THE GOVERNMENT
OF THE GRAND DUCHY OF LUXEMBOURG
Ministry of Energy and Land Use Planning
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Ministry of the Environment, Climate and Sustainable Development;

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Integrated National Plan
energy and climate in Luxembourg
for the period 2021-2030

Draft update

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1 outline and procedure for drawing up the plan

1.1 summary

1.1.1 summary table of key objectives

Dimension	Key objectives
Decarbonisation	• Reduction of GHG emissions allocated to Luxembourg under Regulation (EU) 2018/842 by 55 % by 2030 compared to 2005 ○ Sectoral climate targets from 2021 to 2030 for 5 sectors (industry, transport, buildings, agriculture, waste) covering all GHG emissions allocated at national level • Long-term objective of climate neutrality to reach net zero emissions in Luxembourg by 2050 at the latest • Increase in net absorption in LULUCF by -27 kt CO_{2eq} in 2030 compared to average net removals for the years 2016, 2017 and 2018 (estimated total net absorption in 2030: —403 kt CO_{2eq})
Renewable energies	• Increase in the share of renewable energy in gross final energy consumption compared to NECP 2020 from 25 % in 2030 to 37 % in 2030 • Accelerated deployment of different technologies in the sectors of electricity and heat production from renewable energy sources as well as electromobility and the use of sustainable and renewable hydrogen biofuels and its derivatives in the transport sector
Energy efficiency	• 44 % energy efficiency improvement target by 2030 (compared to EU PRIMES (2007) European benchmark for 2030) • Efficient and high-quality energy renovations (thermal envelope improvement) of existing buildings with the introduction of (European) public sector obligations, incentives (before mandatory phase) and obligations for non-residential buildings and voluntary approach with subsidy and support for residential buildings • All new residential and non-residential buildings automatically equipped with fossil-free heating systems • Decarbonisation of existing residential buildings as a priority through heat pumps with a fossil phase-out based on a voluntary approach with significant financial incentives • Decarbonisation by accelerated fossil phase-out for existing functional buildings with a surface area greater than $^{1.000\ m^2}$ with priority over administrative buildings in the tertiary sector, through heat pumps and after consultation with the sectors concerned regarding the timing of the entry into effect of the obligation • Energy Efficiency Obligation Scheme (EEOS) with ambitious annual targets • Evolution of the voluntary agreement with Luxembourg industry with the integration of decarbonisation as a complement to energy efficiency and renewable electricity generation and self-consumption

	• Implementation of the Climate Pact for Business with SME support to identify and mobilise the implementation of their concrete energy transition and decarbonisation projects • Installation of renewable thermal networks • Reducing traffic through the massive expansion of public transport and a 49 % share of electro-mobility by 2030 • Risk-sharing mechanism for energy efficiency and business decarbonisation projects • Emergence of an important energy efficiency market in the industrial sector, SMEs and administrative buildings
Security energy supply	• Ensuring a very high level of security of energy supply for all types of energy • Remaining among the countries with the highest level of security in Europe • Maintain a good balance between the expected level of security compared to the resources invested by the state and consumers, base as far as possible on energy efficiency, flexibility, as well as local and renewable resources • Ensuring network capacity that meets the increasing demands of the country's economic and demographic development • Diversifying countries of origin and supply routes • Anticipate security of supply needs for hydrogen and prepare corresponding measures, including synergies with other forms of energy (e.g. storage of surplus renewable electricity)
Internal energy market	• Ensuring a high level of interconnection beyond the interconnection levels of other EU countries • Increasing integration into the interconnected European electricity grid • Deepening the common gas market with Belgium • Developing the hydrogen market and infrastructure that meets future needs • Deepen cooperation at the Pentalateral Energy Forum • Developing the national market with a view to a high level of transparency, competitiveness and efficiency for the benefit of household customers and businesses • Pushing digitalisation and making the energy market more flexible • Tackling energy poverty
Research, innovation and competitiveness	• Strengthening governance and coordination of R & D & I activities in relation to NECP themes • Strengthening interdisciplinary collaboration across the entire maturity chain (from basic research to technological or regulatory implementation) • Accelerate the implementation of solutions produced by the public and private R & D & I ecosystem in Luxembourg

1.1.2 summary table of key policies and measures

Dimension	Key policies and measures
Decarbonisation	Cross-cutting policies and measures • Climate Law establishing the institutional framework and governance of climate policy at national level, including national and sectoral climate targets • Annual CO_2 surcharge of EUR 5/t CO_2 to reach a level of EUR 45/t CO_2 in 2026, with the revenues generated being used fairly to finance climate and energy transition measures and social compensation measures for low-income households, namely the 'climate tax credit' for the two lower income quintiles and the increase in the cost of living allowance • Continuous development of the Climate Pact with municipalities • Decarbonisation strategy pursuing the objective of climate neutrality of the state administration as of 2040 • Wide range of financial incentives (Klimabonus Wunnen, Klimabonus Mobilitéit, Klimabonus Bësch, business support schemes, etc.) and consolidation of financing tools (Climate and Energy Fund, etc.) • Supporting citizens and businesses through awareness-raising offers and programmes, information and advice • Initial and continuing vocational training in skills needed in the energy transition and climate action • Design of measures ensuring the implementation of a just transition and development of a 'Social Climate Plan' in line with Regulation (EU) 2023/955 establishing a Social Climate Fund Buildings • Nearly zero-energy buildings (nZEB) according to the regulation on the energy performance of decarbonised buildings and heating systems (a heat pump is the reference for any new construction (decarbonisation through electrification)) • Ambitious renovation of the existing building stock, with a focus on supporting and supporting energy renovation measures • Decarbonisation of existing residential buildings as a priority through heat pumps with a fossil phase-out based on a voluntary approach with significant financial incentives • Decarbonisation by accelerated fossil phase-out for existing functional buildings with a surface area greater than$^{1.000\ m^2}$ with priority over administrative buildings in the tertiary sector, through heat pumps and after consultation with the sectors concerned regarding the timing of the entry into effect of the obligation • Financial incentives for the decarbonisation of residential buildings through the Klimabonus Wunnen scheme, complemented by a social top up • Energy Efficiency Obligation Scheme (EEOS) in place since 2015 with ambitious annual targets complemented by alternative policy measures to achieve energy savings for final consumers • Pioneering role of the state and municipalities, in particular with regard to their buildings and lighting

	Transport and Mobility • Implementation of the National Mobility Plan 2035 (PNM2035) and promotion of public transport and active mobility • Accelerated development of electromobility through aid schemes for the acquisition of zero-emission vehicles and the installation of charging points (Klimabonus Mobilitéit, social leasing of electric cars and business support schemes), complemented by tax incentives for electric cars • Extension of the charging infrastructure by means of aid schemes and by facilitating the installation of charging points, in particular in buildings in co-ownership and areas of activity • Reduction of the sale of fuel to non-residents through the gradual increase of CO_2tax Industry • Climate Pact for Enterprises (SMEs) (Klimapakt fir Betriber) • Voluntary agreement on decarbonising and improving energy efficiency in industry • Mandatory energy audits (with revised criteria and identification of decarbonisation potentials) • Energy Efficiency Obligation Scheme (EEOS) facilitating the identification of the largest energy savings potential in industry • Revision of aid schemes for enterprises, with the introduction of contracts for difference (OPEX aid) in addition to investment aid (CAPEX aid), in line with European state aid rules • Risk-sharing mechanism for energy efficiency and business decarbonisation projects Waste • Implementation and continuous development of the waste legislation and the National Waste and Resource Management Plan • Promoting the circular economy, including through the implementation of the 'Kreeslafwirtschaft Lëtzebuerg' and 'Null Offall Lëtzebuerg' strategies • Modernisation and extension of waste water treatment plants and implementation of the strategy for the recovery of sewage sludge Agriculture • Legal framework transposing Luxembourg's National Strategic Plan for the implementation of the Common Agricultural Policy 2023-2027, including farm advice and support for sustainable and environmentally-friendly agriculture • Strengthening the regulatory framework for the use of nitrogen fertilisers in agriculture LULUCF • Consolidation of sustainable management of public and private forests • Promotion of the Klimabonus Bësch scheme for private forests • Increased use of wood from Luxembourg forests as building material • Financial incentives for arable land management to increase organic carbon content, complemented by support for agroforestry

Renewable energies	• Accelerated PV deployment through tenders and a multitude of regulatory and economic measures • Increase in wind power through 'Repowering' projects and the authorisation of new sites • Use of heat pumps to increase the share of renewable energy in the heating sector • Development of renewable hydrogen transport and storage infrastructure and use of hydrogen in industry sectors that are difficult to electrify • Blending of biofuels, accelerated deployment of electro-mobility and the use of hydrogen and its derivatives in the different transport sectors
Energy efficiency	• Nearly zero-energy buildings (nZEB) according to the Energy Performance of Buildings Regulation • Ambitious renovation of the existing building stock, with a focus on supporting and supporting energy efficiency improvements in housing • Creation of an important energy efficiency investment market for industry, SMEs and large office buildings (through a combination of energy audits, strengthening the voluntary agreement with the industrial sector and implementing the business climate pact targeting in particular SMEs, pursuing and maintaining the ambitious objectives of the Energy Efficiency Obligation Scheme (EEOS) obliging electricity and natural gas suppliers to incentivise energy savings among final consumers) • Increased energy efficiency in the transport sector through reduced traffic, massive expansion of public transport and rapid development of electro-mobility in cars and vans (state aid, establishment of a fast charging network on national territory) • Reducing the sale of diesel fuel to lorries in transit • Pioneering role of the state and municipalities, in particular with regard to their buildings and lighting • In-depth training and education programmes for craftsmen and planners (engineers/architects)
Security energy supply	• Monitoring the security of supply situation, in close cooperation with relevant stakeholders (network operators, suppliers, HCPN, etc.) • Development and refinement of emergency procedures and measures related to electricity, natural gas, oil and hydrogen • Address energy dependencies through intensified cooperation at bilateral, regional and European level
Internal energy market	• Upgrade electricity transmission and distribution capacities • Study on future hydrogen infrastructure needs • Access of Luxembourg network users to the German and European balancing market • Establishment of an energy data platform • New tariff structure for network tariffs • Introduction of dynamic electricity prices

	• Facilitating the sharing of electricity and energy communities • Support for long-term contracts (power purchase agreements PPP)
Research, innovation and competitiveness	• Creation of a National Centre of Excellence in Research (ncer) for energy transition and climate action • Establishment of a strategic RDI agenda for the governance of the energy transition and climate action • Support the establishment of research chairs and public-private or public-public partnerships at the University of Luxembourg and at public research centres

1.2 overview of the current state of policies

1.2.1 Context

The Paris Agreement, adopted in December 2015, is the basis for global climate action. Achieving the main objective of this agreement requires achieving climate neutrality (net-zero GHG emissions) by the mid-21st century, which requires a rapid and profound transformation of the economy and society. This is why, in December 2019, the European Commission presented 'The European Green Deal', a strategy for sustainable and inclusive growth to transform the European Union into a fair and prosperous society, with no net GHG emissions by 2050 and decoupling growth from resource use. The implementation of the Green Deal is ongoing. For example, the European Climate Law1, setting out the objective of climate neutrality by 2050 (and a net reduction of at least 55 % in GHG emissions in the EU by 2030), was adopted on 30 June 2021.

Like the European Climate Law, the amended Climate Law of 15 December 2020 aims at the long-term objective of climate neutrality, which is to achieve "net zero emissions" in Luxembourg by 2050 at the latest. Overall, the Climate Law sets out the legal framework (objectives, integrated national energy and climate plan, long-term strategy for GHG emission reduction) and institutional framework (Climate Action and Transition Platform, Climate Policy Observatory) to achieve national mid- and long-term climate targets. The intermediate target is to reduce Luxembourg's greenhouse gas emissions under Regulation (EU) 2018/842 (excluding emissions governed by the EU Emissions Trading System) by 55 % by 2030 compared to 2005. In implementation of the aforementioned law, sectoral climate targets are set by Grand-Ducal Regulation2 for the following five sectors until 31 December 2030, so that emissions from these sectors decrease steadily and continuously and reach the national climate target of -55 % in 2030:

1. Energy and manufacturing industries, construction;
2. Transport;
3. Residential and tertiary buildings;
4. Agriculture and forestry;
5. Waste and waste water treatment.

The integrated national energy and climate plan (NECP) for the period 2021-2030, the current version of which was adopted by the Luxembourg Government in 20 May 2020, in implementation of Regulation (EU) 2018/19993, forms the basis of Luxembourg's climate and energy policy for 2030. Addressing the following five dimensions, namely decarbonisation, including renewable energy, energy efficiency, security of energy supply, the internal energy market as well as research, innovation and competitiveness, the NECP is the main planning and monitoring tool in this area. In addition to the above-mentioned target of reducing non-ETS GHG emissions by 55 % by 2030 compared to 2005, the NECP also contains the targets to improve energy efficiency by 4044 % in terms of final energy compared to the 2007 European Reference Scenario and to increase the share of renewable energy to 25 % of gross final energy consumption by 2030. It describes the policies and measures to achieve these objectives and is therefore a roadmap that is implemented through the adoption of laws and regulations, programmes and projects and other measures.

Under Regulation (EU) 2018/1999, Member States are required to update their respective NECPs and to submit to the European Commission a draft update of the latest notified version and subsequently a final version of the update by 30 June 2024 at the latest.

1.2.1.1 Administrative structure

This draft update of the NECP is the result of intensive inter-ministerial collaboration within the Interministerial Committee for Climate Action, chaired by the Ministry of the Environment, Climate and Sustainable Development. The compilation and description of the measures have been prepared in sectoral working groups by the experts of the ministries represented in the Committee and their respective administrations. A separate working group accompanied the work entrusted to

1Regulation (EU) 2021/1119 establishing the framework for achieving climate neutrality
2Grand Ducal Regulation of 22 June 2022 determining the annual greenhouse gas emission allocations for the period up to 31 December 2030 of the sectors referred to in Article 5 of the amended Climate Law of 15 December 2020
3Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action

STATEC on modelling and projections of energy consumption and production and GHG emissions in the various sectors, with the projections for agriculture being prepared by the Rural Economy Service of the Ministry of Agriculture, Viticulture and Rural Development, as well as those concerning waste and the LULUCF sector by the Environment Administration.

Based on the experience gained, the Interministerial Committee also serves as a platform for the coordinated implementation of energy and climate policies and measures.

1.2.1.2 Specific situation in Luxembourg

When designing energy and climate policy, account must be taken of certain specific features of Luxembourg's situation and of the structure of energy consumption. Luxembourg is characterised first and foremost by a very dynamic demographic development. In recent years, the population has increased from 493 500 in 2009 to 660 809 in 2022. Moreover, Luxembourg's very open economy is characterised by dynamic development. Another atypical situation: fuel consumption is disproportionately high in Luxembourg compared to its neighbouring countries and accounts for about two thirds of total final energy consumption. The main causes are the central situation in Luxembourg in Europe and the favourable differences in fuel prices compared to neighbouring countries. This structure also generates a relatively low percentage in terms of electricity consumption in Luxembourg, which is just under 15 %. In the electricity sector, the country mainly uses imports (85 %), as Luxembourg does not have large electricity generation plants and its own electricity production based mainly on renewable energy, although growing, cannot meet current needs. Moreover, the structure of industrial energy consumption must be regarded as atypical. Indeed, the share of electricity consumption of the steel industry alone accounts for around 40 % of domestic electricity consumption. The above factors have therefore influenced the structure of energy consumption in recent years and are likely to continue to do so in the future.

Luxembourg is also characterised by a high degree of energy dependence. Luxembourg is one of the few countries in the European Union that do not have fossil resources and therefore has to import virtually all the fuels it needs, be it oil or natural gas. Luxembourg also has no seaport or refining capacity; it is not equipped with gas storage due to inadequate geology and has limited storage capacity for petroleum products.

Therefore, Luxembourg has few means to influence security of supply through national measures. Coordination of measures and sharing of relevant information at European level is therefore essential. In the framework of the Pentalateral Energy Forum (DE, FR, BE, NE, LU, AU, CH) and in close cooperation with its neighbouring states, Luxembourg has already relied in the past on diversifying sources of origin and supply routes to ensure the country's security of supply.

The current energy crisis has led to the need to introduce extraordinary measures to ensure security of energy supply. At national level, a significant number of activities and measures have been stepped up by the stakeholders concerned, including the Ministry of Energy and Spatial Planning, the High Commissioner for National Protection, and the network managers, in order to monitor, manage and anticipate the crisis.

As a result, and despite the geopolitical situation and the resulting energy crisis, security of supply in Luxembourg therefore remains at a very high level.

Luxembourg has always been in favour of a well-functioning competitive internal energy market and also encourages European approaches to energy infrastructure. These approaches are fully in line with the principles of the European Energy Union.

1.2.2 current policies and measures

In recent years, Luxembourg has made significant progress in terms of energy efficiency, renewable energy and climate action; these are briefly set out below.

1.2.2.1 Climate action

As regards climate action, Luxembourg has implemented a range of policies and measures in recent years, notably on the basis of the current version of the NECP adopted in 2020. Policies and measures that will be further strengthened and complemented by this NECP update. To name just a few current policies and measures, the Climate Law, the CO_2 tax, the Climate Pact with municipalities and the wide range of support schemes encouraging citizens, municipalities and businesses to invest in the energy and climate transition need to be highlighted.

Since 2021, fossil fuels have been subject to the CO_2 tax. The annual rates of the CO_2 tax were EUR 20/t CO_2 in 2021 and EUR 25/t CO_2 in 2022. From 1 January 2023, the rate is equivalent to EUR 30/t CO_2. The revenue generated by the CO_2 tax is used fairly to finance climate and energy transition measures and social compensation measures for low-income households, such as the tax credit for the two lower income quintiles (Q1 and Q2) as well as the increase in the cost of living allowance.

In 2012, the Luxembourg Government launched the Climate Pact with the municipalities with a view to guiding, supporting and supporting local authorities in the fight against climate change. Through their commitment under the Climate Pact, the municipalities align themselves with the objectives set at national level and are actively promoting climate protection and the energy transition. Through a catalogue of 64 measures, municipalities are effectively oriented towards sustainable policy in the areas of energy transition, climate change, circular economy, air quality, adaptation to climate change and mobility. The catalogue of measures shall be regularly revised to take account of national objectives and regular evaluations of the programme. In return for their commitment, the municipalities receive the assistance of a climate counsellor and subsidies from the State depending on the level of certification obtained. The State shall provide the legislative, financial, technical and advisory framework until 31 December 2030. Klima-Agency is mandated for the operational implementation and continuous development of the programme.

1.2.2.2 Energy efficiency

In the field of new building construction, Luxembourg has continuously raised the level of energy efficiency requirements in the last fifteen years, since the introduction of the first energy performance certificates in Luxembourg in 2008, and is a pioneer in Europe. The national level of requirement for a near-zero-energy residential building (nZEB level, near Zero Energy Building) has been mandatory for every new building since the beginning of 2017 and is now close to the "passive house" level, which is a globally recognised benchmark. These nearly zero-energy buildings are usually designated as AA buildings in national energy performance certificates.

In 2020, Luxembourg presented its national strategy for the renovation of buildings (LTRS – Long Term Renovation Strategy), which was welcomed by the European Commission mainly for its detailed overview of the building stock, but also for the national information, awareness-raising and training programmes. Given the significant energy saving potential at the level of the national building stock, the Building Renovation Strategy foresees the implementation of a national initiative for energy renovation. With the involvement of stakeholders in the construction sector, several measures of this building renovation strategy have been further developed and taken into account in the formulation of even more ambitious policies and measures. These strategic approaches and measures are being put into practice, including through pilot projects.

A number of support instruments have also been developed and introduced to support the energy renovation of buildings. These instruments include investment aid for households (State subsidy scheme Klimabonus, combined with grants offered by municipalities and obligated parties under the EEOS) and municipalities (via the Climate and Energy Fund), as well as the introduction of low interest climate loans for energy renovation. In order to give a new impetus to energy efficiency, Luxembourg introduced in 2015 a mechanism that obliges natural gas and electricity suppliers to make concrete energy savings by incentivising energy efficiency measures among final consumers in the sectors they themselves have identified. This mechanism has been extended for the period 2021 to 2030 at an ambitious target level.

In the industrial sector, the voluntary agreement between the Government and FEDIL on improving energy efficiency in Luxembourg's industry was reformed for the period 2021 to 2023 in order to improve energy efficiency and by including the consideration of on-site renewable electricity consumed by businesses. Investment support programmes for companies to improve energy efficiency and promote renewable energy have also been reformed and temporarily adapted in the context of soaring energy prices in order to maintain the competitiveness of businesses.

1.2.2.3 Renewables

In the field of renewable energy, Luxembourg achieved the target of 11 % renewable energy in final energy consumption in 2020, which was set by Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources. The share of renewable energy in final energy consumption reached 11.7 % in 2021 compared to 6.38 % in 2017.

In the area of new residential buildings, the Energy Efficiency of Residential Buildings Regulation introduced an implicit requirement on the use of renewable energy. The regulation on feed-in tariffs has been regularly adapted in recent years to create attractive incentives for investment, in particular in the areas of biomass, wind and photovoltaic, as well as for photovoltaic cooperatives. In 2019, for example, feed-in tariffs for photovoltaics were increased and in 2018 a first national tendering procedure for photovoltaic systems in buildings, industrial or landfill sites was introduced. Since then, several calls for tender have taken place. These measures triggered a major wave of investments, which increased solar production from 131 MW in 2018 to over 319 MW in 2022. Recently, new models have been promoted by the government, such as self-consumption (by individuals and businesses) and innovative concepts such as Agri-photovoltaics (the latter through a call for pilot projects). In addition, a number of progress has been made in hitherto undeveloped areas such as renewable geothermal energy and hydrogen, in order to pave the way for their future development.

