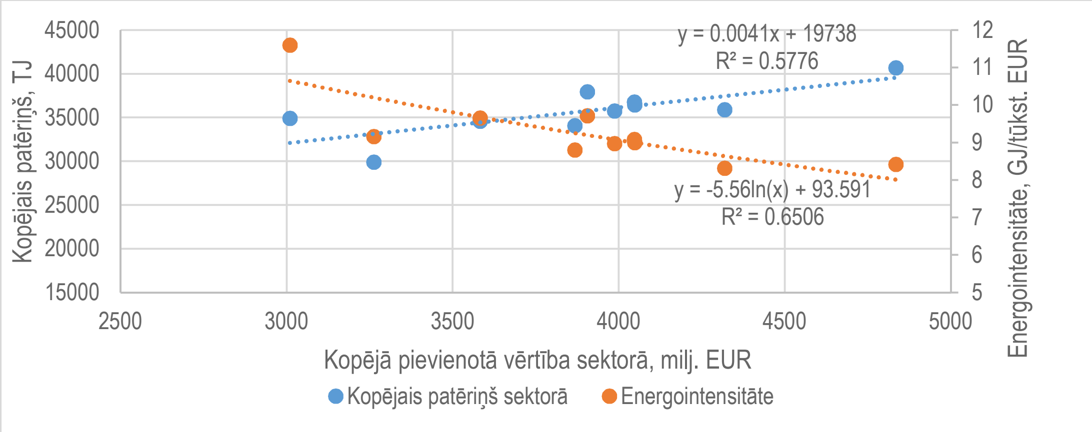

Figure 2.10 Regression analysis results for industrial and construction sectors

Figure 2.11 shows regression analysis for the household sector. Energy intensity in this sector has decreased by 37% compared to 2009 and 2018 values. It is clearly in the household sector that the reduction in energy consumption is driven by increased energy efficiency rather than by economic or climate conditions.

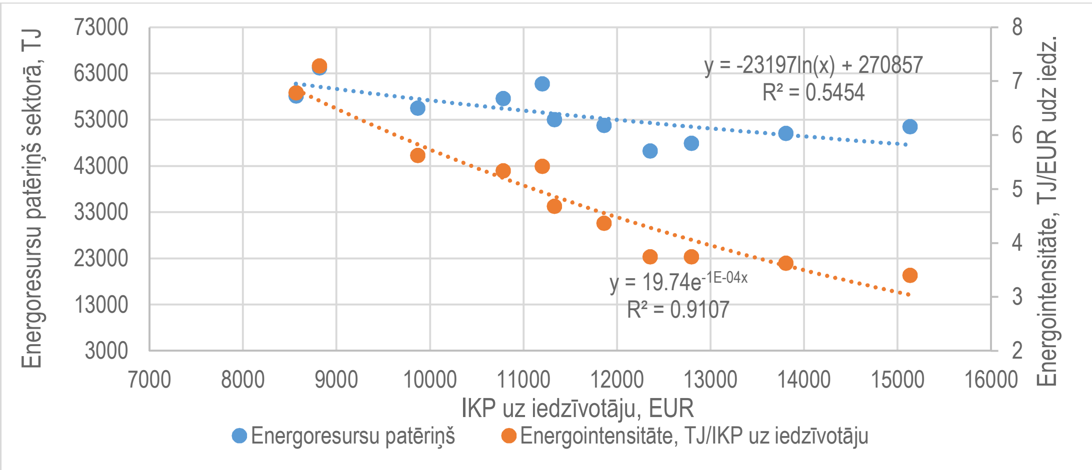

Figure 2.11 Regression analysis results for the household sector

Figure 2.12 shows regression analysis for the transport sector. Correlation factors are high for values from 2011 to 2018, with red-tagged data points in 2008-2010 that differ significantly from those of other years. Energy intensity in this sector has decreased by 27% compared to 2011 and 2018 values. This reduction has been driven by both the improvement of the economic situation and the increase in the energy efficiency of vehicles.

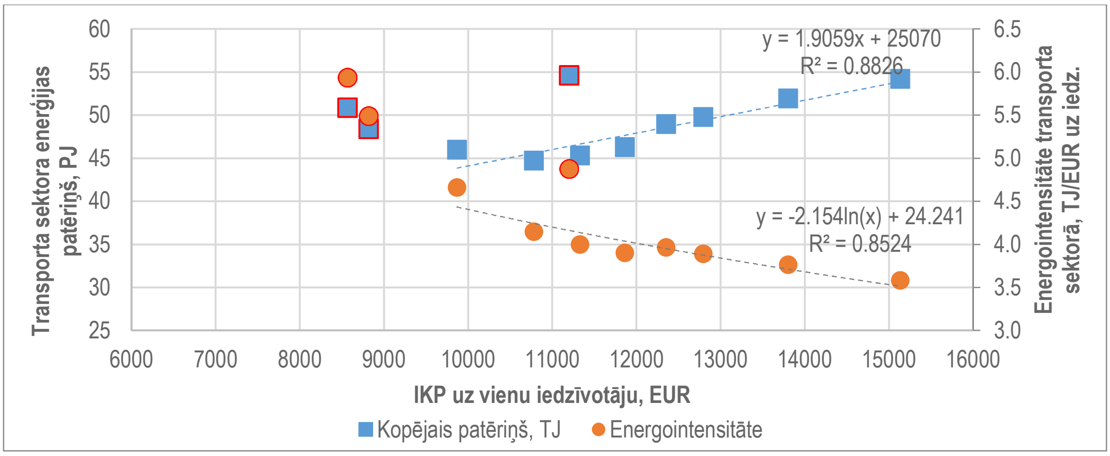

Figure 2.12 Regression analysis results for the transport sector

An in-depth analysis of the efficiency indicators of the transport sector identified different specific energy consumption indicators for different types of vehicles (see Figure 2.13). The energy consumption of road transport is attributed to the total distance travelled by road in kilometres (ODYSSEE database, n.d.). The energy consumption of air transport is attributed to the turnover of passengers transported in passenger-kilometres (Central Statistical Bureau, n.d.-d) and rail transport against the turnover of the transported goods (Central Statistical Bureau, n.d. - c), given that freight transport entails a higher railway transport load. It can be seen that the specific energy consumption of road transport per million travelled is reduced every year. Comparing the 2010 and 2016 figures shows a 10% decline. The specific energy consumption of rail transport shows a significant decrease in 2011, which is slightly increasing in 2012 and 2013. The reduction in energy consumption of air transport is the smallest - 6% compared to the 2010 and 2016 figures.

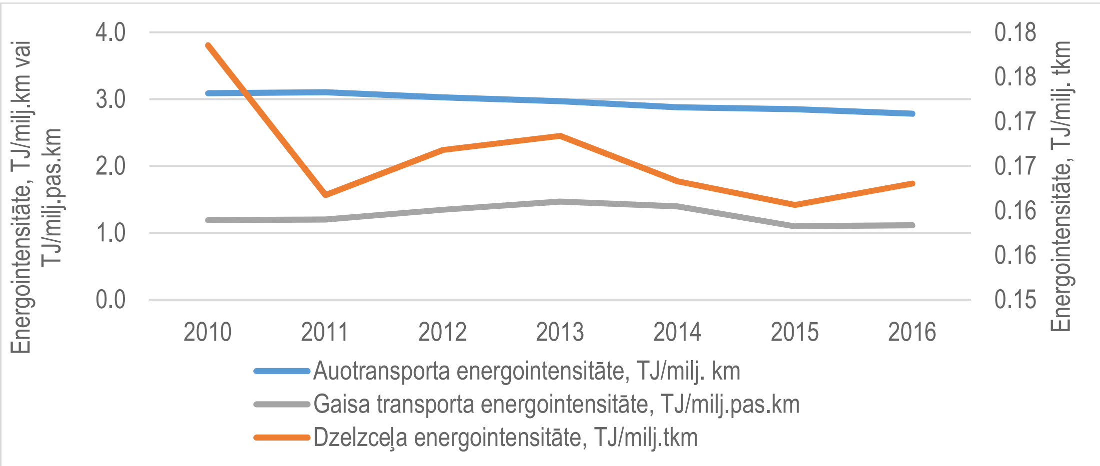

Figure 2.13 Changes in the values of energy consumption indicators for different modes of transport

A key indicator taken into account in the sustainability assessment of the energy sector is supply efficiency. To assess this, the quantities produced and delivered by specific energy carriers, shown in Figure 2.14, are compared. The efficiency of electricity supply appears to be almost unchanged at 87%, with a slight increase in the efficiency of natural gas supply and the efficiency of district heating.

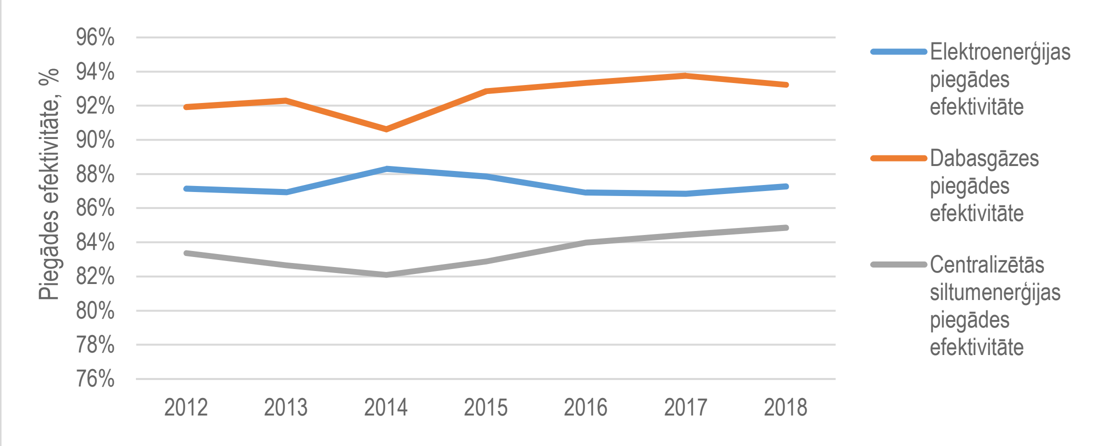

Figure 2.14 Changes in the efficiency of the supply of different energy carriers

In order to assess the diversification of energy resources, the share of different energy sources in the overall energy mix is analysed and the changes shown in Figure 2.15 Compared to 2008 and 2018 have decreased from 28% to 24%, while the share of wood consumption has increased from 23% to 31%. The share of petroleum products has fallen slightly from 35% to 32%. The total share of renewable energy resources in the overall energy mix increased from 30% in 2008 to 39% in 2017.

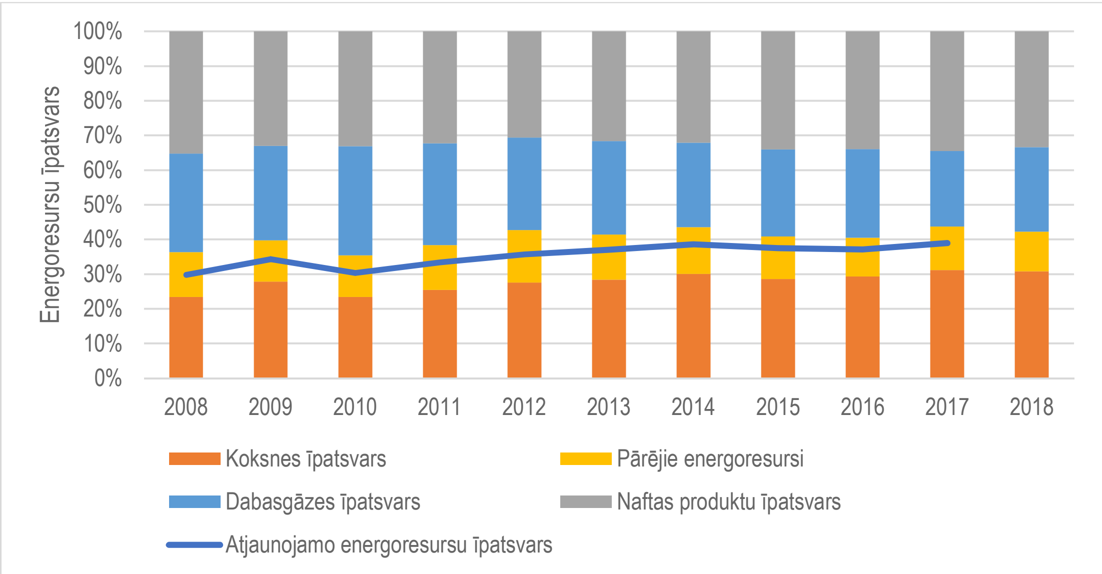

Figure 2.15 The share of different energy sources in the energy mix and the total share of renewable energy sources