Finally, it should also be noted that the rate of biofuel to be added to the fuel was set at 5.85 % for 2019 and 7.7 % for 2020. In 2019, the minimum rate for biofuels produced from waste, residues and non-food cellulosic material and falling under the "double counting" principle was set at 35 %. In 2020, this rate was even increased to 50 % (after double counting). The government programme also plans to limit the use of first generation biofuels to a maximum of 5 %, in order to promote the use of second-generation biofuels considered more sustainable.

1.2.2.4 Sustainable Mobility.

Alongside the increased promotion of public transport and active mobility (Luxembourg has the largest relative investment programme in trains, trams and buses in Europe), electromobility has also been strongly developed in recent years. Luxembourg had, as a first step, opted for the development of a common national infrastructure for public charging stations for electric vehicles. With around 1400 charging points installed so far in all municipalities in the country, complemented by 88 ultra-fast SuperChargy charging stations, of which about a third is already installed, the Chargy network acts as a national base infrastructure that covers a large part of the current need.

However, the increasing number of electric vehicles requires complementary activities. For example, a scheme to subsidise electric charging points at home, as well as an aid scheme for companies investing in charging infrastructure for electric vehicles both accessible to the public and serving their own needs, have been introduced and enable the charging infrastructure to develop continuously. As a result, the private sector is able to take over and complement the national network of charging stations. With more than 3.000 publicly accessible recharging points for a total fleet of more than 30.000 registered electric cars, Luxembourg continues to have one of the most dense recharging networks in the European Union.

1.3 Consultations and participation of national and Union entities and their results

Involving citizens and stakeholders in the preparation of the update of the integrated national energy and climate plan respectively is an important objective of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action and the amended Climate Law of 15 December 2020.

Thus, in preparing the preliminary draft and the draft of this update of the NECP, conventional (legally regulated) and non-conventional (non-statutory) forms of participation were applied.

The Climate Law establishes the framework for conventional participation processes, establishing the Climate Policy Observatory and the Platform for Climate Action and Energy Transition, and defining the provisions of the public inquiry.

The Climate Policy Observatory (CPO) is a scientific council currently composed of seven national and international scientists with expertise in different climate-related fields. Its tasks are to advise on projects, actions or measures likely to have an impact on climate policy, to scientifically assess and analyse the effectiveness of measures taken or planned in the field of climate policy, and to propose new measures and to propose research and studies in all areas relevant to climate. Its tasks also include drawing up an annual report to the Government on the implementation of climate policy.

In the context of the 2022 Annual Report, the JPO made recommendations for the update of the NECP. These recommendations have been analysed and taken into account in the preparation of the preliminary draft update. Subsequently, the JPO made a statement on the preliminary draft which was taken into account in the finalisation of the

draft update.

The Climate Action and Energy Transition Platform (Climate Platform) was created to establish a multi-level dialogue between local and national authorities, civil society organisations, professional chambers and employers' and wage organisations, and other relevant stakeholders, such as youth. One of its tasks is to participate in the preparation of the preliminary draft of the NECP. In this context, it was asked to give an opinion on the preliminary draft update.

This opinion, which was sent to ministers in July 2023, sets out the elements on which consensus has been found within the platform, the importance of which is recognised by all members, but on which there are nuanced views on their application/implementation, and the elements on which views diverge. The individual contributions and positions of the Platform members shall be annexed to the opinion and shall form an integral part of it.

In addition, the Climate Law provides for the organisation and conduct of a 30-day public consultation. It was open from 17 April to 16 May 2023 and accessible via the portals emwelt.lu and enquetes.public.lu. During that period, interested parties could express their views and consult a series of documents, in particular the preliminary draft update of the NECP, as adopted by the Council of Government on 31 March 2023, a summary of the preliminary draft and a frequently asked questions. They also had the possibility to submit their comments by e-mail or by post.

A total of 42 contributions were received. Of these, 19 come from citizen.ne.s and 23 from organisations, mostly grouped in the Climate Platform: ABBL, ALFI, Climate Alliance, Chamber of Agriculture, Chamber of Commerce, Chamber of Trades, Chamber of Employees, Luxembourg Confederation of Commerce, Fédération des Artisans, FEDIL, Groupement Energies Mobilité Luxembourg, House of Automobile, ILR, LCGB, LSFI, Movement Ecologique, Movement Patrimonial, OAI, OGBL, SYVICOL, UNICEF, City of Differdange, votum Klima.

In addition to the conventional bodies and processes for participation, the government launched a new initiative, the "Klima-Biergerrot" (KBR), aimed at introducing additional non-conventional consultation mechanisms, enabling representative participation and better awareness of energy and climate policies. "Can and will Luxembourg go further in the fight against global warming? And if so, how?" From the end of January to early July 2022, KBR gathered a representative sample of 100 people living or working in Luxembourg to discuss this issue. In around 15 meetings, KBR members expressed their views on Luxembourg's current commitment to combating climate change. In their final report, they brought together 56 proposals to give new impetus to climate policy.

In September 2022, KBR members presented their proposals to the government. Subsequently, the proposals were also presented and discussed in the Chamber of Deputies. In addition to taking into account the proposed measures in the preparation of the preliminary draft update of the NECP, they will also be able to inform about other plans and strategies. The representatives of the KBR were also invited by the relevant ministries (Ministry of Energy and Spatial Planning and Ministry of the Environment, Climate and Sustainable Development) to take part in bilateral exchanges in order to discuss the various proposals and explain the decision-making process.

All contributions from the various conventional and non-conventional consultations have been identified, analysed and duly considered in an inherently collaborative approach between the ministries concerned, with a view to incorporating the draft update of the NECP into the draft draft update of the NECP. Firstly, the contributions received led to changes to the measures contained in the preliminary draft update and to a few new measures. In addition, some contributions require further analysis and exchange and could be included in the final version of the update. Moreover, many comments concerned details of the implementation of measures contained in the plan, which will be taken into account during the implementation process, where appropriate in consultation with the relevant stakeholders.

1.4 Regional cooperation in preparing the plan

1.4.1 Energy Forum Pentalateral – The Pentalateral Energy Forum

(Penta) is a voluntary regional cooperation between Belgium, France, Germany, Luxembourg, the Netherlands and since 2011 Austria. These countries account for more than 40 % of the EU population and cover more than 50 % of electricity production in the EU. Switzerland joined the Forum as a permanent observer in 2011 and is actively contributing to technical work and decision-making. In close cooperation with the European Commission (upon invitation), the Pentalateral Energy Forum shall strengthen cooperation between all stakeholders to contribute to the development of a reliable, decarbonised and efficient electricity system based on integrated and efficient markets. As the power sector plays a crucial role in decarbonising all our societies by 2050 at the latest, the Penta countries aim to further increase the share of renewables and fully decarbonise their electricity system as soon as possible and ideally by 2035.

Cooperation is led by ministers responsible for energy policy, who meet regularly. The activities are monitored by the Penta coordinators under the direction of the respective Directors-General of the Penta countries. The work programme is implemented by ministries, transmission system operators (TSOs), distribution system operators (DSOs), regulatory authorities and market participants who meet regularly in four thematic support groups. In order for each support group to achieve its objective, exchanges between and within support groups are strongly encouraged and supervised at penta coordinator level. Support groups also liaise with other international fora, such as the North Seas Energy Cooperation.

As the transition to a decarbonised energy system is accelerating, countries are becoming increasingly interdependent and regional cooperation is becoming increasingly important to address the challenges. The Pentalateral Energy Forum is well placed to address many of these challenges, for example by working on security of supply, market integration, energy efficiency and decarbonisation. Over the past two decades, Penta countries have moved from a purely national political perspective on energy markets to a regional approach. The Penta countries are therefore ideally placed to contribute to the next phase of the energy transition.

Supply security

Security of supply has been at the heart of the Pentalateral Energy Forum since its creation. Since the beginning, countries have been cooperating closely to foster security of supply and to prevent, prepare and manage electricity crises in a spirit of solidarity and trust. Important milestones have been achieved through various regional adequacy assessments, common crisis exercises and a common framework under Regulation (EU) 2019/941 on risk-preparedness in the electricity sector.

Today, the work on security of supply is organised in a dedicated support group, structured by two main work streams: assessment of resource adequacy, on the one hand, and risk preparedness, on the other. Future work is planned on these two work streams as well as on the interface between them.

Assessment of resource adequacy

As regards resource adequacy assessments, Penta countries will work together with European studies carried out by ENTSO-E (European resource adequacy assessment, seasonal outlook) to improve alignment and usefulness for Penta countries. Based on expertise and in-depth knowledge in this area, complementary sensitivity analyses could be carried out by Penta TSOs, with a focus on the Penta region and taking into account regional specificities and cross-border interdependencies. The topics that deserve further consideration at regional level are:

- The link between the planning of the national energy system, the implementation of the TEN-E Regulation and the rapid evolution of the European energy system;
- The role of demand-side response and other flexibility resources for the adequacy of the system;
- Improved methods for assessing resource adequacy;
- The need to increase network capacity and optimise the existing network;
- Analysis of critical situations and possible countermeasures.

Risk preparedness

As regards risk preparedness, the objective is to foster regional cooperation in the Penta region to prevent, prepare and

manage electricity crises in a spirit of solidarity and transparency and in full respect of the requirements of a competitive internal electricity market and TSOs' operational security procedures. The Penta countries will seek effective solutions between all relevant entities involved in crisis management and between European, regional and national levels. As such, work will focus on the implementation of the Memorandum of Understanding on Risk Preparedness in the Electricity Sector, signed on 1 December[2021], and in particular on:

- Analysis and evaluation of regional measures, including the technical, legal and financial provisions necessary for their implementation;
- Organisation of regional exercises;
- Review of regional electricity crisis scenarios for the Penta region in close cooperation with ENTSO-E and the Commission on the applicable methodologies
- In the event of an electricity crisis within Penta, application of the agreed framework.

Interface between resource adequacy assessment and risk preparedness

In addition to the above, Penta countries will also work on the interface between resource adequacy assessments and risk preparedness. A first step was achieved through the Penta study on Methodological improvements of Resource Adequacy Assessment, which examined differences and overlaps. Penta countries will seek to close existing gaps between long-term analysis and short-term operational planning, technical and political decision-making, as well as between countries. More specifically, Penta countries intend to support the development of analytical tools and procedures for information exchange and decision-making, closely involving ministries, TSOs, regulatory authorities, as well as ACER, ENTSO-E, the EU DSO and the regional security centres located in the Penta region (i.e. Coreso and TSCNET).

Market integration

The Pentalateral Energy Forum has two decades of experience in market integration. During this period, the Penta has witnessed and driven major changes in the political landscape, with the most important steps being the introduction of flow-based market coupling, first in the Penta region, and now in a larger part of continental Europe.

Promoting future-proof market design

In recent years, work on market integration within Penta has expanded in terms of focus and topics. Ministers Penta firmly placed hydrogen on the national and European agenda as a key element necessary for system and market integration. The newly created SG4 contributes actively to the development of an integrated European hydrogen market.

The Pentalateral Energy Forum also aims to contribute to the integration of renewables and the development of a future decarbonised electricity system, in which integrated markets play a crucial role. More recently, two studies have been carried out: "Vision 2050" and "Flexibility". These studies were carried out in the framework of the Support Group 3 (SG3) on the future electricity system and will serve as a basis for the future work of the Penta Forum.

The Vision 2050 report compares national decarbonisation scenarios and proposes basic elements for a common political vision of the future electricity system. These building blocks describe the elements necessary for the efficient development of a future electricity system. The Penta countries will continue their work on the Vision 2050 project by drafting a political declaration containing a common vision for the future integrated energy system.

To develop this future electricity system, Penta countries recognise the need for future-proof market design and will actively exchange on improving and implementing electricity market regulation, while highlighting areas where further work is needed. Based on their past experience, Penta countries will work together to highlight welfare gains from an integrated and market-based approach to policy issues that may materialise. They will also continue to organise technical exchanges and projects that contribute to the effective implementation of energy policies in the Penta regions.

Flexibility

The Flexibility report provided additional information on the current and future state of flexibility in the region. It describes the needs and sources of flexibility in 2030/40/50, driven by the integration of renewable energy, and shows that cooperation

can lead to significant synergies between countries, thus reducing overall flexibility needs. The report also provides important recommendations on how to promote flexibility in the region and potential measures to improve the flexibility of market participants. Consequently, the Penta countries:

- Will exchange views on the harmonisation of non-standardised products such as network services (e.g. redispatching and topological remedial measures).
- Will exchange views on how to facilitate the contribution of flexible market participants to the balance of the energy system through wholesale markets and to the operation of electricity networks in a secure and stable manner.
- Will follow the development of technical requirements for additional electricity demand (e.g. heat pumps and other sources of flexibility) to ensure interoperability so that the additional electricity demand is truly flexible.
- Work together on the implementation of flexibility provisions in future EU legislation, such as the electricity market reform and the network code on demand-side response. As far as possible, the Penta countries will endeavour to take into account the region's flexibility needs when developing national policy.

Energy efficiency

The Pentalateral Energy Forum recognises the importance of continuously improving energy efficiency as a means to reduce dependence on fossil fuels and to mitigate the scale of the challenge of the energy transition. In this respect, the Penta considers it important to save energy and make energy demand more flexible. Penta countries exchanged on the implementation of the electricity demand reduction obligation imposed by EU legislation for winter 2022/2023.

Penta countries will continue to work together by exchanging on the implementation of the revised Energy Efficiency Directive and best practices on energy savings.

Decarbonisation

As described above, and building on previous work on Vision 2050, Penta countries continue to work on a common political vision on a decarbonised electricity system, which should be achieved as soon as possible and ideally by 2035. The Penta countries will work together to further develop renewable energy and raise awareness of the importance of flexibility to move towards a fully decarbonised electricity system without losing security of supply. The Penta countries fully recognise the importance of better regional cooperation and are working to improve it in order to exploit synergies and achieve efficiency gains. Penta countries will explore the added value of additional regional cooperation on renewable energy integration, grid planning, connection between offshore and onshore (in cooperation with North Seas Energy Cooperation) and addressing other cross-border issues that may arise in the transition to a decarbonised electricity system.

Hydrogen

In 2020, a dedicated hydrogen support group was set up to advance Penta's work and close cooperation on hydrogen. The SG4 focuses on regulatory and market developments for hydrogen deployment in Penta countries, in relation to the national, European and international framework. On the basis of the political declaration on the role of hydrogen in decarbonising the energy system in Europe signed in 2020 and recent developments, notably REPowerEU and the IEA report A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas, Penta countries exchange information and define common positions on future market design for hydrogen deployment developments. In particular, SG4 will continue to work on the development of hydrogen certification, the emerging hydrogen infrastructure in the Penta region and the measures needed to develop cross-border interconnections. It will also monitor progress in the implementation of Penta countries' hydrogen strategies by looking at regulatory development, support mechanisms, investment, supply and demand developments, trade, among others.

1.4.2 North Seas Energy Cooperation – Regional cooperation in the field of offshore renewable energy

Luxembourg is part of the North Sea region with significant renewable energy potential. The deployment of offshore wind energy will play an increasingly important role in achieving Europe's energy and climate objectives. The EU Offshore Energy Strategy set the ambitious target of an installed capacity of 300 GW for offshore wind and 40 GW for offshore energy by 2050. On 19 January 2023, the North Sea Energy Cooperation (NSEC) facilitated the development of a non-

binding agreement on 2050 offshore renewable energy generation targets with intermediate milestones in 2040 and 2030 for the North Sea priority grid corridor under the TEN-E Regulation. The objectives for the NSOG priority offshore grid corridor are 60.3 GW in 2030, between 134,9 and 158 GW in 2040, and between 171,6 and 218 GW in 2050. This represents a significant change of scale for the offshore sector, the deployment of renewable energy and the integrated strategic development of offshore. High energy prices, for example in 2022, and geopolitical events threatening the European energy system have highlighted the need to accelerate the deployment of national renewable energy generation capacities and offshore transmission grids at regional level as soon as possible, thereby significantly improving energy security.

Luxembourg works with the other NSEC countries to identify, analyse and realise opportunities for concrete cooperation projects. The NSEC is a voluntary, bottom-up, market-oriented regional cooperation initiative, established in 2016, which aims to:

- Create synergies;
- Avoid incompatibilities between national policies;
- Share knowledge on international best practices;
- Promote common strategies where possible and beneficial.

Energy ministers meet regularly in the framework of the NSEC. In 2023, the NSEC will be composed of Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway and Sweden, with the participation of the European Commission. On 18 December 2022, the Nordic Energy Ministers and the European Commissioner for Energy signed a Memorandum of Understanding on cooperation with the United Kingdom in the field of offshore renewable energy. The establishment of this Memorandum of Understanding was provided for in the Trade and Cooperation Agreement between the European Union and the United Kingdom of 30 December 2020, builds on the NSEC and is distinct but complementary to the NSEC framework.

For the offshore wind sector, it is essential to provide a predictable and stable operating environment in the long term in order to facilitate long-term investments and further reduce costs. To this end, existing barriers need to be removed and attractive investment conditions created. The members of the NSEC work together to make an important contribution to achieving these objectives through a regular exchange of expertise focused on several topics within the four NSEC Support Groups (SGs):

- SG1: development of hybrid and joint projects;
- SG2: permits, maritime spatial planning and environmental considerations;
- SG3: funding and support frameworks;
- SG4: long-term network and infrastructure planning.

In order for each support group to achieve its objective, exchanges between and within support groups are strongly encouraged and supervised at penta coordinator level. The following examples illustrate this: ports (SG1 and SG4), maritime spatial planning and network planning (SG2 and SG4), and how non-tariff criteria can enhance innovation on key challenges for accelerated, cost-efficient and responsible offshore wind deployment (SG1, SG3 and SG4). Finally, the Support Groups work closely with other international fora, such as the Pentalateral Energy Forum and the Clean Industrial Forum, on land network planning, market agreements and stakeholder engagement.

Development of hybrid and joint projects

The NSEC SG1 serves as a platform to collaborate on concepts for potential offshore wind projects and on a coordinated electricity infrastructure, including transmission infrastructure. The group's activity intensified as NSEC countries launched more joint and hybrid projects in the North Sea, to facilitate technical and ministerial discussions and the sharing of best practices as projects progressed.

In addition to the joint projects on offshore wind, which will be connected and supported by several countries, the Support Group is also working on possible 'hybrid' solutions that use cross-border options to connect offshore wind farms to more than one electricity market and create synergies between countries, as well as relevant EU and national market provisions.

As a result, SG1 members are developing opportunities for collaboration on hybrid projects as well as on possible legal, regulatory and commercial barriers. SG1 will continue to work on the obstacles and milestones of hybrid and joint projects, which can be addressed at national and regional level. In addition, collaboration will continue to function as a reflection forum on how to work on issues related to legislative processes at EU and national level.

Permits, maritime spatial planning and environmental considerations

In order to achieve our energy and climate objectives in the EU, it is necessary to speed up planning and authorisation procedures at European and national level, while at the same time better understanding the possible ecological boundaries of large-scale wind development in the North Seas and the impacts on other sea users. SG2 has compiled an inventory of spatial tensions of offshore wind farm developments by 2030 at regional sea level. The next steps will be to better define ecological tensions and potential threats to development and to define space strategies to avoid or mitigate these threats. In order to improve knowledge and support the deployment of wind energy in the North Sea, North Sea countries will continue to cooperate closely on maritime spatial planning, environmental research and assessment of the cumulative impact of wind farms between energy, maritime spatial planning and environmental authorities.

Financing and support frameworks

Offshore tenders are a central topic for funding and support frameworks. NSEC members coordinate offshore tenders by sharing information on the timetables of national tenders under SG3. In the Working Group, countries also exchange best practices on tender design, grant free support, design elements supporting system and sector integration, and network connection schemes. To achieve these ambitious goals, it is becoming increasingly important to implement joint projects.

This is why the Group is also looking into the possibilities for financing joint cross-border offshore projects, including through EU financial instruments such as the Connecting Europe Facility and the EU Renewable Energy Financing Facility. Finally, Power Purchase Agreements (PPAs) play an increasingly important role in the financing of offshore projects. Countries will look into problems, obstacles and solutions for wider adoption of PPAs. In addition, the Group exchanges on decommissioning, extension of lifespan and energy replenishment of wind farms.

The aim of these exchanges is also to jointly develop and discuss ideas for the medium-term future of the offshore energy system in terms of installed capacity, for example through coordinated tender timetables.

Delivering 2050: long-term network and infrastructure planning

The NSEC SG4 works with ENTSO-E to provide and coordinate contributions to the Offshore Network Development Plan for North Seas Offshore Networks under the EU TEN-E Regulation. In addition, the SG4 aims to broaden the discussion on long-term grid planning to also include the early development and increase of production and transport of green offshore hydrogen, as well as its potential role in an increasingly interconnected North Sea energy system. Green hydrogen will play an important role in decarbonising our energy system. Power-to-X, and in particular hydrogen, will play a key role in providing flexibility where and when needed. Demand for hydrogen is expected to increase significantly, especially after 2030, due to its potential as a storage energy carrier and as a fuel and raw material for hard-to-electrify activities. Several NSEC countries have announced targets for the production of green hydrogen on land and at sea. In the context of SG4, NSEC countries will exchange their first experiences with hydrogen in relation to offshore wind, and exchange knowledge on transport infrastructure, renewable energy development and power-to-X offshore production. They will work together to provide information on offshore hydrogen production, to discuss electrolysis deployment and to increase synergies between long term offshore grid and hydrogen grid planning. In all aspects of medium- and long-term infrastructure planning, SG4 underlines the importance of broad engagement in this planning process with Member States and relevant stakeholders, including industry and NGOs, to anticipate and eliminate supply chain bottlenecks (e.g. port development and availability) in the deployment and acceleration of the implementation of our North Sea energy system. This is closely linked to the importance of safeguarding the security of critical offshore and underwater infrastructure, as well as the supply of critical raw materials, through innovation and better circularity.