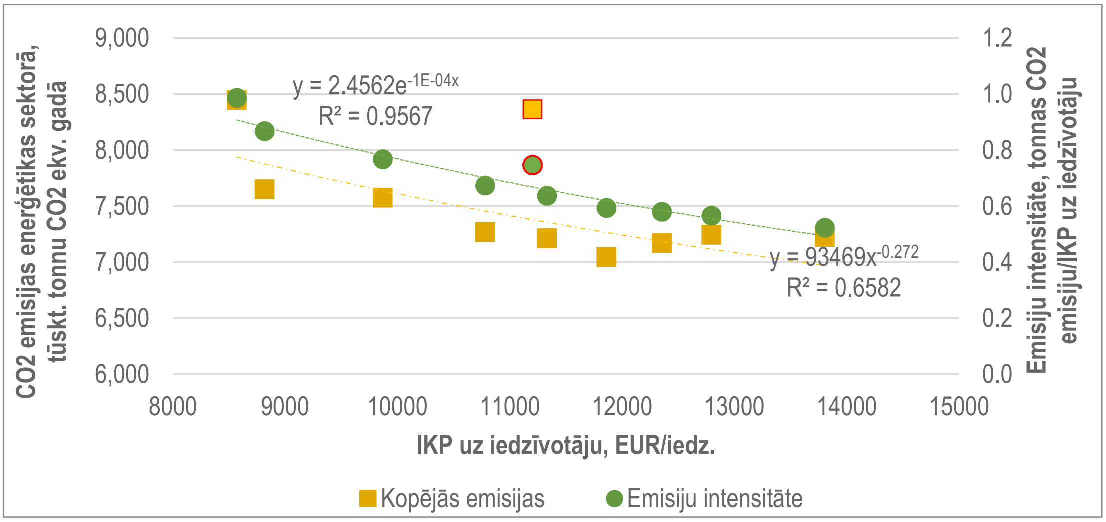

Figure 2.4 Energy sector CO_2 Emission intensity

The European Environment Agency (2019) per capita GDP indicator (see Figure 2.16) is used as an indicator for the assessment of the environmental dimension. Comparing 2008 and 2018, the specific emissions of CO_2 from the energy sector decreased from 0.7 tonnes of CO_2 eq./EUR per injection to 0.5 tonnes of CO_2 eq./EUR per injection.

A timetable of GHG emissions per capita across EU countries from 2010 to 2017 is shown below.

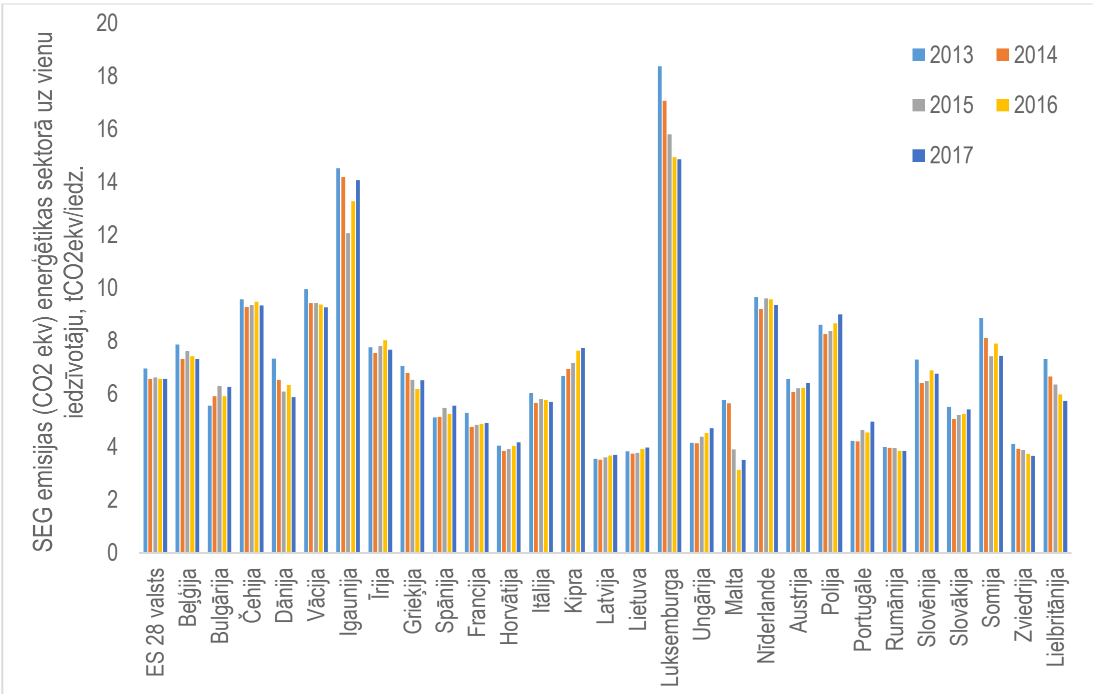

Figure 2.17 GHG emissions in EU countries per capita between 2013 and 2017.

The EU average GHG emissions per capita in the energy sector decreased by 15% between 2013 and 2017, a decrease from 7.55 tCO_2eq./per capita. In 2010, up to 6,59 tCO_2eq./per capita. In 2017. The lowest GHG emissions per capita in 2010 are for Latvia with 3.98 tCO_2eq./per capita., while in 2017 the lowest rate is Malta with 3.51 tCO_2eq./per capita. For which GHG emissions per capita have decreased by 75% over that period.

A second indicator addressed by different EU countries is GHG emissions in the energy sector against GDP.

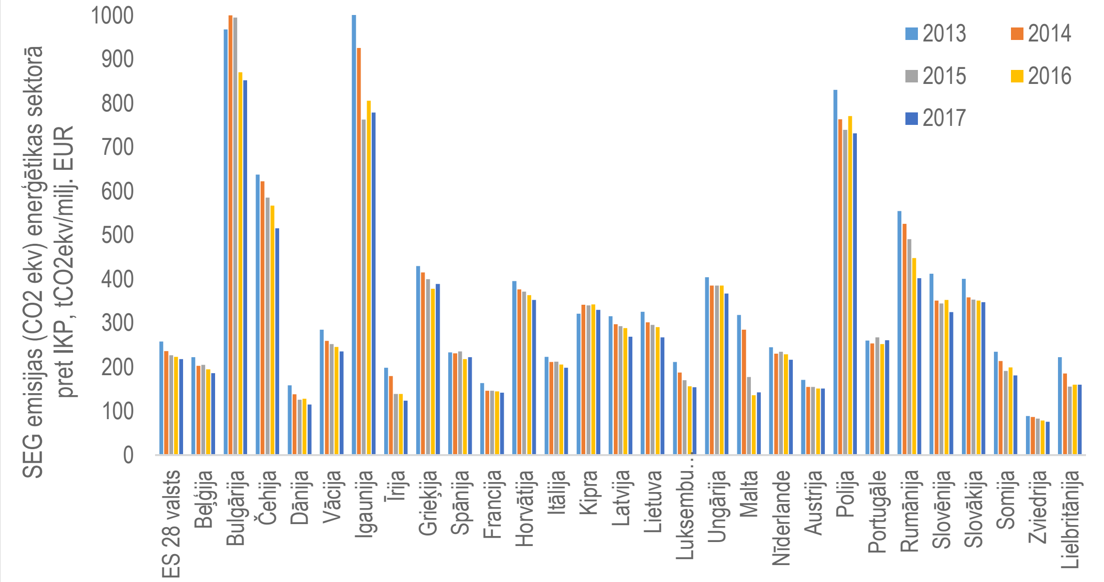

Figure 2.18 GHG emissions to EU GDP from 2013 to 2017

The EU's average GHG emissions in the energy sector per million euro GDP decreased by 1% between 2010 and 2017, a decrease from 295,7 tCO_2eq./million EUR 2010 to 218,54 tCO_2eq./million EUR in 2017. The highest indicator value in 2010 was for Estonia, which reached 1274.31 tCO_2eq./million EUR, while the lowest indicator value was for Sweden -125,9 tCO_2eq./million EUR. In 2017, the largest indicator value is for Bulgaria – 852.8, while the lowest remains unchanged for Sweden – 76,4 tCO_2eq./million EUR. The largest decrease in the absolute values of the indicator is seen in Estonia from 1274.3 tCO_2eq./million EUR to 779,5 tCO_2eq./million EUR. The largest percentage reduction was observed for Malta, which reduced GHG emissions by 169%, with the smallest reduction in both absolute and percentage values.

Figure 2.19 below looks at the change in the ratio of GHG emissions to GDP.

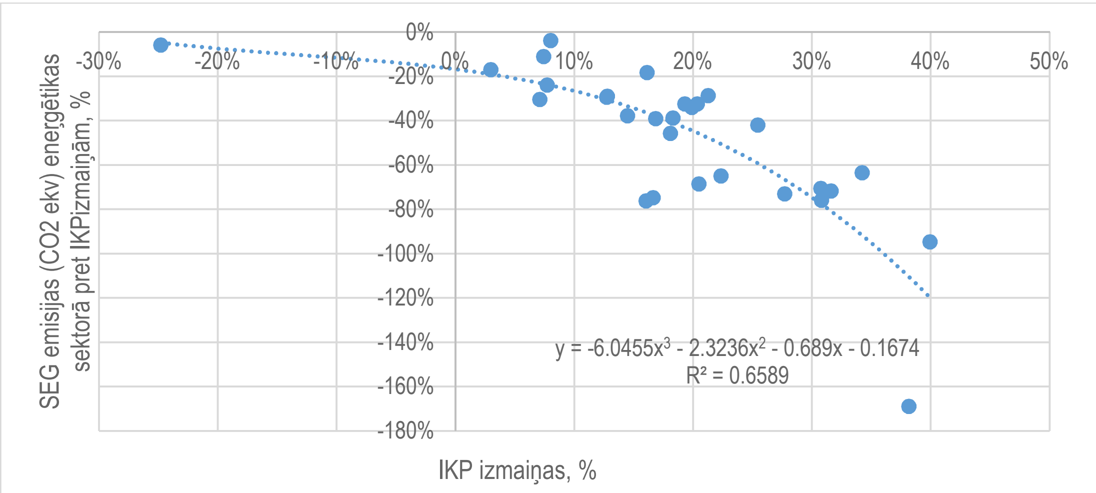

Figure 2.19 GHG emissions-to-GDP change to relative GDP changes.

The GDP of EU countries (except Greece) has increased between 2010 and 2017. The change in GHG emissions relative to GDP across all EU countries has decreased, which means that it does not contribute proportionally to GHG emissions, the higher GDP growth, the higher the reduction in the indicator value.

2.3. Development of proposals for long-term policy

The indicators for sustainable development of the energy sector set out in Chapter 2.2.3 have been used in the development of policy proposals, based on the methodology shown in Figure 2.20. The indicators used are summarised in Table 2.9.

Table 2.9 Indicators used in the analysis, their terms

Indicators	Legend	Value changes[4]
Energy intensity per GDP	$EI_{GJ/EUR}$	-36%
Energy intensity per inhabitant	$EI_{GJ/iedz.}$	+12%
Share of imported energy	$E_{imp.}$	+2%
GHG emission intensity	GHG	-47%
Energy intensity in the transport sector	$EI_{transport}$	-40%
Energy intensity in the household sector	$EI_{housholds}$	-50%
Energy intensity in the public and commercial sector	$EI_{public.commercial}$	-37%
Energy intensity in the agricultural sector in the agricultural sector	$EI_{agricalture}$	-16%
Energy intensity in the industrial sector	$EI_{industrial}$	-27%
Efficiency of energy supply	EF_{supply}	0%
Diversification of energy resources	E_{mix}	-
Renewable energy share	RES	+28%

The largest reduction in energy intensity is seen in the household, transport and commercial sector, as well as the energy sector's GHG emissions have decreased significantly. Less energy intensity is seen in the agricultural and industrial sectors. Comparing the 2010 and 2018 figures shows that the share of imported energy has increased slightly and the average energy supply efficiency has remained stable. As regards the diversification of energy resources, it should be noted that the share of natural gas has decreased, while wood consumption has increased. Consequently, three main energy sources – natural gas, wood and petroleum products – still dominate the energy balance.