2 national objectives and targets

2.1 Decarbonisation dimension

2.1.1 GHG emissions and removals

Following the adoption of the integrated National Energy and Climate Plan 2021-2030 (NECP) in May 2020, the amended Climate Law of 15 December 2020 provided the legal basis for the climate policy of the Grand Duchy of Luxembourg. In particular, the Climate Law sets out the national climate targets, namely:

- the long-term objective of climate neutrality to reach net zero emissions in Luxembourg by 2050 at the latest; and
- the intermediate target of reducing Luxembourg's greenhouse gas emissions under Regulation (EU) 2018/842 by 55 % by 2030 compared to 2005 (4excluding emissions governed by the EU Emissions Trading System).

Thus, the national 2030 climate target exceeds the binding contribution required from Luxembourg under the amendment of Regulation (EU) 2018/842 as part of the Fit for 55 package, which includes a 50 % reduction target for Luxembourg. Luxembourg is therefore not required to adjust its 2030 greenhouse gas emission reduction target in the context of the revision of the NECP.

The aforementioned law also stipulates that sectoral climate targets are set, by means of Grand-Ducal Regulation, for five sectors covering all GHG emissions allocated at national level, the delimitation of which is precisely defined by law:

1. Energy and manufacturing industries, construction;
2. Transport;
3. Residential and tertiary buildings;
4. Agriculture and forestry;
5. Waste and waste water treatment.

The Grand-Ducal Regulation of 22 June 20225 determines the annual emission allocations for the 5 sectors for the period up to 31 December 2030, so that emissions from those sectors decrease steadily and continuously in accordance with the mechanism referred to in Article 4 of Regulation (EU) 2018/842 and reach the national climate target of -55 % in 2030.

4Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030

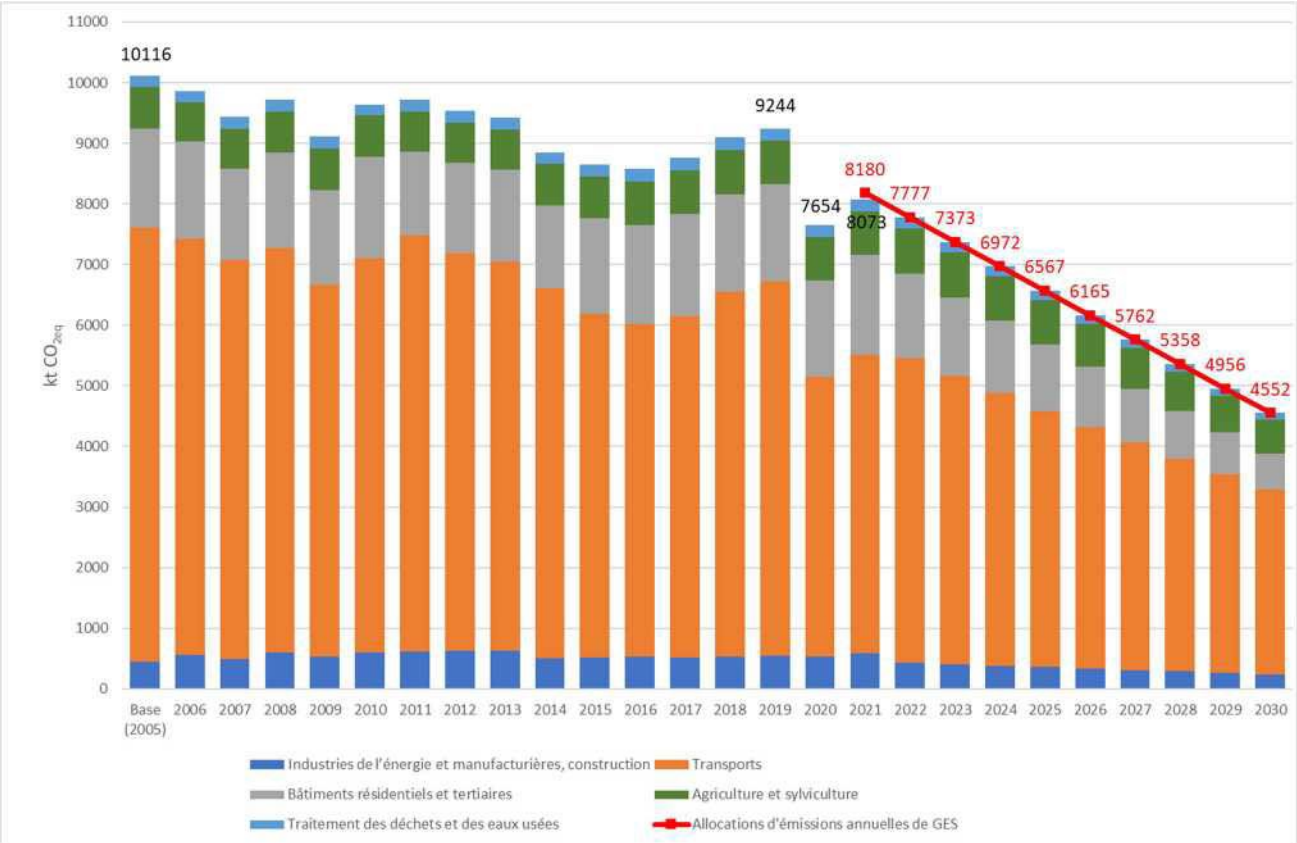
5Grand Ducal Regulation of 22 June 2022 determining the annual greenhouse gas emission allocations for the period up to 31 December 2030 of the sectors referred to in Article 5 of the amended Climate Law of 15 December 2020

Table 1: Annual GHG emission allocations for the period up to 31 December 2030

[Thousand tonnes CO_{2eq} (AR5)]	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy and manufacturing industries, construction	455	431	408	384	360	337	313	289	266	242
Transport	5279	5018	4757	4494	4228	3986	3747	3504	3271	3053
Residential and service sector buildings	1497	1396	1295	1195	1094	993	893	792	691	590
Agriculture and forestry	760	752	742	736	731	704	672	645	609	556
Treatment of waste and waste water	189	180	171	163	154	145	137	128	119	111
TOTAL	8180	7777	7374	6971	6568	6164	5761	5358	4955	4552

Annual GHG emission allocations are expressed on the basis of the values for global warming potentials used in the Fifth Assessment Report of the IPCC (AR5), 2014.

Figure 1: Annual GHG emission allocations for the period up to 31 December 2030 (with historical emissions from 2005 to 2021)



Source: GHG emissions inventory (submission of March 2023); Grand Ducal Regulation of 22 June 2022 determining annual greenhouse gas emission allocations for the period up to 31 December 2030

6In line with the amendment of Regulation (EU) 2018/841 as part of the Fit for 55 package and in order to consolidate carbon sinks towards climate neutrality by 2050 at the latest, the Grand Duchy of Luxembourg shall strengthen its targets for net greenhouse gas removals in the land use, land use change and forestry (LULUCF) sector for the period 2026-2030. The 2030 target is to increase net absorption by -27 kt CO_{2eq} compared to the average net removals for the years 2016, 2017

6Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework

and 2018, which, for information and based on the data reported in the inventory submitted in 2020, would lead to a total net absorption of -403 kt CO_{2eq} in 2030. For the period 2026-2029, an absorption volume to be respected will be established in 2025 on the basis of a linear trajectory starting in 2022 at the average of net removals for the years 2021, 2022 and 2023 and reaching target 2030.

2.1.2 renewable energy

Overall objectives

- Development of renewable energy in the national territory:
  - Increasing the share of renewable energy in gross final energy consumption compared to the 2020 NECP from 25 % in 2030 to 37 % following the Green Deal, Fit for 55, REPowerEU and the revision of the Renewable Energy Directive;
  - Ambitious deployment of wind, solar, heat pumps and electro-mobility in Luxembourg.
- Cooperation measures:
  - Annual use of the European Union renewable energy financing mechanism as a reference instrument;
  - Specific conclusion of cooperation agreements with other Member States with a view to promoting, in particular, innovative projects such as energy islands and the development of hydrogen and its renewable liquid and gaseous transport fuels of non-biological origin (RFNBO).
- Scenario with current measures:
  - In 2030, renewable electricity produced on the territory will reach 37 % of final electricity consumption and together with the measures of the EU financing mechanism, this share will reach 60 % (in 2030) and increase to 100 % in 2035 (IEA decarbonisation target).
  - Wind will have to significantly exceed the projected output of the NECP 2020 (674 GWh) to reach 1 043 GWh in 2030.
  - The ambitious target of 1 112 GWh for photovoltaic in the NEC2020 poses a challenge in view of the disruption of production chains in the field of photovoltaic installations, but is maintained as the objective to be achieved.
  - In 2030, renewable heat/cold produced in the territory will reach 40 % of final consumption in this sector, with an increased role for heat pumps.
- Scenario with additional measures: an increase in the share from 25 % to 37 % by 2030 implies the need for additional measures, both at national level through an even deeper solar offensive and European cooperation measures with larger quantities.

National specific objectives

- Renewable electricity:
- Photovoltaic
  - Continuation of invitations to tender and continuous increase in volumes for large photovoltaic installations:
    - Regular annual calls for tender with market bonuses;
    - Targeted tenders with investment grants with a focus on self-consumption;
    - “Agrivoltaic” invitation to tender for the installation of photovoltaic panels in the agricultural environment with a view to ensuring continued agricultural use and improvement of the ecological quality of the area concerned;
  - Introduction of a solar obligation for new buildings combined with targeted organisational support for households with less income.
  - Adaptation and extension of aid schemes for small and medium-sized installations;
  - Increase in self-consumption in the residential and business sector;
  - Informing and raising awareness among citizens and businesses;

- Updating and continuously improving the solar cadastre tool;
- Drawing up recommendations to standardise and facilitate authorisation procedures.

- Eolien
  - Possibility of authorising new sites for the installation of wind turbines using new technologies for the protection and detection of birds and bats;
  - Identification and removal of barriers to wind energy development (e.g. wind turbine installations near areas of economic activity and along transport infrastructure);
  - Promotion of large installations, in particular by repowering old installations;
  - Facilitation of authorisation procedures.

- Solid biomass/Biogaz
  - Use of sustainable wood from the Greater Region, cascading principle;
  - Implementation of the biogas strategy, strategy developed in 2022 and published in 2023, as provided for in the NECP 2020, including increased promotion of the use of local manure;
  - Promotion of district heating networks powered by renewable heat from biogas plants;
  - Promotion of awareness raising and training of operators in the biogas sector;
  - Implementation of sustainability and greenhouse gas emissions saving criteria.

- Renewable heat
- Heat pumps
  - Accelerated deployment of heat pumps in the residential and tertiary sector;
  - Continued financial incentives to support the deployment of heat pumps;
  - Facilitating authorisation procedures for geothermal heat pumps.
- Geothermal
  - Accelerated installation deployment to use surface geothermal energy (up to 400 m depth) in combination with heat pumps through regular reassessment and, if necessary, adaptation of financial incentives;
  - Exploiting the potential of medium depth geothermal energy (400-2 000 m) to decarbonise the heat sector. With a view to carrying out first pilot projects, the Geological Service is conducting a seismic study in the south of the country to refine the potential in this region;
  - Provision of tools and sources of information on national geology to facilitate the planning and sizing of geothermal installations.
- District heating
  - The development of industrial and urban heating networks based on renewable and waste heat and the introduction of legislation favourable to their development;
  - Adjustments to financial incentives to take account of low-temperature heat networks;
  - Establishment of a legal framework promoting the establishment of district heating networks;
  - Promotion of efficient district heating and cooling by providing an IT planning tool.
- Transport
  - Increased deployment of electro-mobility (rail, tram and individual mobility);
  - Continuation of the use of advanced biofuels, biofuels and bioliquids and hydrogen and its renewable derivatives for vehicles that are difficult to electrify (e.g. synthetic and renewable fuels of non-biological origin).
- Hydrogen
  - Implementation of the seven measures of the Hydrogen Strategy, prepared and published on 27 September 2021, as foreseen by the NECP 2020;
  - Prepare the ground for the deployment of hydrogen transport (and transit) infrastructure, in particular through the introduction of structured legislation and the continuation of regional and European

infrastructure studies;

- Development of instruments to support the production and consumption of renewable hydrogen and support for pilot projects.

2.1.2.1 NECP – current version

The Government Council adopted on 20 May 2020 the initial version of the National Climate and Energy Plan (NECP). The plan describes the policies and measures to achieve the ambitious national targets for reducing greenhouse gas emissions (-55 %), for a minimum share of renewable energy in Luxembourg's gross final energy consumption (25 %) and for improving energy efficiency (reducing energy consumption by 4044 %) by 2030. It is therefore a roadmap that will be put into practice through the adoption of laws and regulations, programmes and projects in the specific areas.

The draft NECP was adopted for the period 2021-2030 by the Government in Council at its meeting of 7 February 2020 and submitted for public consultation from 12 February to 29 March 2020 inclusive. As part of the public consultation, 328 citizens submitted comments and proposals. In addition, 30 institutional players and groups from organised civil society, as well as employers' and wage organisations that submitted their opinions.

The vast majority of stakeholders welcomed the overall level of ambition of the NECP. In the more detailed comments and proposals, citizens and groups mainly referred to issues of implementation of the NECP. As far as possible, adjustments to the NECP were subsequently made and

the Government Council chose to take account of comments and proposals when drafting regulations, programmes and projects in the specific areas of the NECP between 2020 and 2030.

Since the adoption of the original version, the world has faced multiple crises, including the health crisis and the war crisis in Ukraine. In general, the NECP can be seen as a key element of the economic recovery package following the health crisis to address the pressing and urgent threat of climate change. The NECP supports the national economy and will unlock significant potential to strengthen the link between energy transition and climate policy on the one hand and economic development on the other.

The ambitions of the initial NECP (hereafter NECP 2020) by sector are shown in Table 2.

Table 2: Sectoral shares of renewable energy according to the 25 % target scenario as defined in the NECP 2020

NECP 2020	2017	2020	2025	2030	2035	2040
RES share, electricity sector%	8.1 %	11.9 %	23.5 %	33.6 %	38.8 %	45.4 %
RES share, heat sector%	8.1 %	13.7 %	19.9 %	30.5 %	35.8 %	47.1 %
RES share, transport sector%	6.4 %	11.3 %	18.4 %	25.6 %	40.4 %	54.3 %
Biofuel addition rate%	5.6 %	7.7 %	8.8 %	10.0 %	14.4 %	18.7 %
Total RES share – Domestic production/consumption%	6.4 %	9.4 %	13.9 %	19.6 %	24.8 %	31.9 %
Total RES share – cooperation RES included%	6.4 %	11.8 %	17.6 %	25.0 %	31.0 %	39.3 %

ENR: renewables

2.1.2.2 Renewable energy – Accelerating the transition to 100 % renewables

Directive 2009/28/EC (replaced by Directive (EU) 2018/2001 on 30 June 2021) provided for the establishment by each Member State of a renewable energy action plan, the NREAP, which set out the national target for the share of energy from renewable sources consumed in electricity production, in the transport sector, in the heat and cooling sector in 2020, taking into account the effects of other energy efficiency measures on final energy consumption. This target was set at 11 % for Luxembourg, with a share of 11.7 %, thanks to sustained national development and the conclusion of cooperation agreements with Estonia and Lithuania. From 2019 to 2020, the share of renewable electricity increased from 10.9 % to 13.9 %, transport from 7.7 % to 8 % (12.6 % according to the calculation method of Directive 2009/28/EC) and heating/cooling from 8.7 % to 12.6 %. The efforts and policies undertaken throughout the period 2010 to 2020 have been successful and have also contributed to the overall objective of the European Union.

For 2021, the course is maintained and Luxembourg reaches 11.7 %, according to the STATEC/EUROSTAT models.

On

Table 3 shows the evolution by sector and the impact of European cooperation.

Tableau 3: Shares of renewable energy in gross final energy consumption in the different sectors from 2017 to 2021

EUROSTAT-SHARES	2017	2018	2019	2020	2021
RES share, electricity sector%	8.1 %	9.1 %	10.9 %	13.9 %	14.2 %
RES share, heat sector%	7.5 %	8.5 %	8.9 %	12.7 %	12.9 %
RES share, transport sector (without multipliers)%	5.4 %	5.4 %	7.0 %	8.0 %	8.0 %
Total RES share – Production/Consumption%	5.9 %	6.2 %	7.0 %	10.1 %	9.9 %
Total RES share – including RES cooperation%	5.9 %	8.6 %	7.0 %	11.7 %	11.7 %

Source: STATEC-EUROSTAT-SHARES

The period 2021 to 2030 is governed by the recast of the Directive on the promotion of the use of energy from renewable sources (2018/2001/EU), which entered into force on 30 June 2021. In the meantime and since the health crisis and the energy crisis, ambitions at European level have evolved and the European bodies have drawn up two plans called 'Fit for 55' and 'REPowerEU', increasing ambitions in terms of renewable energy production.

For Luxembourg, the increase in the share of renewable energy in gross final energy consumption compared to the 2020 NECP will in principle increase from 25 % to 37 % in 2030.

This will require increased efforts, in particular through constant, even accelerated and targeted deployment of wind power, photovoltaic installations in both residential sectors, increased obligations for new buildings, industrial and tertiary buildings and the use of heat pumps as a reference heating installation in the new building and as a solution to decarbonise the existing building.

In addition to national efforts, European cooperation remains an important pillar for achieving the short-, medium- and long-term objectives, be it through cooperation agreements with other countries (Luxembourg signed such an agreement with Denmark on 3 October 2022 for the period 2021-2025) or through the EU renewable energy financing mechanism (REFM). Luxembourg considers that this instrument will become a reference instrument for the development of European cooperation in the field of renewable energy, given the size of the national territory and the limited national potential. Luxembourg will remain at the forefront of these calls for applications organised by the European Commission.

Tableau 4: Projected evolution of sectoral shares to meet the updated NECP increased targets

NECP – update	2022	2023	2024	2025	2026	2027	2028	2029	2030
RES share – electricity sector%	16.5 %	18.9 %	24.8 %	28.0 %	30.0 %	31.8 %	33.2 %	35.2 %	37.3 %
RES share – heat sector%	13.9 %	15.4 %	22.8 %	24.8 %	27.1 %	29.7 %	32.8 %	36.0 %	40.3 %
RES share – Transport *%	9.0 %	9.0 %	9.4 %	10.5 %	11.2 %	12.1 %	13.4 %	14.9 %	18.0 %
Overall RES share – without cooperation%	10.7 %	11.6 %	15.0 %	16.5 %	18.0 %	19.7 %	21.6 %	23.7 %	26.1 %
Overall RES share – with cooperation%	13.7 %	11.6 %	15.0 %	24.0 %	18.8 %	29.0 %	23.6 %	26.6 %	37.0 %
Indicative trajectory and overall target%	13.5 %	11.0 %	11.0 %	24.0 %	11.0 %	29.0 %	11.0 %	11.0 %	37.0 %

with multipliers (Article 27 Directive 2018/2001/EC)

Member States are also obliged to meet the binding national target of 11 % for Luxembourg throughout the period. From 2023, this will be achieved without European cooperation.

2.1.2.3 Renewable electricity sector

The electricity sector derives its renewable energy mainly from three resources; wind, photovoltaic and biomass. Wind and photovoltaic will remain the two springs with the greatest potential.

Table 5 shows the annual production of electricity from renewable sources for the years 2017 to 2021.

Table 5: Production of energy from renewable sources/technologies in the renewable electricity sector 2017-2021:

STATEC		2017	2018	2019	2020	2021
Hydroelectric	GWh	78	85	98	84	97
Wind turbine *	GWh	235	255	281	351	314 *
Photovoltaic	GWh	108	120	130	161	160
Renewable waste	GWh	47	47	47	43	43
Biogas * *	GWh	72	75	71	63	61
Solid biomass * * *	GWh	52	95	159	266	285
Total	GWh	593	677	787	968	960

Source: STATEC

* ongoing repowering projects

* * inclusive: sewage treatment plant gas and landfill gas

* * * inclusive: discarded wood

Over the past 5 years, the share of renewable electricity has increased by more than 62 %, notably thanks to 3 large cogeneration installations based on solid biomass or discarded wood and the expansion of the wind farm, from 593 GWh produced in 2017 to 960 GWh in 2021. Primary technologies for energy production from renewable sources in Luxembourg are wind (32.8 %), solid biomass (29.7 %) and photovoltaic (16.7 %).

In 2019, the revision of tariffs for photovoltaic installations, the extension of the tariff beneficiaries' framework between 30 and 200 kW to all private persons and businesses (previously reserved for cooperative societies), as well as the various calls for tender, accelerated the deployment of photovoltaic installations, with the result that in 2021 some 90 MW7 8 in terms of photovoltaic installations were built, a record despite the health crisis. The total installed capacity of photovoltaics in 2020 was 187 MW[8].

2022 was marked by crises in the various energy markets and supply problems. Among the sectors affected are crafts and construction. In order to prevent the reduction in tariffs from having a detrimental and dissuasive effect on delays independent of the implementation of facilities to be carried out by investors, the decline was temporarily frozen for the new plants which were first injected in 2023.