[4] Comparing 2010 and 2018 figures

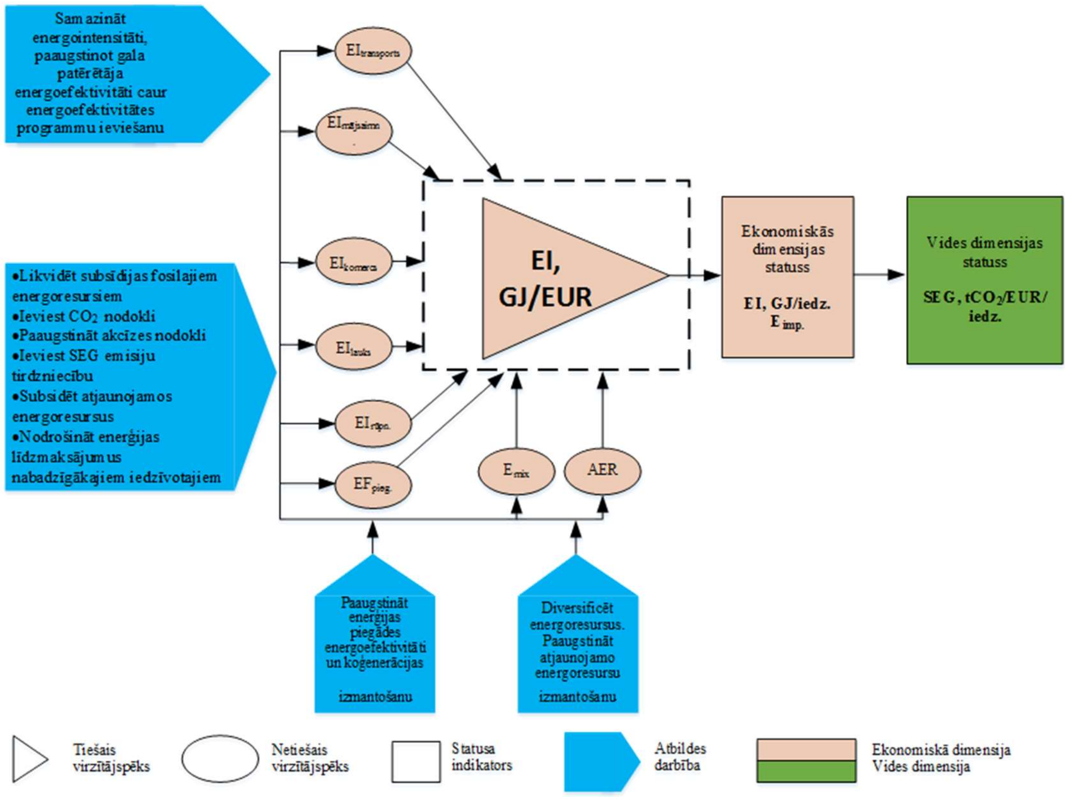

Figure 2.20 Methodology for the development of proposals based on indicators for sustainable development in the energy sector (Streimiiene et al., 2007)

The main policy measure to reduce energy intensity is increasing energy efficiency. Various energy efficiency improvement programmes are already in place in Latvia, which is an effective means of achieving this goal. However, these programmes and the results achieved need to be continuously reviewed in order to promote the integration of energy efficiency programmes into all sectoral policies. In this respect, the introduction of a legal and regulatory framework enabling the creation of an environment conducive to energy efficiency is crucial.

2.3.1. Evaluation of energy efficiency programmes

In order to assess the effectiveness of the various energy efficiency policies, the specific cost of energy saved against the co-financing provided for the various support mechanisms in different sectors is so determined. An overview of the programmes analysed, applicants for support, the implementation period, the administering authority, the benefits to be supported and the number of projects analysed is shown in Table 2.10.

Among the programmes analysed are four programmes to improve the energy efficiency of buildings, a district heating energy efficiency programme analyzing projects for the reconstruction of heat streams, as well as an energy efficiency programme for industrial firms, which allowed production companies to take very different energy efficiency measures. At present, none of these programmes has undergone a detailed assessment of the total energy saved against the financial support provided. In order to assess the cost-effectiveness of the programmes, publicly available information on the activities carried out, the indicators achieved and the co-financing of the projects awarded was pooled.

Table 2.10 Energy efficiency programmes analysed

Energy Efficiency Programme	**Aid applicants**	**Implementation period**	**Administrative body**	**Supported Activities**	**Number of projects analysed**
Promoting efficient use of energy resources, reducing energy consumption and switching to RES in the manufacturing sector	Manufacturing companies	2018-2020	CFCA	Warming-up of buildings, replacement of production equipment, rebuilding of heat production system	39
Promoting energy efficiency and the use of local RES in district heating	District heating plants	2018-2020	CFCA	Reduction of loss of heat transmission	29
Measures for improving the thermal resilience of multi-apartment dwellings	Owners of multi-apartment buildings	2009-2013	IDAL	Warming of buildings	487
Complex solutions to reduce greenhouse gas emissions	Government	2010-2012	Environmental Investment Fund	Warming of buildings, reconstruction of the ventilation system, reconstruction of heating systems	85
Support for the implementation of energy efficiency improvement measures for apartment owners of multi-apartment houses	Owners of multi-apartment buildings	2018-2020	ALTUM	Warming of buildings, reconstruction of the ventilation system, reconstruction of heating systems	48
Promote energy efficiency and the use of renewable energy resources in municipal buildings in line with the local government's integrated development programmes	Government	2018-2020	CFCA	Warming of buildings, reconstruction of the ventilation system, reconstruction of heating systems	68

Figure 2.21 shows that financial support for energy efficiency in industrial companies has been most efficient, mainly due to the low co-financing rate (30%) and the high potential for energy savings in different production processes. Woodworking and metalworking companies dominate the sectors to be supported.