The additional capacity of all renewable technologies was 68 MW in 2022. Repowering projects, and new wind installations have delivered around 29 MW, photovoltaic 38 MW and biomass 1 MW.9

It is clear that wind energy and photovoltaics are the main drivers of renewable electricity and it is imperative to speed up their development and promotion. Detailed measures are included in the chapter on objectives and technologies.

Table 6: NECP 2020 – Proposed evolution of renewable technologies in the renewable electricity sector

NECP 2020		2022	2023	2024	2025	2026	2027	2028	2029	2030
Hydroelectric power	GWh	95	95	96	97	98	98	99	100	100
Eolian	GWh	245	288	333	382	436	492	552	613	674
Photovoltaic	GWh	418	526	650	786	917	1014	1053	1085	1112
Biogas *	GWh	68	70	73	70	77	82	88	91	93
Biomass solid * *	GWh	194	193	219	228	241	243	254	257	271
RESproduction	GWh	1020	1172	1370	1563	1769	1930	2046	2146	2251
EConsumption	GWh	6374	6449	6542	6656	6664	6669	6674	6682	6708
Share of RES el	%	16.0 %	18.2 %	20.9 %	23.5 %	26.5 %	28.9 %	30.6 %	32.1 %	33.6 %

* including: sewage treatment plant gas and landfill gas

* * including: discarded wood

7 ILR – CLUDED CHIFFERS OF THE ELECTRICITY MARKET 2021 - https://assets.ilr.lu/energie/Documents/ILRLU-1685561960- 998.pdf

8 ILR- CLUDED CHIFFERS OF THE ELECTRICITY MARKET 2020 - https://assets.ilr.lu/energie/Documents/ILRLU-1685561960- 889.pdf

9National Register of Power Plants (RNCP)

Table 7: Updated NECP – Proposed evolution of renewable technologies in the renewable electricity sector

NECP – update		2022	2023	2024	2025	2026	2027	2028	2029	2030
Hydroelectric power	GWh	100	95	96	97	100	100	100	100	100
Eolien	GWh	330	430	511	699	800	867	903	962	1043
Photovoltaic	GWh	316	390	480	580	680	780	890	1000	1112
Renewable waste	GWh	43	44	45	46	47	48	49	49	50
Biogas *	GWh	67	71	75	79	84	88	92	96	100
Solid biomass * *	GWh	285	290	540	554	568	582	596	610	624
$_{RES}$production	GWh	1141	1321	1747	2055	2278	2465	2630	2817	3029
$_{EConsumption}$	GWh	6910	6972	7056	7351	7582	7753	7923	8013	8122
Share of RES $_{el}$	%	16.5 %	18.9 %	24.8 %	28.0 %	30.0 %	31.8 %	33.2 %	35.2 %	37.3 %

* including: sewage treatment plant gas and landfill gas

* * including: discarded wood

Thanks to the contribution of wind power following numerous repowering projects and a third large cogeneration installation based on discarded wood (approximately 250 GWh of electricity produced) at an industrial site, planned for 2024, the total renewable electricity production of the updated NECP is 35 % higher than the NECP 2020 for 2030.

Electricity consumption is also likely to be higher, in particular due to the deployment of heat pumps and the principle of general electrification of the energy system to decarbonise industry in particular, hence the importance of energy efficiency aswell as residential and functional buildings.

Compared to the 2020 NECP, where final electricity consumption was estimated at 6.708 GWh for 2030, the new modelling of final electricity consumption for 2030 shows a clear increase in electricity consumption to 8.122 GWh due to the above explanations and the assumptions of Luxembourg's economic and demographic growth until 2030.

In the light of Luxembourg's increased efforts in the area of renewable energy development at national level, and despite the projected increase in electricity consumption, Luxembourg now aims to achieve a target of 37.3 % renewable electricity in its final electricity consumption in 2030, which represents a net increase towards the 2020 NECP target (NECP target 2020: 33.6 %). Total electricity production from renewable energy sources in 2030 will therefore be significantly higher than that foreseen in the NECP 2020 (3.029 GWh instead of 2.251 GWh), an increase of 35 %.

Together with European cooperation and in particular the European Union's renewable energy financing mechanism, Luxembourg will be able to produce around 60 % of its electricity consumption from renewable sources on national and European territory in 2030. Luxembourg will thus make significant efforts in European cooperation and aims at combined national and European production, with a target of 100 % of renewable electricity compared to its electricity consumption in 2035.

2.1.2.4 Renewable heat sector

The heat sector has made significant progress in recent years, notably due to large solid biomass or discarded wood installations and these have contributed significantly to the achievement of the objectives in general. For individuals, the purchase of heat pumps, wood pellet heating or the connection to an urban network is partly financed by upgrading investment aid, called Klimabonus, so that renewable heat will also find buyers in the residential sector.

On the other hand, heat consumption increased in 2021 from 12.800 GWh in 2020 to 13.400 GWh in 2021 (Source: Statec-Eurostat), after a year of 2020 marked by the health crisis and a slowdown in economic activity.

Heat consumption is expected to decrease again in the coming years due to measures taken in terms of renovation of residential buildings, support for individuals (Klimabonus), or the strengthening of the voluntary agreement with the industrial sector. More details can be found in section 2.2. "Energy efficiency dimension".

Centralised heat production encompasses heat that is distributed through district heating networks to end users, while in the decentralised production system heat is produced at the place of consumption.

Table 8: Production of energy from renewable sources/technologies in the renewable heat sector 2017-2021

STATEC		2017	2018	2019	2020	2021
Biogas (centralised) * -Biomethane	GWh	98	102	96	85	82
Solid biomass * * (centralised)	GWh	260	418	689	1122	1202
Solid biomass (decentralised)	GWh	236	251	154	142	131
Thermal solar	GWh	25	27	28	30	31
Heat pumps (PAC)	GWh	30	38	45	55	65
Total heat from RES	GWh	649	835	1012	1433	1511

Source: STATEC

* including: sewage treatment plant gas and landfill gas

* * including: discarded wood

Table 9: NECP 2020 – Proposed evolution of renewable heat production

NECP 2020		2022	2023	2024	2025	2026	2027	2028	2029	2030
Biogas (centralised) * — Biomethane	GWh	129	133	138	133	146	155	168	172	176
Solid biomass * *, centralised	GWh	593	588	619	621	642	638	657	653	672
Solid biomass, decentralised	GWh	842	878	912	955	978	1005	1028	1059	1091
Solar systems thermal	GWh	80	90	101	115	127	141	156	173	190
Heat pumps	GWh	132	153	178	207	239	277	319	368	422
Total heat from RES	GWh	1776	1843	1948	2030	2133	2216	2328	2425	2551
Consumption ch	GWh	11199	10883	10555	10223	9877	9519	9152	8775	8371
Share EnR ch	%	14.5 %	16.9 %	18.5 %	19.9 %	21.6 %	23.3 %	25.4 %	27.6 %	30.5 %

* including: sewage treatment plant gas and landfill gas

* * including: discarded wood

Heat pumps play an important role in this sector, not only in the residential sector where new buildings, built after 1January 2023, become the reference technology, but also in the industrial or tertiary sector. Next to the new building, heat pumps will also be implemented at increasing speed in the existing building during energy renovations. The renovation rate of existing buildings will need to be accelerated in the coming years in order to decarbonise the building sector until 2050.

Other avenues will also be explored, such as medium-depth geothermal energy or renewable district heating networks powered by renewable or waste heat.

Geothermal energy is proving to be a promising technology to support the decarbonisation of the heat sector. There is a distinction between geothermal energy close to the surface (0-15 m), shallow geothermal energy up to 400 m and medium deep geothermal energy at a depth of 400 m. Shallow geothermal energy or near-surface geothermal energy is mainly used to provide heat to single-family houses or residences in combination with a heat pump. This technology is currently eligible under the Klimabonus aid schemes, which provide for state contributions for geothermal heat pumps through vertical sensors (geothermal sensors) or horizontal sensors (geothermal baskets). While there are therefore already subsidy instruments in place to promote the exploitation of near-surface and shallow geothermal energy, the government aims to develop economic aid instruments to also support the deployment of medium-deep geothermal energy.

Medium-deep geothermal energy consists of hydrothermal doublets which can reach higher temperatures compared to shallow systems. This technology should be promoted for projects with higher energy needs such as school/sports sites or for heating residential neighbourhoods.

In order to determine the potential of deep geothermal energy in Luxembourg, a study has been carried out which has demonstrated a high potential in particular in the south-east and east of the country, thus mainly in areas

with a high need for thermal energy. In order to exploit this potential in Luxembourg, several pilot projects are being analysed. For example for the Neischmelz project in Dudelange or the Mondorf-les-Bains velodrome where feasibility studies are being pursued.

The above-mentioned study concluded that in Luxembourg the estimated thermal output per geothermal duplicator can be between 0.45 MW and 0.95 MW depending on the sites studied. The study also points out that the Esch-sur-Alzette – Contern – Mondorf-les-Bains triangle has the most favourable conditions for the exploitation of medium-depth geothermal energy.

Given that the municipalities of Esch-sur-Alzette, Schifflange and Dudelange are among the areas with high energy density and have heat demand in excess of 10 GWh/a per municipality in 2030, centralised supply via district heating networks powered by geothermal doublets seems to be a viable option. In the near future, as an estimate of the potential to decarbonise the use of this technology, it can be assumed that a number of district heating networks could be installed in the abovementioned enabling region.

The ministries and administrations concerned are currently working together to facilitate authorisation procedures which may represent a major obstacle to the implementation of medium-depth geothermal projects.

In Luxembourg there are a number of district heating networks of different sizes. In recent years the development of district heating networks has involved both densification and expansion of existing networks and the implementation of innovative low-temperature projects in new neighbourhoods.

It is planned to develop efficient district heating based on renewable energy sources and waste heat recovery. While conventional heat networks operate at a high temperature, the fifth generation of district heating networks allows low-temperature energy sources to be integrated, intelligent management of energy flows and decentralisation of production.

The supply of heat by district heating networks is currently not subject to specific regulatory provisions, respectively to a regulatory authority. A specific regulatory framework is planned to define the rights and obligations of district heating operators.

The government shall put in place the necessary measures to develop district heating and cooling from solid biomass, biogas, solar, ambient and geothermal energy as well as from waste heat and cold.

In 2022, a decrease in heat consumption is expected due to energy-saving efforts in the face of an increasingly limited supply of natural gas since the Russian invasion of Ukrainian territory in February 2022.

In industry consumption of natural gas will be reduced in 2022. However, this reduction is linked to energy-saving efforts, as described above, and will need to be complemented in the coming years by the deployment of less energy intensive industrial production processes and/or based on decarbonised energy carriers. Heat pumps will thus decarbonise ‘low temperature’ heat production (up to 150 °C). Some processes, especially in the steel industry, and in general those requiring temperatures above 800 °C, will require alternative fuels such as renewable hydrogen (or its derivatives).

Table 10: Updated NECP – Proposed evolution of renewable sources/technologies in the renewable heat sector

NEC- update		2022	2023	2024	2025	2026	2027	2028	2029	2030
Biogas (centralised) * – biomethane	GWh	119	125	132	138	145	151	158	164	170
Solid biomass (centralised) * *	GWh	1300	1310	2050	2068	2103	2139	2177	2217	2259
Solid biomass (decentralised)	GWh	150	170	190	210	230	250	270	290	310
Renewable waste (centralised)	GWh	12	12	12	13	13	13	13	13	14
Thermal solar panels	GWh	35	40	45	50	55	60	65	70	75
Heat pumps (PAC)	GWh	151	237	317	396	485	593	706	840	1036
Renewable hydrogen (Industry)	GWh	0	0	0	0	0	0	35	63	130
$_{RES}$Consumption	GWh	1767	1894	2747	2875	3030	3206	3424	3658	3994
Consumption $_{ch}$	GWh	12750	12290	12021	11617	11191	10800	10454	10160	9915
Share EnR $_{ch}$	%	13.9 %	15.4 %	22.8 %	24.8 %	27.1 %	29.7 %	32.8 %	36.0 %	40.3 %

* including: sewage treatment plant gas and landfill gas

* * including: discarded wood

With a third large industrial installation of scrap wood-based cogeneration planned in the south of the country for 2024 and the accelerated deployment of heat pumps, renewable heat production will continue to increase significantly. The modelling also showed that total heat consumption is significantly higher than that calculated in PNEC 2020 (9.915 GWh instead of 8.371 GWh). However, the renewable share increases from 30.5 % to 40.3 %, which is a net increase compared to the ambitions of the 2020 NECP. The total production of heating/cooling from renewable energy sources in 2030 will therefore be significantly higher than that foreseen in the NECP 2020 (3.994 GWh instead of 2.551 GWh), an increase of 57 %.

Heat production from thermal solar panels could grow less strongly than foreseen in the NECP to allow photovoltaic installations and heat pumps. Finally, the decline in heat consumption is likely to be lower than expected in the NECP despite measures to reduce energy consumption following the energy crisis.

2.1.2.5 Transport sector

In the transport sector, Directive 2009/28/EC provided for a minimum share of 10 % of energy from renewable sources in total energy consumption (in the transport sector) for 2020, which was achieved with a share of 12.6 % (including multipliers), thanks to the increased use of biofuels listed in Annex IX to Directive 2009/28/EC, known as ‘double-counting’. Biofuels are incorporated in accordance with the amended Law of 17 December 2010 laying down excise duties and similar taxes on energy products, electricity, manufactured tobacco products, alcohol and alcoholic beverages. The rate of biofuels blended with petrol has remained constant since 2021, due to market

uncertainties and multiple crises (pandemic, spike in costs), but is expected to move upwards in the years to the rates included in the 2020 NECP.

Since 2020, Luxembourg has limited the use of high indirect land-use change-risk biofuels to 5 %, and intends to decrease this input in the coming years in accordance with Directive (EU) 2018/2001.

In the coming years, the transport sector will undergo substantial changes in the light of the steady increase in electro-mobility. According to STATEC, the share of electric cars in new car registrations reached 15.2 % in 2022, compared with only 10.5 % of new car registrations in 2021. Hybrid vehicles remain and even slightly increase with a share of 28.2 % compared to 26.3 % in 2021.10

Table 11: NECP 2020 – Proposed evolution of biofuel rates and consumption – transport sector

NECP 2020		2022	2023	2024	2025	2026	2027	2028	2029	2030
Rates Biofuels	%	8.7 %	8.6 %	8.6 %	8.8 %	9.0 %	9.2 %	9.4 %	9.7 %	10.0 %
Consumption ENR	GWh	3 066	3 228	3 436	3 755	3 916	4 101	4 305	4 527	4 769
Consumption — TR. *	GWh	21735	21282	20919	20454	20098	19688	19317	18989	18601
Share Enr – Consumption with multipliers	%	14.1 %	15.2 %	16.4 %	18.4 %	19.5 %	20.8 %	22.3 %	23.8 %	25.6 %

10 https://statistiques.public.lu/fr/actualites/2023/stn03-nouvelles-immatriculations.html

Table 12: Updated NECP – Proposed evolution of biofuel rate and consumption – transport sector

NEC- update		2022	2023	2024	2025	2026	2027	2028	2029	2030
Biofuel incoporation rate%	%	8.0 %	8.0 %	8.4 %	8.8 %	9.0 %	9.2 %	9.4 %	9.7 %	10.0 %
Fossil fuels	GWh	18157	18701	18444	17443	16120	14445	13032	11822	10634
Share of biofuels – road transport	GWh	1453	1496	1549	1535	1451	1329	1225	1147	1063
— Simple counting biofuels	GWh	1126	1159	1217	1151	1096	1011	938	887	697
— Biofuels double counting	GWh	309	318	314	297	274	246	222	201	181
— Advanced biofuels	GWh	18	19	18	87	81	72	65	59	186
Renewable hydrogen + SAF	GWh	0	2	10	177	179	182	205	229	524
— road transport	GWh	0	2	10	15	20	25	50	75	100
— air transport	GWh	0	0	0	162	159	157	155	154	424
Electricity share	GWh	186	213	250	299	355	416	482	552	624
— RES transport	GWh	5	10	18	28	51	74	101	129	158
— RES rail	GWh	20	22	26	28	38	43	47	50	53
RESConsumption *	GWh	1478	1530	1603	1606	1560	1471	1423	1401	1374
Consumption ENR* *	GWh	1831	1907	2000	2120	2118	2063	2067	2104	2326
Consumption– Tr.	GWh	20386	21099	21235	20275	18900	17019	15481	14165	12904
RES share – * *	%	9.0 %	9.0 %	9.4 %	10.5 %	11.2 %	12.1 %	13.4 %	14.9 %	18.0 %

* without multipliers
* * with multipliers (Article 27 Directive 2018/2001/EC)

Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources provides for multipliers for renewable electricity in order to promote renewable electricity in the transport sector and to reduce the comparative disadvantage in energy statistics. These multipliers are not involved in the final calculation of the overall share of renewables.

From 31 December 2023 until 31 December 2030 at the latest, the limit for high indirect land-use change-risk biofuels shall gradually decrease to 0 % in accordance with Directive (EU) 2018/2001 and shall be replaced by low indirect land-use change-risk biofuels. In addition to simple counting, biofuels are known as 'double counting', which are mainly produced from waste oils and can be counted twice. Finally, the share of advanced biofuels produced elsewhere from waste must be incorporated into the road transport sector at least 0.2 % in 2022, at least 1 % in 2025 and at least 3.5 % in 2030.

As regards multipliers, it is not clear in Article 27 of Directive (EU) 2018/2001 whether they are to be considered in the numerator or denominator, so the legal interpretation of the Commission is that they apply to both. The consequence of that interpretation is that the methodology for applying multipliers is no longer comparable to that taken into account when calculating the shares of renewable energy in the transport sector in the NECP 2020.11

Consumption in the transport sector will be linked to the rise and growth of electro-mobility. Luxembourg also continues to invest significant amounts in the public transport sector such as the rail network or the bus network, and in the construction of parkings.

With the announcement in 2022 of the creation of a first hydrogen service station, a first step in Luxembourg's hydrogen strategy is in the process of being implemented. It is important to note that a station has only a limited effect on the decarbonisation of transport. A certain redundancy in the supply of this energy carrier will be necessary before the logistics and public transport sectors invest in the acquisition of new fuel cell electric vehicles. By 2030, this technology can contribute with some decarbonisation potential in the transport sector. The situation along the European motorway corridors (TEN-T corridors) and the limited size of Luxembourg are the reasons why renewable hydrogen can offer a significant decarbonisation potential for so-called

11 https://ec.europa.eu/eurostat/documents/38154/4956088/SHARES+tool+manual-2021.pdf/11701ebe-1dae-3b00-4da4-229d86d68744? t = 1664793455773 (page 18)

transit transport.

In the field of aviation, it is important to increase the supply of synthetic fuels produced from renewable hydrogen. Indeed, aviation accounts for a significant part of total energy demand. As the additional energy efficiency gains for this sector are limited and electricity solutions are unlikely in the medium term, the only option to contribute to the decarbonisation of the aviation sector is the use of biofuels or synthetic fuels of non-biological origin produced from renewable hydrogen. The accelerated application of SAFs (Sustainable Aviation Fuel) and, above all, synthetic fuels of non-biological origin produced from renewable hydrogen is essential for the decarbonisation of this sector, which is essential for the Luxembourg economy.

A significant regulatory change at European level (ongoing discussion in trilogues) is expected in 2023. This change, resulting from the Fit for 55 measures, would enable renewable energy statistics on renewable hydrogen and its derivatives, which will have to be imported into Luxembourg in significant quantities in view of the limited domestic production potential, in order to meet demand in the transport and industry sector, to be counted towards the balance sheet of the Member State in which these energy carriers are consumed. The supply of these energy carriers will have to be secured in the coming years. The different approaches to European cooperation on renewable energy (bilateral and through the REFM) are already preparing the ground. At the end of such a supply, energy will be counted in Luxembourg.

2.1.2.6 Photovoltaic

PV plays a central role in the country's energy production and will play a key role in the coming years, due to the limited overall potential of other renewable energy sources in Luxembourg.

As the evolution of the PV sector stagnated in 2018 (+ 3 MW of newly installed capacity), the feed-in tariffs were revised upwards and a first call for tenders for large power plants was launched to provide new impetus. Installed powers have gradually increased: 29 MW in 2 019.27 MW in 2020 (health crisis) and 90 MW in 2021. 2022 being characterised by multiple crises, the installed capacity was nevertheless above 40 MW and thus above 2019 and 2020.

This was due to the increase in tariffs in 2019, the opening of power categories from 30 to 200 kW to all natural and legal persons (which alone brought about 30 MW in 2021) and the various invitations to tender organised by the State. In the five tenders published since 2018, out of the first four 74.9 MW, out of the 155 MW to be allocated, the rate was partly due to multiple crises (pandemic, surge in costs, energy crisis, supply chain, lack of skilled labour). For this reason, the modelling of the evolution of installed capacity had to be adapted and new measures considered compared to the 2020 NECP. The supply difficulties can be alleviated by the production of photovoltaic panels on the national territory with a capacity to produce panels corresponding to approximately 50 MW per year.

Table 13: projected evolution of PV production of the NEC2020 and the updated NECP

Photovoltaic — electricity production		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	418	526	650	786	917	1 014	1 053	1 085	1 112
Updated NECP	GWh	316	390	480	580	680	780	890	1 000	1 112

To achieve the ambitious PV targets, measures will need to be stepped up – the 90 MW of 2021 showing that the targets can be met. This effort has been partly started and has been accelerated, respectively, due to the effects of multiple crises. The measures described below, which are already in progress or are in the process of being carried out, may be named.