Significant differences are seen in the indicators achieved by the support programmes for building warming. Less specific costs are in the IDAL and CCFI projects, which are due to lower construction costs at the time these programmes were implemented. On the other hand, significantly higher specific costs for the amount of energy saved are in the programme for energy efficiency improvements in municipal buildings implemented in 2018-2020.

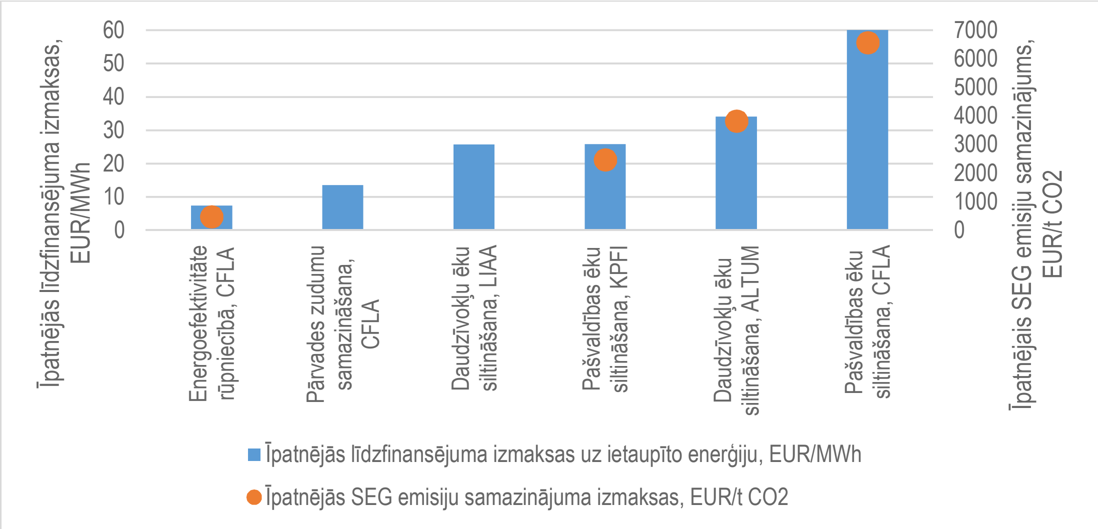

Figure 2.21 Specific co-financing of different energy efficiency programmes and reduced GHG emissions costs

Figure 2.22 shows the specific costs of the various supported energy efficiency improvement projects for municipal buildings. It should be noted that the figure does not show projects for which there is no publicly available information on potential savings (e.g. projects implemented by Daugavpils municipality).

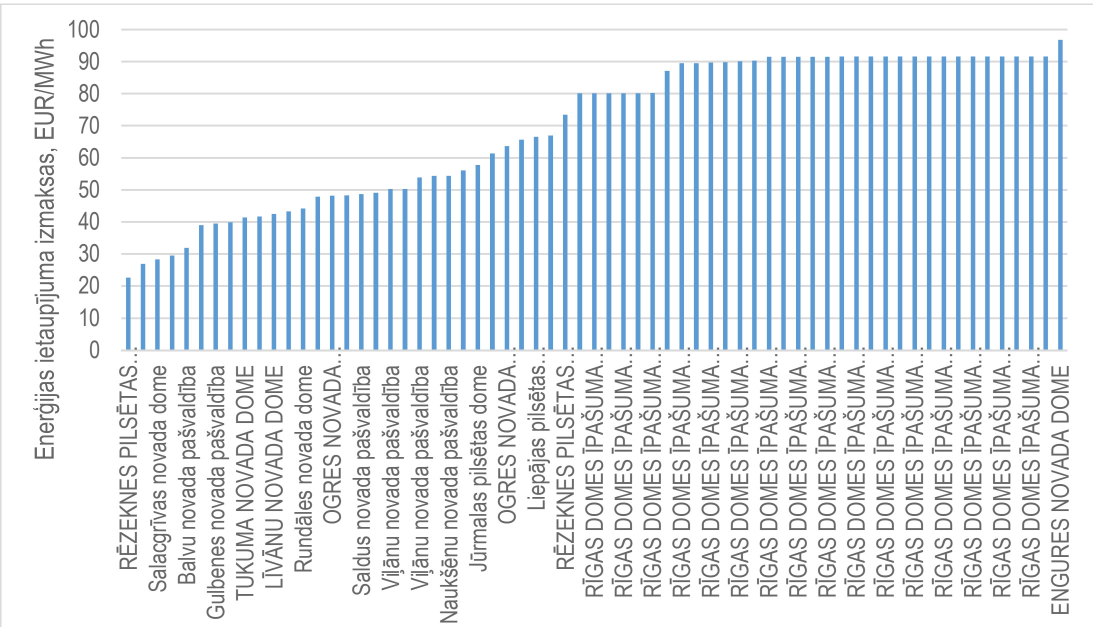

Figure 2.22 Specific costs of projects implemented under the Local Government's Integrated Development Programmes to promote energy efficiency and the use of renewable energy resources in municipal buildings in Round 1 against co-financing

In the light of the analysis of the energy efficiency programmes mentioned above, it appears that the programmes implemented need to be made more targeted so that the funds allocated can provide maximum energy savings. The implementation of the monitoring system and the public availability of data on the savings achieved are essential to assess the effectiveness of the funding provided.

There are still many areas for improving energy efficiency, such as the household sector, which reflects high energy consumption, resulting from both the low efficiency of buildings and the availability of cheap energy. As household consumption accounts for a large part of total energy final consumption in the Baltic States, overall energy efficiency remains quite low. In order to successfully meet the energy efficiency targets, set, investment in the energy efficiency of buildings should be accelerated and sources of financing should be diversified. The main identified barriers to building renovation projects are the large number of owners per building, the fact that many owners have low incomes and limited lending opportunities, the long recovery times for energy efficiency projects, and the lack of energy efficiency specialists and energy services companies. In order to overcome these barriers, it is necessary to continue subsidized loans, credit guarantees and energy efficiency contracts. (Organisation for Economic Cooperation and Development, 2019)

2.3.2. Implementation of the assessment of local government policies

In its Communication on the European Green Deal (European Commission, 2019), the Covenant of Mayors (García & Khandke, 2019) is referred to as a "central force" to "help cities and regions that want to make ambitious climate and energy policy commitments" and "an essential platform for the exchange of good practices on how to implement changes at local level". The Covenant of Mayors' website (European Union, 2019) summarises information on cities and municipalities that have joined the climate and energy initiative. The signatories to the Pact Europe demonstrate a strong commitment to the European Union's climate and energy objectives.

21 municipalities have joined the Latvian Covenant of Mayors, of which 9 have submitted a monitoring report on progress. An overview of Latvian municipalities is shown in Table 2.11.

Table 2.11 Overview of municipalities adding to the Covenant of Mayors and progress reports submitted

Government	Signed mayor's pact	Sustainable Energy Action Plan Monitoring report	Monitoring report	Monitoring report	CO_2 reduction target,%
Balvi	2012	2014			
Daugavpils	2016	2017	2018	2019	40
Ikskile	2011	2013			
Jelgava	2009	2011	2015	2017	20
Jekabpils	2009	2011	2015	2017	20
Jurmala	2013	2014	2016	2018	20
Kegums	2012	2013			
Karsava	2012	2014			
Lielvārde	2011	2014			
Liepaja	2012	2013	2017	2019	35
Limbazi	2012	2014			
Livani	2012	2014	2016	2016	20
Ludza	2012	2014			
Ogre	2011	2013			
Riga	2008	2010			
Salaspils	2011	2013			
Saldus	2012	2014	2017	2017	20
Smiltene	2016	2018	2018	2018	40
Tukums	2009	2011	2015	2015	20
Valka	2013	2014			

Vilani	2013	2014			

In order to encourage the involvement of municipalities in achieving common climate and energy objectives, grouping of municipalities is proposed, depending on the value of the efficiency indicators achieved. It is proposed that local governments be divided into 3 different groups and that appropriate awards, incentives or other incentive measures should be identified, which would stimulate local governments to improve their performance and to enter the group of best municipalities.

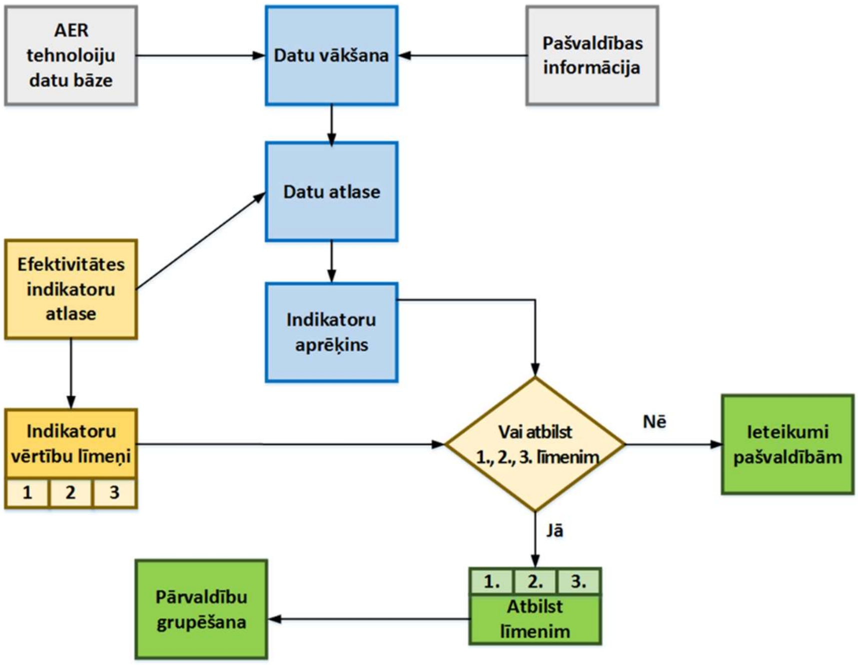

Figure 2.23 Local Government Assessment Algorithm

The key to implementing such an assessment methodology is to use sound and easily comparable indicators. Figure 2.24 provides key steps to identify energy efficiency assessment indicators for the assessment of municipalities

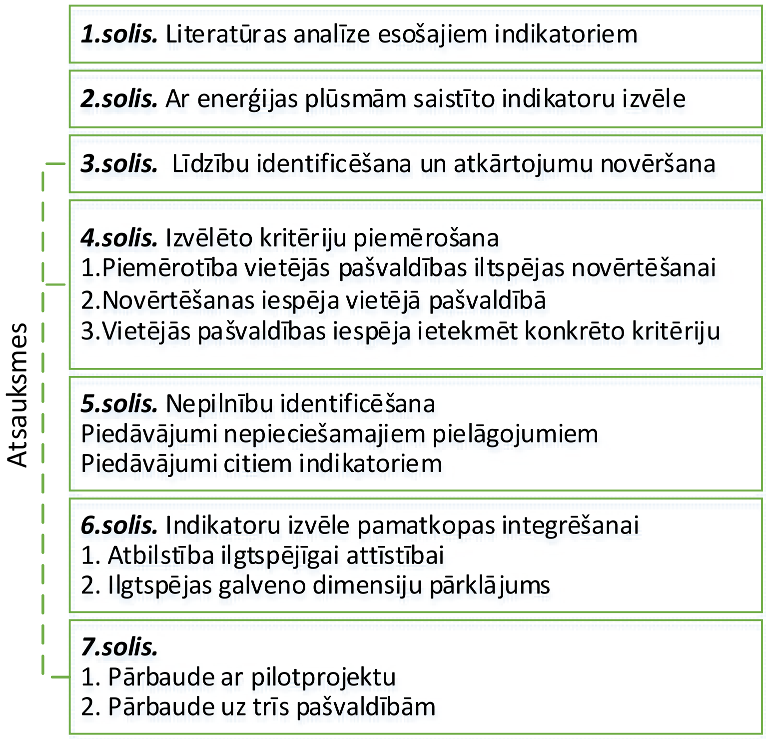

Figure 2.24 Methodology for determining key indicators and rating criteria

Table 2.12 Examples of potential energy efficiency indicators for municipal evaluation