The results of the first five tenders were mixed. The first four were published before the soaring electricity prices, which highlighted the need to make greater use of renewable energy, in particular by increasing the possibility of self-consumption. To support this trend, a first special call for tenders for self-consumption was launched, allocating a budget of EUR 30 million for investment support. After its closure, the budget used is EUR 16 million for an allocated capacity of 46.3 MW, the best result of a tender to date, so that a second call for tenders of this kind is published in July 2023. As regards regular calls for tenders, a new one – the fifth one – was also launched at the end of 2022. By the end of 2023, it will be necessary to analyse the results of the

two calls for tenders, to draw conclusions and to further develop this instrument in view of the 2030 target.

In view of the ambitious targets for photovoltaic energy, further installations will be needed in the future to achieve the ambitious targets: large power plants on vague land. However, due to their direct footprint, these solar parks are often seen as a competition for agricultural activity. A promising technology to combine agricultural production with renewable energy production by protecting crops from climate hazards and promoting a transition to more environmentally friendly agriculture is agrivoltaic ("agri-PV"). This technology is the combination of agricultural production as primary use and the production of electricity from a photovoltaic system as secondary use on the same surface. In October 2022, a pilot tender was launched for pilot projects for the construction and operation of agro-PV plants on agricultural land. The objective of this invitation to tender is to carry out pilot projects adapted to the specific characteristics of Luxembourg agriculture with scientific monitoring to validate the concept of agrivoltaism in terms of energy, agriculture and the environment in Luxembourg.

On the basis of the conclusions and the endorsement of these pilot projects, a future strategy for agri-PV will be developed. As early as 2025, it is intended to organise regular calls for tenders for agrivoltaism (in the order of 50 MW per year).

In addition to the various calls for tenders, the possibility offered by 'Council Directive (EU) 2022/542 of 5 April 2022 amending Directives 2006/112/EC and (EU) 2020/285 as regards rates of value added tax' was seized by Luxembourg and the VAT rate for photovoltaic power plants was reduced by 17 % at the super-reduced rate of 3 %. As regards the obligation to declare income from electricity production in the personal tax return, the power limit below which the income generated by a photovoltaic power plant is not to be declared, has been increased from 4 to 10 kW from the 2021 fiscal year and will be increased to 30 kW following the third tripartite agreement concluded in March 2023.

Installing photovoltaics on surfaces already built, impermeable or impacting by infrastructure remains the government's priority. In order to achieve this, several new measures are envisaged.

A legal framework will be put in place for the obligation to install photovoltaic power stations on all new buildings respectively to provide installations (e.g. cabling duct) to install photovoltaic panels (PV-Ready) in the future. To create greater visibility on the market and to support businesses, large, small or artisanal, in the energy transition from the start of construction of the building. In the area of buildings in co-ownership, an amendment to the relevant law seeks to facilitate energy works, including the installation of photovoltaic power stations. From 1 January^{2025}, each new industrial building must be designed to accommodate a photovoltaic installation on its roof. Another avenue to explore would be to facilitate the installation of PV "plug and play" power stations.

In addition to these measures, it is planned to introduce a measure to support people who do not have the financial means to install a photovoltaic installation at their homes. Both owners and tenants are targeted. With the possibility of self-consumption of the electricity thus produced, the State pursues a twofold objective: installation of photovoltaic panels on roofs where it is difficult to promote the development of renewable energy and provide financial support to the more vulnerable by reducing part of their electricity bills.

It is still up to the State to take an exemplary role. The State is installing photovoltaic panels on all its new buildings, particularly with a view to self-consumption. By 2 030, the State therefore aims to cover the electricity consumption of its real estate by photovoltaic installations on national territory. This objective includes the project to equip all public car parks with photovoltaic ombridges until 2030 (with the exception of possible cases of technical or regulatory impossibility).

Finally, it is intended to facilitate authorisation procedures by identifying potential alleviations, and by drawing up standard formulations, in the town planning rules of the municipalities, which may vary (significantly) from one municipality to another with different levels of restrictions. With the entry into force of Council Regulation (EU) 2022/2577, the authorisation procedures for photovoltaic installations are subject to one-month time limits with tacit agreement for installations with a total capacity of less than or equal to 50 kW, which includes the majority of installations in the residential sector. All other photovoltaic installations must be processed within 3 months.

2.1.2.7 Eolien

In addition to photovoltaics, wind energy will play a key role in achieving renewable energy targets and the installed capacity

figures already show a significant overshooting of the targets in the event of continuous and ambitious efforts.

Table 14: projected evolution of wind energy generation in NEC2020 and updated NECP

Eolien – electricity generation		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	245	288	333	382	436	492	552	613	674
Updated NECP	GWh	330	430	511	699	800	867	903	962	1043

The current wind farm currently has (January 2023) 62 wind turbines with a total installed capacity of 166 MW. Over the next few years, this capacity is expected to increase, notably thanks to technological progress and 'Repowering' with more powerful wind turbines, with higher annual production hours. It will now be easier to reconcile the protection of species with the development of wind energy by using innovative technologies that can detect birds and bats and thus be able to deactivate wind turbines when needed. This technology makes it possible to increase annual production hours and thus make building sites that were not eligible in the past.

In Luxembourg, there are a limited number of project promoters specialising in wind energy. The realisation of the projects depends largely on the wind conditions on the location site and the possibilities of connection to the electricity grid. The wind potential focuses mainly on the northern part of the country and is limited by the size of the national territory, Natura 2000 protection areas, urbanised areas or areas reserved for radar coverage.

However, there are currently untapped possibilities such as the installation of wind turbines on industrial sites or near roads. Legal changes are made in order to allow wind turbines to be located in these areas. Another, not least, facilitation concerns the granting of permits related to the operating projects where different avenues are analysed with a view to facilitating the authorisation procedures in view of the outcome of the REPowerEU plan to further accelerate the deployment of renewable energy. Regulation (EU) 2022/2577 imposes a maximum period of 6 months for 'Repowering' projects and removes the need to carry out an environmental impact assessment under conditions laid down in that Regulation.

2.1.2.8 Biogas

Since 2018, there has been a stagnation in the development of the biogas sector, despite regulatory changes affecting the production of electricity from biogas and the injection of biomethane into the natural gas network. In order to relaunch the biogas sector, the 2018 coalition agreement provided for a technical and economic analysis, with the premiss that biogas production should be prioritised from slurry. In February 2021, a study was finalised, setting out the state of play and scenarios for the development of the sector, while highlighting the environmental aspects of biogas. The study identified great potential in terms of biomethanisation of manure and environmental measures aimed at reducing emissions during plant operation and optimising digestate management. On the basis of the results of this study, the Government adopted the guidelines for the development of the national biogas strategy on 26 March 2021.

As part of the national biogas strategy to be published in spring 2023, the Government set itself the objectives of upgrading 50 % of the manure deposit with a maximum of 1,0 million tonnes per year, of mobilising 75 % of the potential of bio-waste and green waste as defined by the Law on waste management of 21 March 2012 and, taking into account the objectives of the 2018 waste and resource management plan, of limiting the area devoted to the production of energy crops to 1.500 ha. In order to promote the recovery of livestock manure and to take account of new operating conditions aimed at reducing greenhouse gases, the guidelines provide for a revision of the remuneration for electricity production from biogas and for the injection of biomethane into the natural gas grid. The promotion of biogas production is also part of the European Commission's REPowerEU plan to accelerate the energy transition and reduce Europe's energy dependence on unreliable suppliers and volatile fossil fuels.

From 2023, biogas plants with a total rated thermal input equal to or exceeding 2 MW producing electricity, heating and cooling and biogas or non-injected power plants whose characteristics would potentially allow injection with a production capacity equal to or greater than 19.5 GWh of gross calorific value per year must comply with the sustainability and greenhouse gas emissions saving criteria laid down in Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

For gas from wastewater treatment plants and landfill gas, a moderate increase in electricity and heat production is expected by 2030.

Table 15: projected evolution of biogas energy production of the NEC2020 and the updated NECP

Biogas12 – Production electricity		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	68	70	73	70	77	82	88	91	93
Updated NECP	GWh	67	71	75	79	84	88	92	96	100
Biogas * – Heat production		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	129	133	138	133	146	155	168	172	176
Updated NECP	GWh	119	125	132	138	145	151	158	164	170

* including: sewage treatment plant gas and landfill gas

2.1.2.9 sustainability and greenhouse gascriteria

The sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels provided for in Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources have been transposed into national law by the Grand-Ducal Regulation of 3 February 2023 setting sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels. Biofuels, bioliquids and biomass fuels, used to meet the EU renewable energy target and subject to support schemes, must meet the sustainability and greenhouse gas emissions saving criteria. The sustainability and greenhouse gas emissions saving criteria shall apply to:

- biogas injected into a natural gas network, or biogas without injection into natural gas networks, the characteristics of which would potentially allow injection if it is produced in an installation with a production capacity equal to or greater than 19.5 GWh of gross calorific value per year.

The economic actors involved must provide evidence of independent auditing using voluntary national or international schemes authorised by the European Commission.

2.1.2.10 solid biomass

In recent years, the production of energy from solid biomass and discarded wood is mainly focused on large CHP plants. By transposing the provisions of Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, solid biomass plants with a total rated thermal input equal to or exceeding 20 MW must comply with the sustainability and greenhouse gas emissions saving criteria from 2023 onwards.

The government's bioenergy strategy is aligned with the principle of the cascading use of biomass. Future support schemes take into account the availability of biomass for energy and non-energy purposes, the protection of forest ecosystems, the principles of the circular economy and the cascading use of solid biomass. In line with the cascading principle, woody biomass should be used according to its highest economic and environmental added value, in the following order of priority: (1) wood-based products, (2) longer lifespan, (3) reuse, (4) recycling, (5) energy recovery and (6) disposal. Where no use of woody biomass is economically viable or environmentally appropriate, energy recovery shall help to reduce the production of energy from non-renewable sources.

The potential for solid biomass is concentrated on a supply basin formed by border countries and regions (including the Greater Region) to reduce transport-related greenhouse gas emissions.

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solid biomass12 fuels if used in installations with a total rated thermal input equal to or exceeding 20 MW producing electricity, heating and cooling or fuels;

- biogas if used in installations with a total rated thermal input equal to or greater than 2 MW producing electricity, heating and cooling;

Given the limited potential for solid biomass, the government is considering changes in support schemes for new power plants producing electricity from solid biomass. It is expected that the development of solid biomass plants will increase until 2030 and then stabilise. The increase in production from solid biomass is mainly based on discarded wood (671 GWh). With regard to the limited solid biomass resources, there are no plans to increase substantially the use of solid biomass. The principle of cascading use of wood will be strengthened. In the medium term, the use of solid biomass for energy production in the heat sector will decrease and be continuously replaced by energy from heat pumps, respectively by hydrogen-fired boilers – mainly for boilers supplying district heating networks.

Table 16: projected evolution of energy production from solid biomass (including discarded wood) of the NECP 2020 and the updated NECP

Solid biomass — Generation electricity		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	194	193	219	228	241	243	254	257	271
Updated NECP	GWh	285	290	540	554	568	582	596	610	624
Solid biomass — Production of heat *		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	1435	1466	1532	1576	1621	1643	1685	1712	1763
Updated NECP	GWh	1450	1480	2240	2278	2333	2389	2447	2507	2569

* Centralised and decentralised solid biomass

2.1.2.11 heat pumps

Regulatory requirements for energy efficiency in residential and functional buildings have had a major impact on the development of heat pump systems. Aero-thermal and geothermal heat pumps have become the reference technology for heating new buildings. This technology is part of the objective of decarbonisation through electrification of the building sector. From 2023, the heat pump is used as a reference heating when the energy performance certificate for a new building is drawn up. Heat pumps can be combined with photovoltaic installations that promote self-consumption of the electricity produced. Geothermal heat pump on the other side allows the use of geothermal energy and provides higher energy efficiency for aerothermal heat pumps, making it also interesting for application in the existing building.

For existing buildings hybrid systems with heat pumps are a transitional solution to decarbonise the heating step towards full energy remediation. Compared to the 2020 NECP, projected developments show a strong acceleration. This trend is linked inter alia to the regulatory requirements mentioned above but also to the continuation of State aid schemes for heat pumps (Klimabonus Wunnen). In addition, the need to become successively independent from natural gas imports will increase the deployment of heat pumps.

The heat potential of heat pumps in 2030 is estimated to be around 1 036 GWh/a compared to 422 GWh modelled for NECP 2020.

Table 17: projected evolution of heat production from heat pumps of the NEC2020 and the updated NECP

heat pumps – heat production		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	132	153	178	207	239	277	319	368	422
Updated NECP	GWh	151	237	317	396	485	593	706	840	1 036

2.1.2.12 Hydrogen

As announced in the 2020 NECP, Luxembourg's hydrogen strategy was adopted by the Government on 8 July 2021 and the

document was presented to the public on 28 September 2021. This document presents the political aspects and ambitions at different levels (national, regional, international) and the 7 measures planned by the Luxembourg government to develop a renewable hydrogen market.

These measures include infrastructure cooperation and certification, the implementation of flagship or pilot projects, the identification of supply, import and demand potentials, the development of financial instruments to stimulate supply and demand, for example through operating or investment aid as for other renewable energies and the deployment of hydrogen stations, a first installation of which is under construction and will be put into operation in 2023.

Luxembourg's hydrogen strategy had set as a national target the substitution of 100 % of fossil hydrogen currently used in industry with renewable hydrogen by 2030 at the latest.

The strategy was developed under the initiative of the Ministry of Energy and Spatial Planning and finalised in close consultation with the Ministry of Environment, Climate and Sustainable Development, the Ministry of Higher Education and Research, the Ministry of Economy, the Ministry of Finance, the Ministry of Mobility and Public Works and the Ministry of Foreign and European Affairs (Directorate for Cooperation and Humanitarian Action). With the adoption of the hydrogen strategy, the two levels of the "Task Force H_2 Luxembourg" were launched. Under the coordination of the Energy Department of the Ministry of Energy and Spatial Planning, the Steering Committee met for the first time in September 2021 and on a quarterly basis since then, and a first meeting of Task Force H_2 Luxembourg with stakeholders from the various sectors took place in November 2022 to continue consultations to ensure that the various measures of the strategy were implemented.

With a view to developing a support instrument to subsidise the production and consumption of renewable hydrogen in Luxembourg, the Department of Energy cooperates with an external consultant using the platform of the Task Force H_2 Luxembourg for consultation with stakeholders. It is planned to launch first calls for tender for pilot projects on Luxembourg territory under this instrument during the 2024 financial year.

In addition to efforts at national level, Luxembourg regularly participates in meetings of international groups (Greater Region, Benelux Union, Pentalateral Energy Forum (PLEF), North Seas Energy Cooperation (NSEC), and Hydrogen European Network HyENet), in order to highlight Luxembourg's positions, including the development and regulation of a future (trans-European) hydrogen infrastructure.

Following the preparation and adoption in May 2020 of a political declaration by the Ministers of the Pentalateral Energy Forum countries (Benelux, in cooperation with Germany, Austria, France and Switzerland), Luxembourg contributed to the development and adoption of a common paper on the regulatory framework for the future hydrogen market and infrastructure in Europe. Under the initiative of Luxembourg, and under the Luxembourg Presidency in 2022, the Hydrogen Working Group within the Benelux General Secretariat launched a study in the context of the objectives of decarbonising society, on the future needs for hydrogen infrastructure in the Benelux region and on interconnections with neighbouring regions, a study which, following a call for tenders, was entrusted to an external consultant whose report is in the process of being finalised.

At national level, two studies were launched in 2022 which have an impact on the hydrogen sector because it appears that, especially in industry, significant demand can emerge faster than foreseen in the national strategy. Indeed, a study on the decarbonisation of the industry and a study on the decarbonisation of the road transport sector (logistics) show that demand for hydrogen can become substantial already before the end of the decade. It is important to recall that the strategy identified a total demand potential of between 4 000 and 10 000 GWh (renewableH_2) that would contribute to the decarbonisation of society and thus to the objective of climate neutrality. The two studies at national level which are in the finalisation phase (January 2023) therefore show that part of the potential transport demand and that in industry will have to be met faster than expected.

The coordinated deployment of a cross-border hydrogen pipeline infrastructure, not only to ensure the transport of hydrogen to Luxembourg to meet the above mentioned demand, but also useful in terms of transit, is a priority. It is useful also to take into account the potential for hydrogen demand in the neighbouring regions of the Grand Duchy, identified in the study carried out at Benelux level and neighbouring regions. Close cooperation with the Luxembourg natural gas transmission system operator and natural gas transmission system operators in neighbouring countries has been initiated. Luxembourg is working to connect to a European hydrogen infrastructure that will allow the delivery of large amounts of hydrogen to meet emerging demand to

decarbonise sectors and processes that are difficult to electrify. It is estimated that a first hydrogen pipeline could be commissioned around 2035.

Table 18: projected evolution of the production of hydrogen consumption of the NEC2020 and the updated NECP

Hydrogen		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	0	0	0	0	0	0	0	0	0
		2022	2023	2024	2025	2026	2027	2028	2029	2030
Updated NECP – Total consumption	GWh	0	2	10	15	20	25	85	138	230
Consumption in industry	GWh	0	0	0	0	0	0	35	63	130
Consumption in road transport	GWh	0	2	10	15	20	25	50	75	100

The projected evolution shows hydrogen needs in road transport as well as in industry, replacing fossil energy carriers. Given that a hydrogen transport infrastructure through pipelines cannot be built before 2030, the production of this renewable hydrogen will ideally be on the national territory.

2.1.2.13 European cooperation

The current framework for cooperation on renewable energy is set out in Directive 2018/2001/EC. This Directive is currently under revision. A recast is expected in the course of 2023.

However, it can already be differentiated between four types of cooperation:

- Statistical transfers from one Member State to another (Article 8 – Directive 2018/2001/EC): at the end of each financial year, a Member State which has achieved a surplus of renewable energy statistics over its target may decide to cooperate and transfer (part of) this surplus to a Member State with a need for statistics in order to achieve its target. This is an instrument already successfully used by Luxembourg in the past.
- Joint projects within the EU or with third countries in the case of physical interconnection with the Union (Articles 9, 10, 11 and 12 – Directive 2018/2001/EC): in order to exploit the most attractive renewable energy potential, two countries may, in bilateral coordination, develop joint projects with the possibility of upstream financial contributions to a project for which renewable energy statistics are shared fairly according to annual production. Such projects normally involve significant administrative work during implementation, making it more difficult to implement them.
- Union renewable energy financing mechanism – REFM (Art.31 – Regulation 2018/1999/EC): This is a new instrument used very recently by Luxembourg. The instrument is being set up by the Commission and Luxembourg is awaiting the finalisation of a first call for tender leading to photovoltaic projects to be carried out in Finland. This instrument also makes it possible to ensure upstream statistical quantities transferred annually according to the production of the financially supported power plants. This mechanism enables States with lower renewable energy potentials to contribute to the construction and operation of more renewable energy production sites or plants outside their territory, e.g. offshore wind in the North Sea, or photovoltaic in the Mediterranean.
- Import of renewable fuels of non-biological origin for substitution of fossil fuels in industry or transport in Luxembourg (provided for in Article 22a – recast of Directive 2018/2001/EC): Consumption and not production will be decisive for the statistical calculation of renewable energy molecules such as renewable hydrogen and its renewable derivatives. These molecules can be imported into the EU, or from third countries with interesting potentials for the production of renewable hydrogen. With this in mind, Luxembourg will finalise a feasibility study on hydrogen production for export with Cape Verde. Luxembourg is following this development very closely. Luxembourg's industry and the difficult to electrify transport (aviation and transit logistics) will need these molecules and, unlike the methods of accounting in the electricity market, the consumer Member State could benefit from the statistics.

2.1.2.13.1 Bilateral cooperation agreements – statistical transfers

During the period 2018 to 2020 and still under the aegis of Directive 2009/28/EC, Luxembourg had concluded two cooperation agreements with Lithuania and Estonia. For the statistical year 2020, Luxembourg acquired 650 GWh equally from Estonia and Lithuania, and thanks to national efforts and cooperation, the 11 % target could be exceeded with a 11.70 % share.

Following this excellent experience of European cooperation, a cooperation agreement has been concluded with Denmark for the period 2021-2025, taking into account the objectives and forecasts set out in the 2020 NECP. It is foreseeable that according to the conclusions of the “Fit for 55” and “REPowerEU”, the indicative trajectory will need to be adjusted and additional amounts will have to be purchased for 2025 (

Table 23), before starting the cooperation period from 2026 to 2030.

Table 19: Quantities to be procured in the framework of European cooperation according to the NECP 2020.

Quantities of cooperation European		2022	2023	2024	2025	2026	2027	2028	2029	2030
NECP 2020	GWh	1150	1 225	1 299	1 374	1 449	1 524	1 599	1 674	1 748

Talks have also taken place with Lithuania, Estonia and Portugal, and given the close relationship between the latter two countries, not only a Memorandum of Understanding for a cooperation agreement is envisaged, but also cooperation in terms of renewable hydrogen production, either directly through joint projects or through the Renewable Energy Financing Mechanism (REFM).

2.1.2.13.2 EU Renewable Energy Financing Facility – REFM

In addition to cooperation agreements, Regulation 2018/1999 on the Governance of the Energy Union and Climate Action provides for an EU renewable energy financing mechanism, where two calls for applications have already been organised by the European Commission and in which Luxembourg has participated each time, and intends to continue to do so in future publications, as a contributing Member State.

After a first unsuccessful call for applications, due to the lack of successful projects on the part of host Member States (countries carrying out projects on their territory), Luxembourg again participated in the second call for applications launched on 4 March 2022. Luxembourg committed itself in February 2023 with a budget of EUR 40 million with a host State, namely Finland, which has submitted sufficient capacity to the mechanism. According to the distribution, 80 % of the energy produced is statistically returned to Luxembourg; transfers will thus reach some 150 to 200 GWh per year. Given that the project was launched in 2023 and that applicants must submit their tenders and be selected, it is likely that the first installations will start with their electricity production in mi, respectively at the end of 2024. In the year 2025, the expected quantities will therefore be likely to be included in national statistics.

2.1.2.13.3 European cooperation 2026 to 2030

For the period 2026 to 2030, the need for cooperation increases by considering the 'Fit for 55' and 'REPowerEU' packages, which mean that EU and therefore national targets will be increased. For example, the EU target will increase visibly to 45 % by 2030, while Luxembourg's renewable energy target will increase to 37 %. As renewable energy potentials are limited in Luxembourg, it will be increasingly important to turn to these European cooperation mechanisms, be it REFM or cooperation agreements.

The quantities to be purchased following the "Fit for 55" and "REPowerEU" will be larger than those foreseen in the 2020 NECP.

Table 20: Quantities to be predicted Fit for 55/REPowerEU – without additional measures – GWh

	Objective 2030 NECP 2020	Objective 2030 (37 %) updated NECP
Renewable energy production at national level	6287	8397
Quantity required by European cooperation (REFM and statistical transfers)	1748	3500
Sum – National production and cooperation	8035	11891
Adjusted national final energy consumption *	32141	32159
Share Enr – Production/Consumption – Cooperation included	25 %	37 %
Objective 2030	Min. 25 %	Min. 37 %

* see chapter on 2.1.2.14 Intermediate path and overall objectivel

With the increased targets, Luxembourg's participation in the REFM needs to be revised upwards in order to build a stable, more stable basis of renewable energy in national statistics. Since REFM is currently the cheapest and much more concrete means of achieving the objectives than statistical transfers, preference must be given to them.

It is therefore planned, provided that European countries are determined to use this instrument as a reference instrument for European cooperation in the field of renewable energy, to meet around half of the cooperation needs through the REFM. As the implementation deadlines for projects financed under the REFM are in the order of at least 1 to 2 years, the following quantities could be reached with REFM by 2030.

Table 21: Estimated quantities acquired by REFM – 2026-2035

	Provisional commitment REFM [GWh]	Cumulative REFM output — Annual production [GWh]
2022	150	
2023	200	
2024	300	
2025	300	150
2026	400	350
2027	400	650
2028	500	950
2029	500	1350
2030	500	1750

European cooperation in the field of renewable energy could be in the range of 200 to 500 GWh per year. The costs to be associated with these projects are in the range of EUR 40 to 100 million per year. It can be expected that the costs per unit of renewable energy produced from this mechanism will decrease in the future to around EUR 10-13/MWh or less. It should also be noted that once the foundation for European cooperation reaches a sufficiently

high level thanks to the REFM, annual expenditure on participation in annual calls for projects will decrease again (probably as from 2031).

The quantities not reached by the REFM will have to be carried out by statistical transfers (there are binding targets for the years 2025, 2027 and 2030). Under the assumptions set out above, a need for statistical transfers for 2030 of 1.750 GWh is expected.

While Directive (EU) 2018/2001 is still under revision, it is expected that the intermediate targets for 2025 and 2027 will also be revised upwards to around 24 % and 29 % respectively (NECP 2020-17 % in 2025 and 20 % in 2027). The statistical transfers instrument will enable these intermediate targets to be achieved in order to smooth the path pursued. With an average price of EUR 14/MWh, the annual cost in 2030 will be around EUR 24,5 million.

The evolution of domestic renewable energy production and gross final energy consumption in the coming years will show whether the needs in terms of quantities of statistical transfers to be procured will need to be adjusted.

2.1.2.14 intermediate trajectory and overall target

Table 22: Share of renewable energy by sector and overall by 2030 – NECP 2020

NECP 2020		2022	2023	2024	2025	2026	2027	2028	2029	2030
RES share – electricity sector	%	16.0 %	18.2 %	20.9 %	23.5 %	26.5 %	28.9 %	30.6 %	32.1 %	33.6 %
RES share – heat sector	%	15.9 %	16.9 %	18.5 %	19.9 %	21.6 %	23.3 %	25.4 %	27.6 %	30.5 %
RES share – Transport	%	14.1 %	15.2 %	16.4 %	18.4 %	19.5 %	20.8 %	22.3 %	23.8 %	25.6 %
Overall share – without cooperation	%	11.2 %	11.9 %	12.8 %	13.9 %	15.0 %	16.1 %	17.2 %	18.3 %	19.6 %
Overall share – with cooperation	%	14.1 %	15.0 %	16.2 %	17.6 %	19.0 %	20.4 %	21.9 %	23.3 %	25.0 %
Domestic RES production	GWh	4547	4691	4920	5156	5449	5677	5890	6071	6287
European cooperation	GWh	1.150	1.225	1.299	1374	1.449	1.524	1.599	1.674	1748
RES production + European cooperation	GWh	5696	5916	6220	6530	6898	7201	7488	7745	8035
Adjusted gross final energy consumption	GWh	40428	39380	38381	37203	36276	35248	34231	33232	32140
Overall RES share –%	%	14.1 %	15.0 %	16.2 %	17.6 %	19.0 %	20.4 %	21.9 %	23.3 %	25.0 %

Table 23: Share of renewable energy by sector by 2030 – updated NECP

NEC- update		2022	2023	2024	2025	2026	2027	2028	2029	2030
Domestic RES production	GWh	4386	4745	6097	6537	6868	7142	7478	7876	8397
European cooperation	GWh	1200	1000	500	3000	2350	3350	2950	3350	3500
— of which statistical transfers	GWh	1200	1000	500	2850	2000	2700	2000	2000	1750
— of which REFM	GWh	0	0	0	150	350	650	950	1350	1750
RES production + European cooperation	GWh	5586	5745	6597	9537	9218	10492	10428	11226	11897
Final energy consumption	GWh	45823	46163	45837	44851	43464	41705	40275	39025	37866
Aviation	GWh	7820	7986	8056	7964	8037	8109	8179	8250	8048
— Current Aviation share	%	17.1 %	17.3 %	17.6 %	17.8 %	18.5 %	19.4 %	20.3 %	21.1 %	21.3 %
— Aviation threshold	%	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %
Adjusted gross final energy consumption	GWh	40834	41030	40614	39659	38113	36174	34585	33187	32159
Overall RES share	%	13.7 %	14.0 %	16.2 %	24.0 %	24.2 %	29.0 %	30.2 %	33.8 %	37.0 %
Indicative trajectory and overall target	%	13.5 %	11.0 %	11.0 %	24.0 %	11.0 %	29.0 %	11.0 %	11.0 %	25.0 %
RES share – electricity sector	%	16.5 %	18.9 %	24.8 %	28.0 %	30.0 %	31.8 %	33.2 %	35.2 %	37.3 %
RES share – heat sector	%	13.9 %	15.4 %	22.8 %	24.8 %	27.1 %	29.7 %	32.8 %	36.0 %	40.3 %
RES share – Transport *	%	9.0 %	9.0 %	9.4 %	10.5 %	11.2 %	12.1 %	13.4 %	14.9 %	18.0 %
Overall RES share – without cooperation	%	10.7 %	11.6 %	15.0 %	16.5 %	18.0 %	19.7 %	21.6 %	23.7 %	26.1 %
Overall RES share – with cooperation	%	13.7 %	14.0 %	16.2 %	24.0 %	24.2 %	29.0 %	30.2 %	33.8 %	37.0 %
Indicative trajectory and overall target	%	13.5 %	11.0 %	11.0 %	24.0 %	11.0 %	29.0 %	11.0 %	11.0 %	25.0 %

* with multipliers (Article 27 Directive 2018/2001/EC)

The table shows by way of comparison the sectoral shares and the overall share achieved by 2030. The comparison shows that measures and policies will have a positive impact on the different sectors, be it photovoltaic and wind for electricity or heat pumps for the heat sector, as well as the influence of energy efficiency measures. One parameter plays a significant role, the 'aviation course'.

Indeed, Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources provides for the calculation of a Member State's gross final consumption of energy that the share of energy consumed in aviation is considered to be no more than 6.18 % of the Member State's gross final consumption of energy, which implies an adjustment of gross final consumption of energy.

2.2 energy efficiency dimension

The modelling underlying the definition of national energy efficiency targets has been developed by STATEC, in close collaboration with the experts of the ministries directly concerned for the different sectors, in particular as regards the definition of calculation assumptions and the impact of the different measures (PAMs).

The basis for this modelling is the STATEC NEAM and Lux-GEM models. The NEAM model takes into account national projections for changes in the economic situation and thus changes in population, employment, number of cross-border workers, residential areas, tertiary and industrial activities and construction, etc., as summarised in Table 24.

Table 24: Economic indicators used in NEAM (economic developments)

Indicator	Unit	2005	2020	2025	2030	2035	2040
GDP	billion EUR	42.4	59.2	69.3	79.4	91.0	104.2
Population	1000 persons	469.1	634.7	698.3	764.1	833.1	900.4
Employment	1000 persons	307.5	471.6	536.6	603.5	667.6	736.4

Frontier workers	1000 persons	97.7	163.7	196.5	230.0	261.5	299.9
Surface area of residential buildings	million m^2	24.8	33.9	37.6	41.3	45.0	48.7
Surface area of non-residential buildings	million m^2	7.9	13.0	14.1	15.3	16.5	17.6

Source: STATEC (2023)

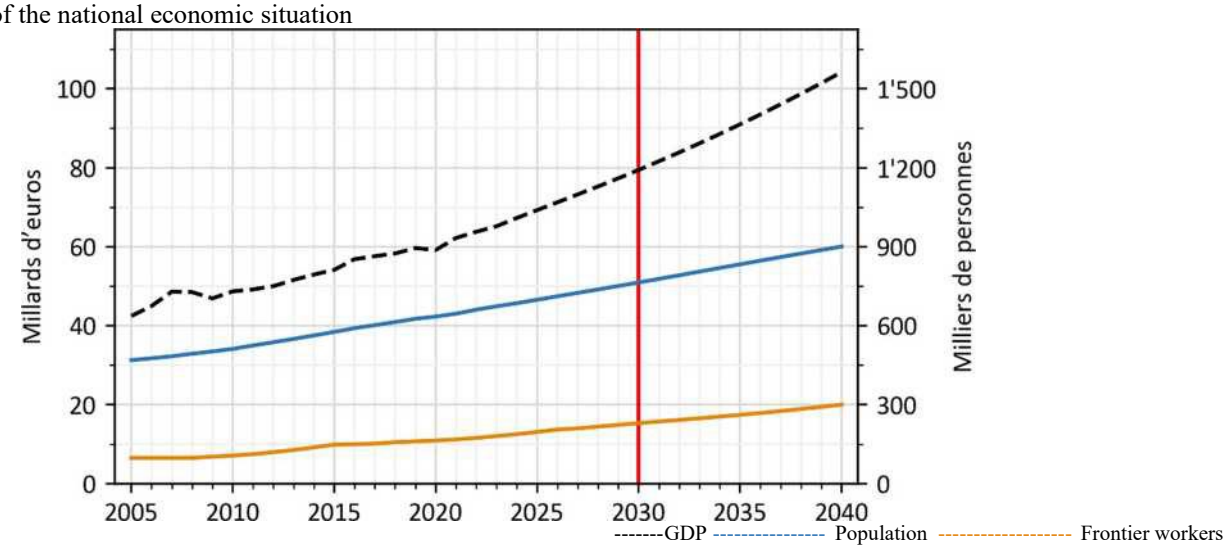
Table 25 summarises the economic and economic projections for 2030. For various indicators (gross domestic product (GDP), population, employment, number of frontier workers, etc.), the forecasts for 2030 are compared with the respective historical values in 2020. This growth in different areas is essential for the objectives of the NECP for 2030.

Table 25: Economic and economic projections for 2030 compared with 2020

Indicator	Unit	2020	2030	Variation
GDP	billion EUR	59.2	79.4	+ 34 %
Population	1000 persons	634.7	764.1	+ 20 %
Employment	1000 persons	471.6	603.5	+ 28 %
Frontier workers	1000 persons	163.7	230.0	+ 41 %
Surface area of residential buildings	million m^2	33.9	41.3	+ 22 %
Surface area of non-residential buildings	million m^2	13.0	15.3	+ 18 %

Source: STATEC 2023 modelling

Figure 2: Evolution of the national economic situation



Source: STATEC 2023 modelling, MEA Graphics

The exceptionally high cyclical growth in Luxembourg, taken into account in the current STATEC projections (and in the modelling for this update of the NECP compared to the 2020 NECP), counterbalances part of the efforts to improve energy efficiency (which are well existing and taken into account in modelling), which explains why the reduction in final energy consumption by 2030 is relatively low or almost non-existent for certain sectors (e.g. manufacturing and construction) and is even increasing for the aviation sector for example.

As regards residential buildings (included in the 'households' sector) and tertiary buildings (included in the 'trade and services' sector), the change in the economic situation, which means changes in GDP and thus in employment, population and cross-border commuters, also leads to an increase in building space, as shown in Figure 8.

This increase in building space is taken into account in the modelling and any net increase (at national level) in the surface area

means additional energy consumption, which partly counterbalances energy efficiency measures at building level.

A possible future adjustment of national economic projections will therefore have a direct impact on modelling and will require, where appropriate, an adjustment of the targets.

Note “EED and EPBD Directives”

The energy efficiency targets and many of the additional measures included in this draft update of the NECP are based on the versions currently under revision (situation in early March 2023) of the following two EU directives, which take into account the Fit For 55 (FF55) and REPowerEU:

EED – Energy Efficiency Directive (2012/27/EU, Energy Efficiency Directive);

EPBD – Energy Performance of Buildings Directive (2010/31/EU).

The adoption of the revised versions (EED recast and EPBD recast) of these two directives at European level is expected before the end of 2023.

Since the health crisis and the energy crisis, ambitions have evolved and the European institutions have drawn up two plans called ‘Fit for 55’ (FF55) and ‘REPowerEU’, so that ambitions for energy efficiency have been increased at European level.

The European Commission established a new reference ‘EU Reference Scenario 2020’ (REF2020) in July 2021, defining a new baseline for the year 2030, compared to the ‘EU PRIMES 2007’ baseline (REF2007) which served as a reference for the initial NECP 2020.

With the introduction of this new reference (REF2020), the percentage targets for improving energy efficiency will no longer be directly comparable between the update of the NECP and the 2020 NECP; table 26 allows a comparison with the two reference scenarios (to be specified that absolute figures in energy consumption (kWh) remain comparable regardless of the benchmark used).

Thenew reference (REF2020) will be updated by the Commission in 2023 on the basis of the latest Eurostat data and communicated to the Member States in 2023. Luxembourg’s national target will then also be compared with the new benchmark.

Table 26: Setting the energy efficiency target under the National Energy and Climate Plan and its update

National target for improving energy efficiency (improvement of energy efficiency = reduction of finalenergy consumption)	final energy consumption in 2030 (FEC – final energy consumption, without ambient heat, including international aviation)	improving energy efficiency compared to REF2007 (EU PRIMES)	energy efficiency improvement compared to REF2020
REF2007 Reference Scenario (EU PRIMES)	*63.453 GWh*	— —	— —
EED2 targets (EU -32.5 %)	42.831 GWh	— 32.5 % (EU)	— —
NECP 2020	**38.000 to 35.568 GWh**	**— 40 to -44 %**	— —
new REF2020 baseline scenario	*with the introduction of the new REF2020 reference, the baseline changes and the targets (in%) between the initial NECP 2020 and the new NECP 2023 are no longer directly comparable*		
	(36.453 GWh) tbc (update FU COM before 2024)		— —
EED3 revision with FitFor55 + REPowerEU (EU -11.7 %)	still to be defined on the basis of EED recast (2023)		— 11.7 % (EU)
Updated NECP	**35.430 GWh**	**— 44 %**	

Source: own calculations 2023

Luxembourg's 2020 NECP sets an energy efficiency improvement target of -40 to -44 % for 2030 compared to the 2007 Reference Scenario (REF2007) used by the EU to set the EU -32.5 % target. In absolute terms, Luxembourg's -40 % target for final energy consumption (FEC) is equivalent to 38.000 GWh in 2030 and an improvement of -44 % is equivalent to 35.568 GWh in 2030. The Commission has described this objective as ambitious and Luxembourg is one of the few Member States with a positive assessment by the Commission of this dimension of its NECP.

The 2030 national target of 35.430 GWh in terms of final energy consumption * is defined on the basis of the modelling (STATEC) of the WAM (With Additional Measures) scenario for this update of the NECP.

(* final energy taken into account for the energy efficiency balance is final energy excluding ambient heat, including international aviation (FEC – Final Energy Consumption, without ambient heat, including international aviation) as defined in the Energy Balance Guide of the European Commission/Eurostat (version of 31 January 2019))

The WAM scenario incorporates the WEM (With Existing Measures) measures, i.e. the existing measures of the current policy (the WEM scenario takes into account measures that were in place before 1.1.2022), as well as the additional measures included in this update, necessary to accelerate the energy transition.

The European Energy Efficiency Directive (EED, Article 4), currently under revision, sets out a new methodology for calculating Member States' national contributions.

The target of 35.430 GWh in 2030 is equivalent to an improvement in energy efficiency (reduction in final energy consumption) of -44 % compared to REF2007 (63.453 GWh) and -3 % compared to the new REF2020 reference (36.453 GWh) (the new European reference REF 2020 will be further updated in 2023).

The new overall national target remains very ambitious and remains in line with the energy efficiency improvement target of -40 to -44 % compared to REF2007, set as an ambitious national target in the 2020 NECP. There are changes in the distribution across sectors due to the new modelling (STATEC 2023) and the new additional measures taken into account (WAM scenario), which were not yet taken into account in the 2020 NECP.

The sectors considered for monitoring Luxembourg's final energy consumption are:

- households (including residential buildings)
  ("private Haushalte" in the 2020 NECP)

  manufacturing and construction
  ("Industry" in the 2020 NECP)

- trade and services (including tertiary buildings)
  ("Gewerbe, Handel, Dienstleistungen" in NECP 2020)

- agriculture
  (agriculture was not reported separately in the NECP 2020)

- transport

Table 27: Overall energy efficiency objective and variations

OVERALL ENERGY EFFICIENCY OBJECTIVE 2030: Target scenario					
	Objective NECP 2020	NECP target 2020 vs REF2007	NECP target mtoj	NECP target: mm vs REF2007	NECP target: mm vs REF2020
Final energy consumption in 2030 [GWh] and compared to REF2007 and REF2020 [%]	38 000 to 35 568	— 40 % to — 44 %	35 430	— 44 %	— 3 %
Final energy consumption in 2030 [GWh] and variations [%]: Target scenario					
			Objectives NECP 2020	NECP targets 2020 vs REF SNEC 2020	Objectives PNEC mtoj
Total all sectors			35 568	— 30 %	35 430
Household			4 611	— 40 %	4 410
Tertiary			3 205	— 24 %	4 904
Industry			6 088	— 17 %	6 985
Agriculture			— —	— —	64
Transport			21 664	— 15 %	19 066
including:					
Total road transport			15 728	— 38 %	10 595
Road transport diesel and petrol			14 845	— 41 %	9 747
Aviation			5 936	0 %	8 472
Other specific objectives					
				Objective NECP 2020	NECP target mtoj
Electromobility: Share of electric cars/plug-in hybrid vehicles in the car fleet by 2030 (residents)				49 %	49 %

Source: STATEC 2023 modelling, MEA table

The WAM scenario takes into account a modulation of the CO_2 tax according to the evolution of the fuel price differential with neighbouring countries at the level of the transport sector (road transport fuels) which is necessary in the context of the national GHG emission reduction targets for 2030 and this modulation of the CO_2 tax is also very important in the context of the energy efficiency objectives, i.e. the final energy consumption of the transport sector.

The cumulative amount of end-use energy savings to be achieved by Luxembourg over the period 2021-2030 under Article 7(1)(b) on energy savings obligations and in accordance with Directive 2012/27/EU as amended was 21.435 GWh (48.716 GWh x 55 x 0.8 %) for the NECP 2020.

This cumulative amount of end-use energy savings is revised upwards in the context of the third revision of Directive 2012/27/EU (EED currently under revision) and now stands at 42.538 GWh. This amount corresponds to 87.3 % of the amount of 48.726 GWh or of the average final energy consumption of the country (Europe 2020-2030) of the years 2016, 2017 and 2018 according to EUROSTAT, as required by the proposed amendment of the Directive. The 87.3 % or 42.538 GWh corresponds to the combination of new annual energy savings to be achieved over the total period from 2021 to 2030 (10 years). The revised text provides for new annual energy savings rates

progressive, 0.8 % from 2021 to 2023, 1.3 % from 2024 to 2025, 1.5 % from 2026 to 2027 and 1.9 % from 2028 to 2030. The total cumulative energy saving rate of 87.3 % represents the sum of these annual cumulative rates.