Target	**Indicators**	**Unit of measurement**
GHG emissions reductions	Specific thermal energy consumption in buildings	kWh/m^2 per annum
	Specific electricity consumption in municipal buildings	kWh/m^2 per annum
	Consumption of energy per capita	MWh/per capita
	Are the energy criteria included in specifications, procurement documents and contracts and all public building services and maintenance contracts?	Yes/No
	Are the energy certificates of the building publicly displayed in all public buildings?	Yes/No
	Do local government energy companies offer energy-efficiency services and renewable energy contracts to their customers?	Yes/No
	Has the municipality developed a Sustainable Development Strategy?	Yes/No
	Do local governments employ energy workers for coordinating and analyzing the financing of energy consumption, energy efficiency, local energy production, infrastructure and related projects?	Yes/No
Renewable energy sources	Share of RES in total municipal energy consumption	%
	Substitution of fossil energy sources with RES	MWh
	Installed RES Capacities	MW
Improving energy efficiency	Share of renovated buildings from total number of buildings	%
	Share of energy-efficient lighting from total lighting	%
	Energy savings from integrating energy supply	kWh
	Improved energy efficiency due to the integration of energy supply	%
	Share of district heating losses	%

	Energy consumption for public transport against passenger km travelled	kWh/km
CO_2 emissions	CO_2 emissions per capita	tCO_2/per capita

Potential energy efficiency indicators are summarised in Table 2.12, which can be used in the assessment of the energy efficiency of the municipality. Among the identified indicators are the specific thermal energy consumption in buildings, which may be separately analysed in municipal buildings and residential buildings. The local government may directly influence the energy consumption of local government buildings by taking energy efficiency measures. The reduction in the consumption of residential buildings has an indirect effect, informing residents about renovation measures, energy efficiency, as well as providing different types of support to reduce energy consumption.

The evaluation includes a variety of qualitative criteria related to the integration of the energy efficiency component into municipal processes, long-term planning, public awareness of the relevance of energy and climate policies, and cooperation with local energy producers. An important role should be given to assessing the integration of the RES by determining the share of the RES in the municipal energy mix, as well as the amount of energy produced from the RES and the capacity installed.

In order to assess the energy efficiency potential of the municipality, the share of renovated buildings, the share of energy-efficient lighting that can be assessed in both buildings and street lighting, and the loss of district heating. The assessment may include energy savings achieved from the integration of energy supply. In addition, the criterion for CO_2 emissions per municipal population is included.

Summary

Different methods exist to assess the existing energy policy and the objectives pursued. An in-depth analysis of the overall environmental policy rigor, the potential for the integration of renewable energy sources, the different national climate plans and the various sustainability indicators of the energy sector.

For the evaluation of renewable energy resources, a status indicator for the deployment of different RES technologies has been identified, allowing an indirect assessment of the effectiveness of the implementation of the policies implemented. The highest status indicator is determined for hydropower and biomass but lower for solar and wind energy. In addition, the implementation costs for two different support programmes are analysed: CCFI "Technology transition from fossil to renewable energy" and "Complex solutions to reduce greenhouse gas emissions" and CFCA "Promote energy efficiency and the use of local RES in district heating". Among these two programmes, more cost-effective results are demonstrated by the RES technologies introduced by the DH, as the DH is equipped with higher capacity equipment with lower specific costs, as well as A higher proportion of the CCFI project competition for the deployment of relatively more expensive RES technologies (solar collectors, heat pumps). However, in order to deepen the analysis of the results obtained from support for RES technologies, there is a lack of information on installed capacity, energy produced and the efficiency of installations.

The report provided by the Institute of Ecology and the European Climate Fund on the first versions of NECP various countries, provides a medium-high assessment. Latvia has a good overall GHG emissions target of -55% by 2030 (compared to 1990). However, a lower assessment is due to the absence of a higher target for non-ETS sector GHG emissions (-6%).

The report concludes that NECP is no information from Latvia regarding the abolition of energy subsidies for fossil fuels, as well as policies for phasing out fossil fuels.

Various indicators describing sustainable state development in the economic and environmental dimensions have been identified in order to assess the current situation in Latvia's energy sector. As the main indicator, the energy intensity is chosen to refer the total energy consumption in different sectors to the GDP indicator in thousands EUR and per capita. In addition, indicators such as the share of imported energy, GHG intensity, energy supply efficiency, diversification of energy resources and the share of renewable energy resources are analysed. The largest reduction in energy intensity is seen in the household, transport and commercial sector, as well as the energy sector's GHG emissions have decreased significantly. Less energy intensity is seen in the agricultural and industrial sectors.

The main policy measure to reduce energy intensity is increasing energy efficiency. Various energy efficiency improvement programmes are already in place in Latvia, which is an effective means of achieving this goal. However, these programmes and the results achieved need to be continuously reviewed in order to promote the integration of energy efficiency programmes into all sectoral policies.

The study identified the specific cost of energy savings against the co-financing of the various support mechanisms for energy efficiency. Among the programmes analysed, the financial support provided to improve energy efficiency in industrial enterprises has been most efficient, the main reasons for which are the low co-financing rate (30%) and the high potential for energy savings in the various production processes. In the light of the analysis of energy efficiency programmes, it is concluded that the programmes implemented need to be made more targeted in order to provide maximum energy savings.

Various policy instruments should play an important role in reducing energy intensity in the transport sector, which is the main source of GHG emissions and an important source of air pollution. The Latvian car fleet is out of date, with high consumption of diesel fuel. Although the population is shrinking, the number of cars is increasing due to the increasing economic wellbeing of the population and the observed suburbanization.

In recent years, renewable energy investments have increased to be pursued in order to meet the EU target for the share of RES in gross final energy consumption. The main reason for the increase in RES has been the increase in the use of biomass in heat and electricity generation. However, in order to achieve the 2030 target, it is necessary to extend the use of other renewable energy sources, particularly solar and wind energy.

In the field of energy security, the main policy actions chosen on the basis of calculated targets are the following:

- Increase the diversity of energy types by supporting alternative energy generation technologies;
- Improving the maintenance of existing energy infrastructure and increasing efficiency;
- Remove restrictions that hinder modernization and investment in new sites.

The possibilities for greenhouse gas mitigation in the electricity and thermal energy sector may be aimed at improving supply efficiency or at reducing consumer energy consumption. GHG mitigation capabilities in the energy sector include, inter alia, improvements in combustion efficiency, fuel switching, reduction of transmission and distribution losses. There are a number of ways to reduce GHG emissions: increasing efficiency and switching to lower-carbon fuels or expanding the energy system through new production technologies.

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