Table 28: Method of calculating the cumulative overall target over the period 2021-2030 according to Article 8 of the revised

Directive

2021	0.8 %										0.8 %
2022	0.8 %	0.8 %									1.6 %
2023	0.8 %	0.8 %	0.8 %								2.4 %
2024	1.3 %	1.3 %	1.3 %	1.3 %							5.2 %
2025	1.3 %	1.3 %	1.3 %	1.3 %	1.3 %						6.5 %
2026	1.5 %	1.5 %	1.5 %	1.5 %	1.5 %	1.5 %					9.0 %
2027	1.5 %	1.5 %	1.5 %	1.5 %	1.5 %	1.5 %	1.5 %				10.5 %
2028	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %			15.2 %
2029	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %		17.1 %
2030	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	1.9 %	19.0 %
Total cumulative energy saving rate for the period 2021 — 2030											87.3 %

The Energy Efficiency Obligation Scheme (EEOS), more detailed in Chapter 3.2, will provide up to 2030 a cumulative energy saving of 13.750 GWh. The remainder of the overall obligation is met by alternative policy measures, described in detail in Chapter 3, the respective references of which are set out in Table 29. The contributions of alternative measures to the achievement of the overall target shall be indicated as a percentage of the total cumulative savings to be achieved up to 2030. Since the expected amounts of energy savings to be achieved by alternative measures are more difficult to quantify by measure than the EEOS bond scheme (the objective of which is precisely quantified in a law), the contributions of alternative measures to the overall target are indicated within a range of values. The energy savings achieved under the EEOS bond scheme are counted at 100 % at national level, while possible overlapping effects are taken into account at the level of alternative measures, in order not to have a double counting effect.

Table 29: National Energy Efficiency Obligation Scheme (EEOS) and alternative policy measures in accordance with Articles 8, 9 and 10 of the proposed revision of the EED Directive

Measures contributing to the achievement of the energy savings obligation target (Directive under revision Articles 7 and 8)	PAMs reference	% compared to the overall final energy savings target	Cumulative energy saving up to 2030 (compared to EU reference Premiums 2020 (REF2020) in GWh
Cumulation of all measures		100 %	42 538
Energy Efficiency Bond Scheme (EEOS)****	121	32 %	13 750
Alternative policy measures	— —	68 %	28 788
including:			
CO2 tax on liquid fuels††††	105	66 %	27 970
Aid scheme Klimabonus Wunnen (residential buildings)	307	3 – -6 %‡‡‡‡	
Individual housing aid scheme	311	1 – -4 %	
Tax incentives for energy renovation of housing	313	1 – -3 %	
Aid scheme for municipalities	314	1 – -2 %	
Promoting public transport	405	6 – -9 %	
Promotion of innovative mobility services	406	1 – -2 %	
Promotion of electrification of Luxembourg registered car fleet	410	7 – -11 %	
Revised road vehicle registration tax	420	1 – -3 %	
Aid scheme for zero CO2 emission vehicles	423	4 – -6 %	
Voluntary agreement on improving energy efficiency in industry (up to and including 2023)	503/504	0 – -1 %	

****overlap effects with alternative measures are corrected directly on them

††††total cumulative savings over the period 2021-2030 modelled on figures provided by STATEC

‡‡‡‡the percentages in italics are estimates of potential contributions, the overlap effects corrected

Obligations for the public sector

Obligation to reduce final energy consumption

With the ongoing revision of the EED Directive (Article 5), a new obligation on the final energy consumption of all public sector activities will be introduced: obligation to reduce final energy consumption by 1.9 % per year (annually). For the first 2 years after transposition of the Directive, this target will still be indicative. Energy consumption of buildings owned by municipal administrations with less than 50.000 inhabitants will not be taken into account for this obligation until 31 December 2026, respectively until 31 December 2029.

for municipalities with less than 5.000 inhabitants (phase-in period depending on the size of the municipalities).

Table 30: Final energy consumption, baseline in 2021 and projection to 2030 for public sector buildings (definition in EED under revision)

Public sector buildings	Final energy consumption for the year 2021 [MWh] (baseline)	1.9 % reduction per year [MWh]	Final energy consumption for the year 2030 [MWh]**	The final energy consumption 2030/2021 [%]
State – TOTAL*	470.000 MWh	8.930 MWh	434.280 MWh	— 7.6 %
State – buildings (owned by the State)	Figures under preparation			
State – public transport	Figures under preparation			
State – Armed Forces	Figures under preparation			
State – other	Figures under preparation			
Municipalities – TOTAL***	304.232 MWh	5.780 MWh	281.112 MWh	— 7.6 %
inclu				
Office buildings	18.638 MWh			
Event centres	29.734 MWh			
Schools, colleges and universities	80.402 MWh			
Crèches and relay houses	19.517 MWh			
Fitness	57.212 MWh			
Rest	98.729 MWh			

* approximate estimate based on LTRS data and ABP information on the total number of buildings
* * entry into force of the obligation two years after transposition of the Directive (probably in 2027)
* * * latest available consumption of municipal buildings for 2020 based on Enercoach

Renovation of public buildings

Under Article 2a of Directive (EU) 2018/844 of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, the Luxembourg Government presented in 2020 the continuation of the national long-term energy renovation strategy (LTRS). This long-term renovation strategy supports the renovation of the national stock of residential and non-residential buildings, both public and private, with a view to building a highly energy efficient and decarbonised building stock by 2050, thus facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings. The guidelines of the renovation strategy are:

Prioritising full and energy efficient renovations: significant increase in renovation depth (amount of energy saved compared to pre-renovation condition) and renovation rate (number of buildings renovated per year
Affordability of energy renovation measures

Better coordination between energy policy and heritage protection Promotion of sustainable construction and circular economy

These guidelines are constantly taken into account when developing the tools necessary for the progress of the strategy. These tools take various forms:

Regulatory provisions (regulations and standards)
Promotion and financing instruments
Fiscal instruments
Training courses
Awareness-raising and publicity work

Research and pilot projects

The different tools align with each other in such a way that the combination of their impacts mutually strengthens them.

From a technical point of view, the focus is on improving the energy envelope of buildings (thermal insulation) and improving the energy efficiency of technical installations, with a particular focus on non-fossil energy sources (replacing old fossil fuel based heating systems with renewable energy systems with a focus on decarbonising buildings through electrification using heat pumps, combined with photovoltaic electricity generation at building level and optimisation of self-consumption of this electricity.

Heat pumps have the advantage of decarbonising a building's energy consumption during use (heating system electrified on renewable electricity) and reducing final energy consumption, as reflected in national targets (ambient energy used (2/3 vs. 1/3 electricity) by a heat pump is not included in the final energy).

Accompanying measures such as continuous training, awareness-raising and research are intended to identify and highlight economic potential, as well as possible improvements and accompanying measures.

In addition to the impact on energy savings and climate, another key indicator for assessing the policy mix is the impact on people living in and using buildings, in particular vulnerable people who are at risk of energy poverty because their income is low and their energy consumption is relatively high. Although Luxembourg is one of the EU Member States with the lowest energy poverty rate, many households are unable to heat adequately or have to rely on state aid to pay their energy bills. An analysis of the situation of energy poverty also shows that the problem is not caused by energy prices alone, but by the phenomenon that in recent years rents have increased at a much faster rate than purchasing power, particularly in lower income groups. An analysis of energy poverty in Luxembourg is therefore a key element of the national energy renovation strategy.

The indicative milestones under the long-term building renovation strategy mainly target the residential stock. Starting from a household final energy consumption of 6.438 GWh/a in 2020, the reduction target announced by 2040 was 2.715 GWh/a with an intermediate target of 4.611 GWh/a in 2030. This corresponds to a reduction of 28 % (2030) and 58 % (2040) compared to final energy consumption in 2020.

Based on the analysis of the effects of existing measures of the current policy (Chapter 4, WEM scenario), a need for further measures to accelerate the transition to a decarbonised building stock by 2050 has been identified and included in the WAM scenario of this update.

Table 31: Comparison of LTRS vs WAM modelling indicators (PNEC update)

Final energy consumption by households (including residential buildings)	2020	2030	2040	Unit
LTRS indicators *	6 438	4 611	2 715	GWh
Updated NECP WAM modelling	5 494	4 410	3 322	GWh

* Note that the indicators announced in Chapter 3.4.1 of the LTRS are not identical to the indicators announced in Chapter 4.1.1. of the same strategy. Only the latter indicators, which are identical to the NECP 2020 indicators, should be used.

In order to assess the national energy renovation strategy objectively, the current indicators need to be consolidated and complemented. Attention is currently being paid to assessing the relevance of potential indicators. A register of the energy performance of buildings under development (in anticipation of the future requirements of the European EPBD Directive currently being revised) will allow monitoring of the evolution, inter alia, of the thermal insulation class of existing buildings, which is an indicator of the evolution of energy renovation.

Mandatory energy renovation of public buildings

According to the energy improvement strategy of the Public Buildings Administration, based on the European Energy Efficiency Directive (EED), 3 % of the surface area of buildings allocated to the central government has been renovated in recent years.

According to data from the Public Buildings Administration (ABP) and in line with Article 5 of the EED Directive, an area of 61,050^{m} 2 (out of a total surface area of 126,253^{m} 2 of buildings occupied by the central state) would still be affected by the

obligation to renovate at the end of 2020. As a result, an area of 1.832 m^2 (or 3 %) would have to be renovated in 2021, 1.777 m^2 in 2022 and so on, in order to arrive at a cumulative total area of energy renovation between 2021 and 2030 of 16.030 m^2.

With the ongoing revision of the EED Directive (Article 6), a new 3 % annual renovation obligation for buildings owned by the public sector (and with lower energy performance than nZEB) is introduced. With this European requirement, it will no longer be exclusively the central State which is concerned, but the entire public sector, namely the State and the municipalities (current definition included in the proposed revision of the EED: 'public bodies: means national, regional or local authorities and entities directly funded and administered by these authorities but not having industrial or commercial characteristics').

The very ambitious nZEB (nearly Zero Energy Building) level, which is currently defined at national level for new buildings by the amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings, will be supplemented by a 'nZEB renovation' level of energy performance,which will be defined in the context of the transposition of the EPBD Directive currently under revision and the introduction of minimum energy performance standards (MEPS – Minimum Energy Performance Standards (EPBD)), taking due account of cost-effectiveness (proportionality) and technical feasibility as provided for in the Directive; this $nZEB_{renovation}$ level will be the minimum requirement for future renovation obligations (notably for the public sector).

Under renovation obligations, less stringent rules are envisaged for certain categories of buildings, such as protected buildings (protected heritage).

Table 32: Surface area of public buildings (according to the definition in force in the year in question) covered by the obligation to renovate at least 3 % useful floor area per year (at a performance level nZEB according to the current text for the revision of the Directive)

Requirements	NECP 2020	Updated NECP	The NECP màj/2020
Total surface area of buildings with a lower energy performance than the minimum	Buildings occupied by the central government: 126.253 m^2 (as of 31.12.2020) (Minimum level required by RGD on energy performance of buildings)	Buildings owned by the State: 5 400 000 m 2 . . * (to 31.12.2022) (nZEB level required by RGD on the energy performance of buildings)	+ 5 273 747 m 2

* The figure given represents only an estimate of the total surface area of the State buildings at the end of 2022, since it is not possible to determine the total area to be insulated (performance level lower than the nZEB level), inter alia because of the lack of a final definition to be adopted in the context of the revision of the EED and EPBD Directives. A list of all public buildings concerned on the basis of the new definition must be drawn up, identifying the buildings covered by the renovation obligation with the respective surfaces and energy consumption.

Energy efficiency targets by sector

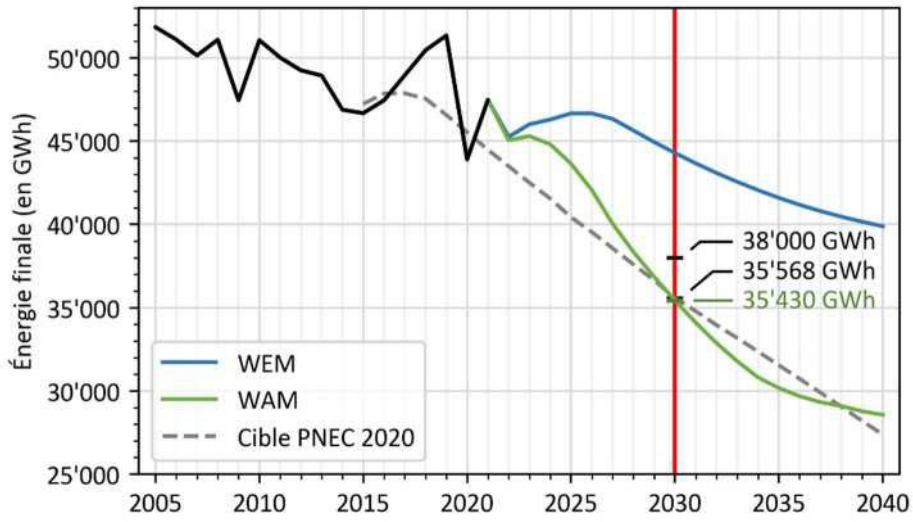
The figures below compare the evolution of final energy consumption for the PNEC 2020 (target) vs WEM vs WAM scenarios (WEM and WAM being based on the new STATEC modelling which is the basis for this update of the NECP).

The final energy considered here is the final energy excluding ambient heat, including international aviation.

Total all sectors

The overall energy efficiencytarget for all sectors modelled in the WAM scenario is shown in the figure below. The ambitious final energy consumption target of 35.430 GWh in 2030 equivalent to -44 % compared to REF2007 is within the energy efficiency improvement range of -40 to -44 % compared to the REF2007 benchmark defined as the national target in the NEC2020.

Figure 3: Evolution PNEC 2020 vs WEM vs WAM – TOTAL all sectors



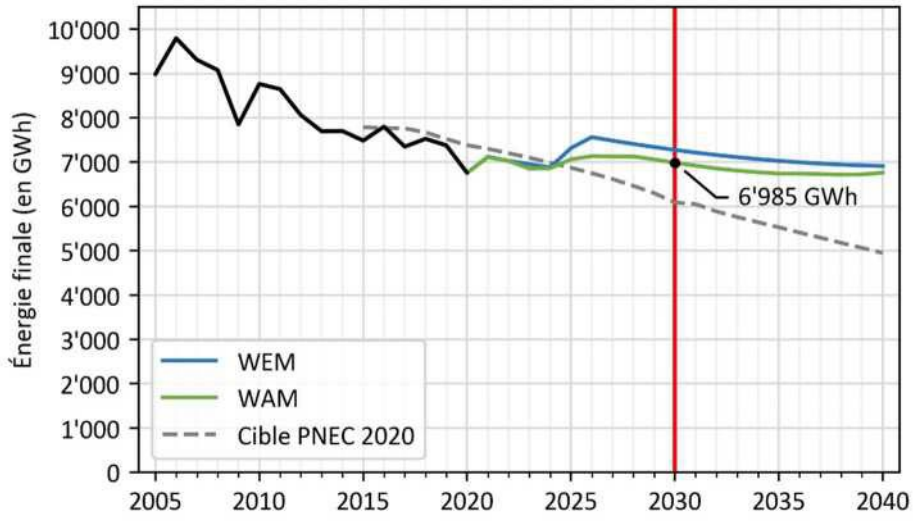
Source: STATEC 2023 modelling, MEA Graphics

Manufacturing and construction

Based on cyclical projections, the continuous increase in manufacturing and construction activities counterbalances almost entirely the improvement in energy efficiency in this sector, which explains the almost constant final energy consumption between 2020 and 2040, with slight fluctuations.

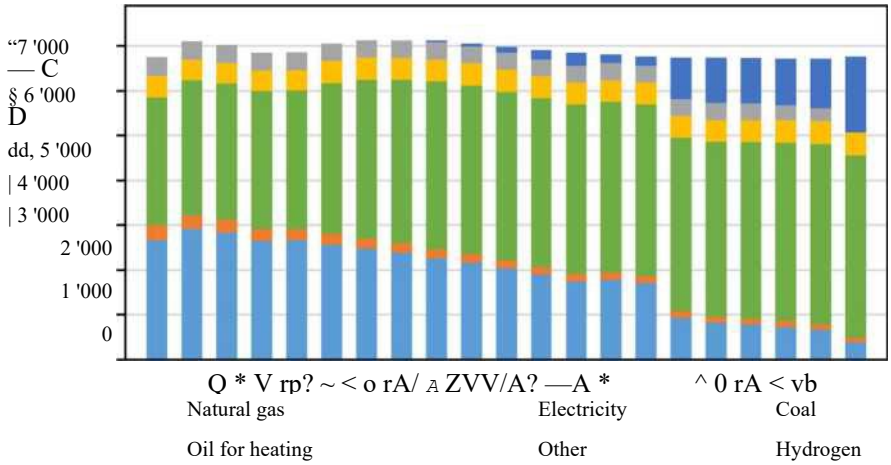
It should be pointed out that the increase in activities is mainly at the level of non-ETS companies and that there is virtually no change at the level of HTA companies.

Figure 4: Evolution PNEC 2020 vs WEM vs WAM – Manufacturing and construction



Source: STATEC 2023 modelling, MEA Graphics

Figure 5: WAM evolution by energy carrier – Manufacturing and construction



Source: STATEC 2023 modelling, MEA Graphics

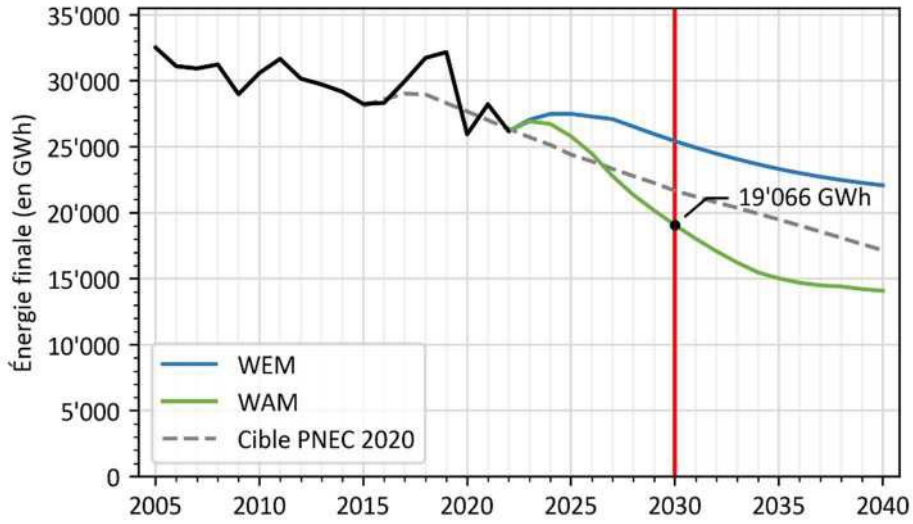
Transport

The sharp decline in final energy consumption in the transport sector is primarily influenced by the modulation of the CO_2 tax according to the evolution of the fuel price differential with neighbouring countries (road transport fuels).

The electrification of the transport sector has a rather low impact on final energy consumption, but has a significant influence on the reduction of GHG emissions from the sector.

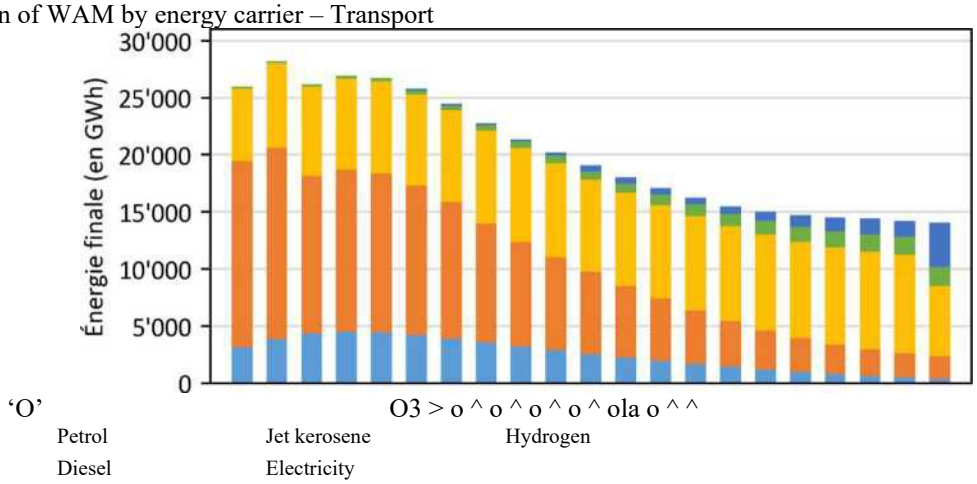
The strong growth of the aviation sector (passenger and freight transport) counterbalances some of the improvements in energy efficiency.

Figure 6: Evolution PNEC 2020 vs WEM vs WAM – Transport



Source: STATEC 2023 modelling, MEA Graphics

Figure 7: Evolution of WAM by energy carrier – Transport

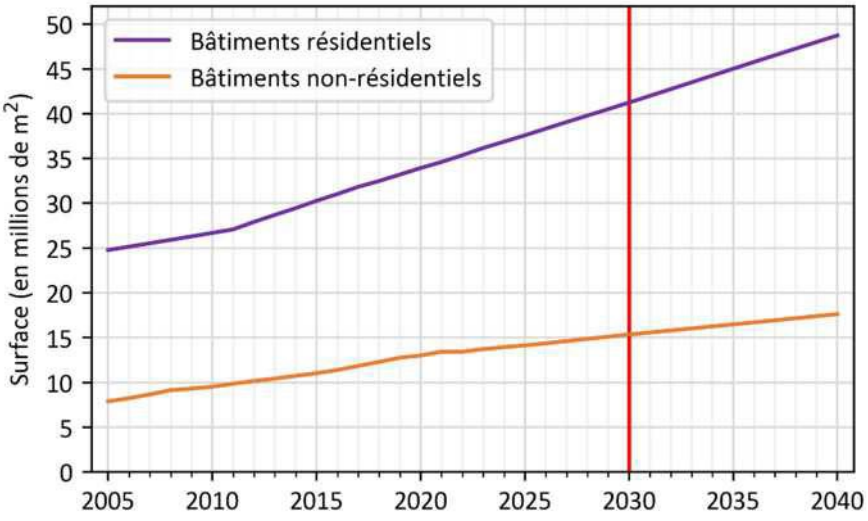


Source: STATEC 2023 modelling, MEA Graphics

Households (including residential buildings)

For the household sector, as well as for the trade and services sector, the significant changes in the surface area of buildings (as shown in the following illustration) must be taken into account when interpreting the evolution of final energy consumption.

Figure 8: Evolution of building surface area – Households (residential buildings) and Commerces and services (tertiary buildings)

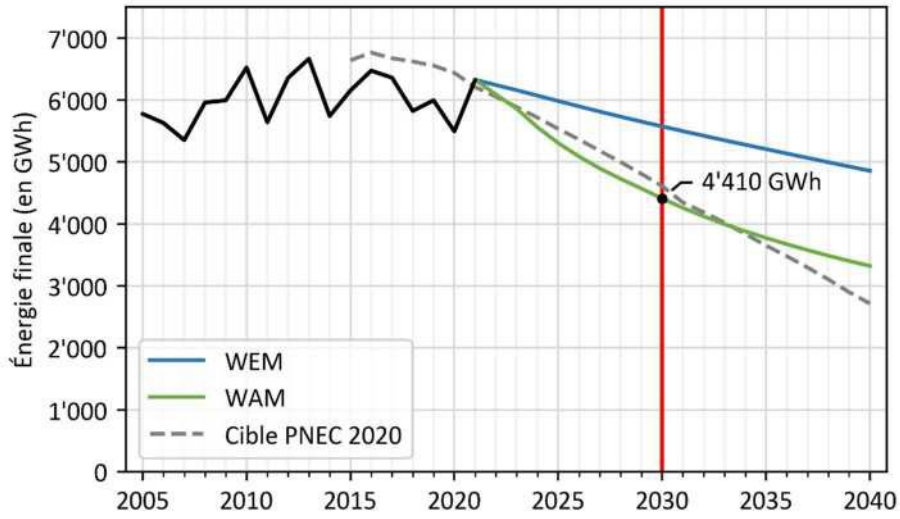


Source: STATEC 2023 modelling, MEA Graphics

The energy consumed by households is largely directly related to the use (heating) of residential buildings.

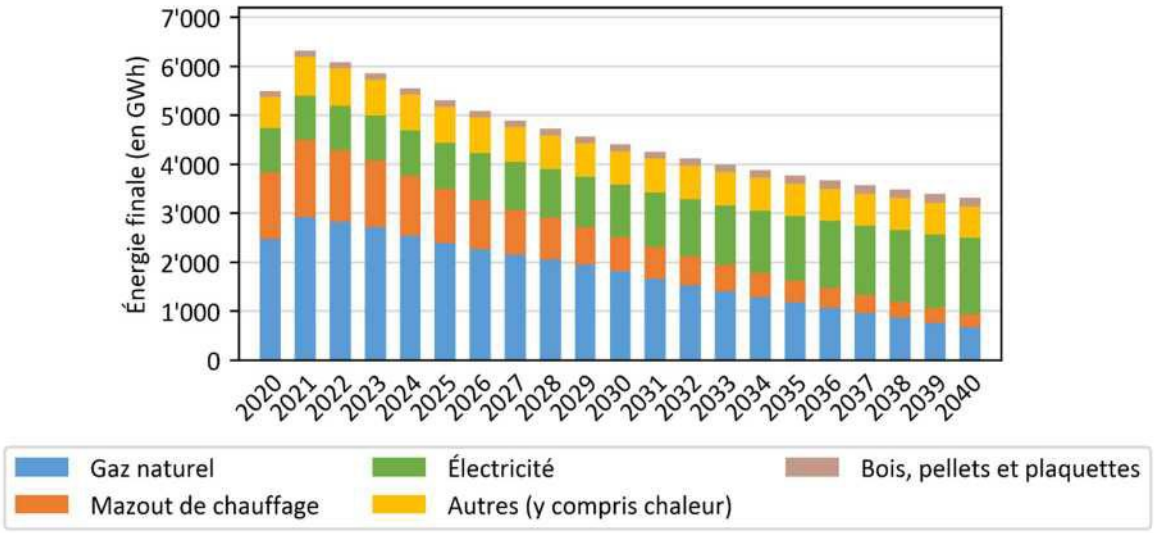
The decarbonisation of buildings through electrification, i.e. the replacement of fossil heating systems with renewable energy systems, including heat pumps, has a direct effect on GHG emissions and a significant effect on the reduction of the final energy consumed.

Figure 9: Evolution PNEC 2020 vs WEM vs WAM – Households



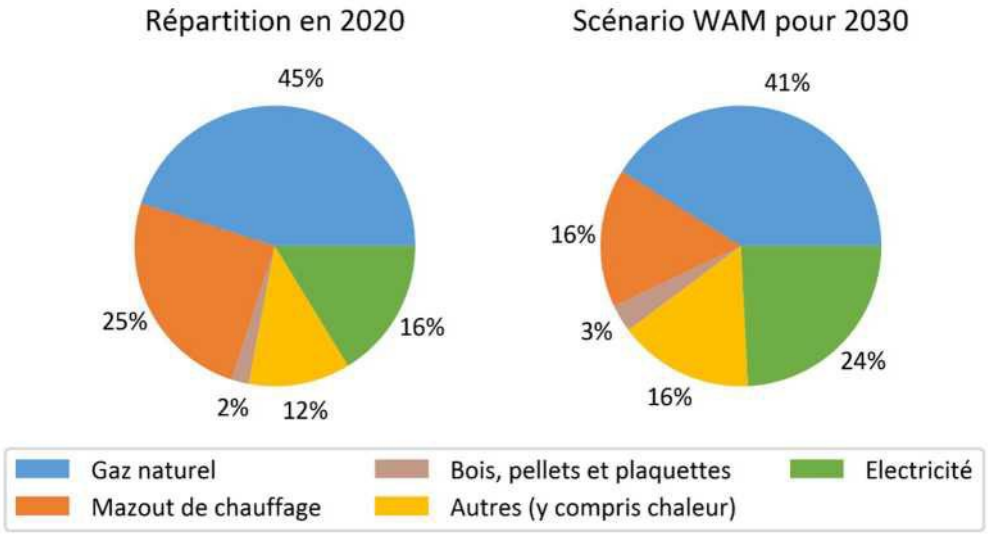
Source: STATEC 2023 modelling, MEA Graphics

Figure 10: WAM evolution by energy carrier – Households



Source: STATEC 2023 modelling, MEA Graphics

Figure 11: Distribution by energy carrier – Households



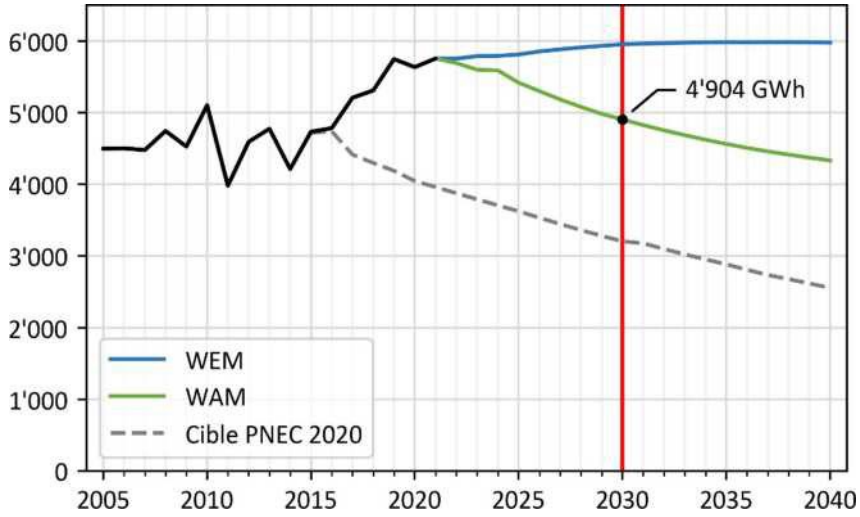
Source: STATEC 2023 modelling, MEA Graphics

Shops and services (including tertiary buildings)

This sector includes tertiary buildings but also all commercial and service activities (which are not specifically allocated to another sector).

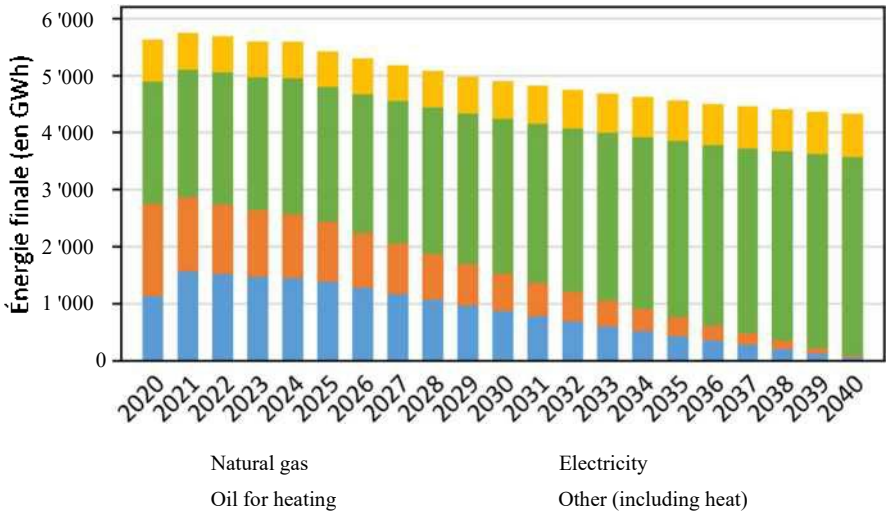
The decarbonisation of buildings through electrification, i.e. the replacement of fossil heating systems by renewable energy systems and in particular by heat pumps has a direct effect on GHG emissions and a significant effect on the reduction of the final energy consumed (as ambient heat operated by a heat pump is not counted as final energy (FEC without ambient heat)).

Figure 12: Evolution PNEC 2020 vs WEM vs WAM – Commerces and services



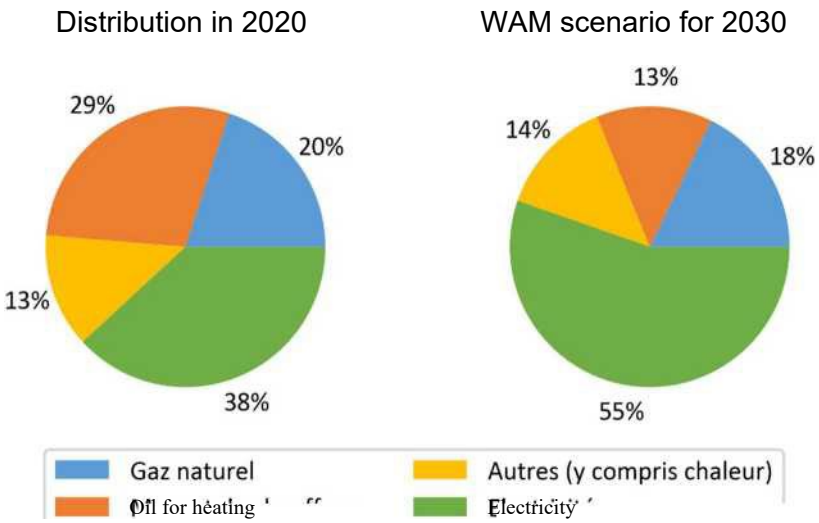
Source: STATEC 2023 modelling, MEA Graphics

Figure 13: WAM evolution by energy carrier – Commerces and services



Source: STATEC 2023 modelling, MEA Graphics

Figure 14: Distribution by energy carrier – Commerces and services

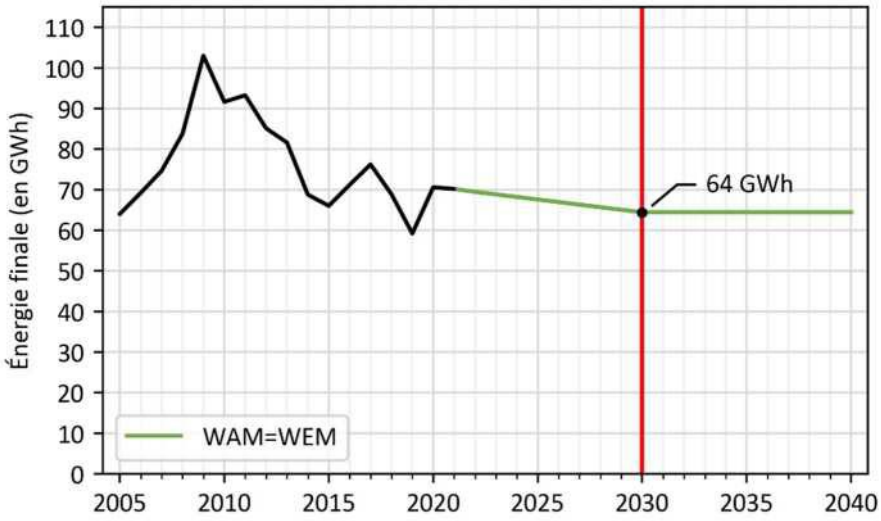


Source: STATEC 2023 modelling, MEA Graphics

Agriculture

The agriculture sector has a negligible final energy consumption compared to the other sectors considered above. Figure 60 shows the evolution of its final energy consumption up to 2040.Figure 15 shows the evolution of its final energy consumption up to 2040.

Figure 15: WAM scenario – Agriculture



Source: STATEC 2023 modelling, MEA Graphics

2.3 Dimension energy security

In line with the statistics from previous years and decades, Luxembourg's main objective is to ensure a very high level of security of energy supply for all types of energy, and to remain among the countries with the highest level in Europe.

At the same time, the objective is also to follow an effective approach, i.e. to maintain a good balance between the expected level of safety compared to the resources invested by the state and consumers. In addition, security of supply will need to be ensured through sustainable investment, a need which is clearly reinforced by the new geopolitical context and the energy crisis following the war in Ukraine. Thus, the strategy should be based as far as possible on energy efficiency as well as local and renewable resources.

The expansion of renewable energy needed to meet the targets will enable Luxembourg to significantly reduce its dependence on electricity imports. However, due to the huge demand for electricity from the industrial sector, national energy sources will not be sufficient to cover Luxembourg's energy supply in the future. In the area of load flexibility, Luxembourg aims to significantly increase the share of consumers actively participating in the electricity market.

Industry efficiency and electrification measures, strict thermal insulation standards for buildings and the renovation strategy developed for the building stock will reduce demand for natural gas and consequently reduce energy dependency.

However, as Luxembourg is dependent on energy imports, the European internal market for electricity and gas needs to be fully operational. The country therefore wishes to speed up the completion of the internal market in electricity and gas, with intensive cross-border competition between suppliers and an expansion and diversification of renewable energy offers, for example through renewable PPAs. Among other things, investment in off-shore wind energy offers an interesting way to support the security of energy supply through the high availability of wind energy resources. Therefore, Luxembourg is also in favour of strengthening regional cooperation in the field of security of energy supply, and aims to accelerate the development of demand flexibility and its integration into the internal market in order to address the intermittency of certain renewable energies.

Due to their legal obligations, electricity and gas network suppliers attach great importance to the good condition of their infrastructure, which wants it to be at the cutting edge of the technology. The available capacity of the networks must meet the increasing demands of the country's economic and demographic development. The widespread installation of smart meters for all consumers will enable network providers to manage their networks even smarter and more secure.

In the interest of security of supply in the oil sector, it will be important in the future to be able to continue diversifying countries of origin and supply routes. Since the supply of fuel to Luxembourg airport is provided directly through an underground pipeline network (CEPS), the diversification of supply routes mainly concerns petroleum products such as diesel, petrol and heating oil. Indeed, most of the imports are by road, while only about one fifth is carried out by rail. The remaining part of the imports is by inland waterway transport on the Moselle to Luxembourg's sole port in Mertert.

As a member of the European Union and of the International Energy Agency (IEA), Luxembourg is required to have an oil reserve corresponding to an average of 90 days of imports from the previous year. Importers of petroleum products are also subject to the national legal obligation to store eight days on national territory, 37 days in the regional territory outside Luxembourg and the remaining quantities in the rest of the EU.

For hydrogen, the aim will first be to determine the level of security to be considered for hydrogen supply, in order to then define the necessary measures to secure hydrogen supply at the required level. Moreover, hydrogen could further enhance Luxembourg's security of electricity supply by opening up an additional pathway to increase flexibility in the electricity grid at national level and by offering seasonal storage possibilities at European level.

2.4 Dimension internal energy market

2.4.1 Electricity interconnectivity

Despite ambitious targets to advance domestic renewable energy production, Luxembourg will remain dependent on imports to cover its electricity needs. Therefore, the country requires a high level of interconnection beyond the interconnection levels of other EU countries. Luxembourg's interconnection capacity already exceeds by far the European targets of 15 % for 2030. The level of interconnection (N-0) with Germany is currently around 230 %, calculated in relation to the maximum annual load. The planned network expansion projects will increase this level to around 400 % in 2030, thus providing sufficient reserves to cope with future increases in consumption in all areas.

The connection to the electricity network with Belgium is a support connection which increases Luxembourg's overall security of supply and is particularly useful in the event of major unplanned unavailability on the German side.

2.4.2 Energy transmission infrastructure

In the gas sector, the current infrastructure of the transmission network is considered sufficient, especially as the dismantling of the former Twinerg Gamz-Steam Turbine (TGV) power plant has significantly reduced gas consumption in peak times. No further expansion of cross-border connections is necessary. At the same time, the common gas market with Belgium, which has existed since 2015, will be further developed.

In the electricity sector, Luxembourg intends to further increase its integration into the interconnected European grid in the medium term. Strengthening existing interconnections is indeed necessary given the expected increase in electricity demand and peak load due to projected population growth, diversification of economic activities as well as overall economic growth. Therefore, the Transmission System Operator Creos plans to build a 380 kV line to replace one of the double 220 kV lines to Germany by the end of 2028. However, there are no plans to connect the Luxembourg public electricity network to the French electricity network.

In the area of hydrogen, Luxembourg's hydrogen strategy has been public since the end of 2021. As a follow-up to this strategy, and under the initiative of Luxembourg, the Working Group on Hydrogen within the Benelux General Secretariat launched a procedure to launch a study in the context of the objectives of decarbonising society, on the future needs of hydrogen infrastructure in the Benelux region and the interconnections with neighbouring regions, which will be finalised shortly.

2.4.3 Market integration

From a Luxembourg perspective, the completion of the internal energy market remains particularly important for the electricity sector. Luxembourg supports the European Commission's efforts to develop a new European market design for electricity markets. This design of the electricity market within the Member States must first and foremost be consistent. Specific national approaches weigh on electricity consumers, neglect the impact on other Member States and, at worst, undermine security of supply.

The Luxembourg Government, ILR and the Transmission System Operator Creos are actively involved in the development of the internal electricity market in European bodies and institutions.

Cooperation within the Pentalateral Energy Forum (PLEF), which includes Belgium, the Netherlands, France, Germany, Austria and Switzerland, is particularly important. This region has been closely linked in technical and economic terms for years as a pioneer in the convergence of European electricity markets. Within the PLEF, the strong integration of the German and Luxembourgish electricity markets into the cross-border market area is once again distinct. Luxembourg wishes to maintain this common market area and to further deepen cooperation.

It will examine whether the conclusion of bilateral agreements with other Member States on mutual solidarity in the event of energy crises can improve security of supply in Luxembourg.

Compared to the rest of Europe, electricity and gas prices in Luxembourg are well below average. However, the proportion of consumers switching suppliers is relatively low. In this context, it is important to maintain comparability and transparency. The active comparison of a supplier's tariffs with those of its competitors as well as, where appropriate,

switching may allow consumers to significantly reduce their energy bills. It is therefore important to be able to compare prices in full transparency, including for new types of offers such as dynamic prices.

Luxembourg has replaced 98 % of electricity meters with smart meters. This new situation allows and will improve the integration of active consumer markets, be it through decentralised generation or active participation in flexible markets to be defined, through individual or collective self-consumption of self-generated electricity or participation in energy communities.

In order to improve the integration of renewable energy markets, Luxembourg had already converted part of its aid scheme into a rolling market premium. On the other hand, self-consumption is promoted by substantial investment aid in return for waiving the injection premiums.

In order to minimise the risk of supply problems in the natural gas sector, as well as to increase security of supply and integrate markets in general, the Belgian gas network operator Fluxys and Creos brought together the two national gas markets into a cross-border market in 2015. As a result of this merger of markets, the non-interruptible capacity available on the Belgium-Luxembourg border has also been considerably increased to its maximum. This makes it possible to considerably increase uninterruptible capacity, even without expansion of the lines, and to ensure Luxembourg's security of supply in the long term. This common market also enables undertakings to rely on a more competitive and fluid market for their supply.

As the hydrogen market does not yet exist on the same scale as other energy markets, the development of such a market will be actively accompanied and Luxembourg's integration into such a European market will be promoted with a view to the transition of the economy to a decarbonised economy.

2.4.4 Energy poverty

Climate change and the health effects of fossil fuels are particularly affecting low-income groups. Climate action therefore also makes a tangible contribution to greater social justice. However, measures to combat climate change also need to be integrated from a social point of view in order to prevent energy poverty.

Luxembourg has a wide-ranging policy to combat general poverty (minimum wage, REVIS, etc.). The country also has a number of measures to provide targeted support to people affected by energy poverty. Under the Laws of 1 August 2007 on the organisation of the electricity market and the organisation of the natural gas market, a household customer who is unable to pay his electricity or gas bills may obtain social assistance from the competent social office.

The Law of 18 December 2009 organising social assistance provides, for its part, that, when applying the procedures laid down by the abovementioned laws on the organisation of the electricity and natural gas market, the competent social office must carry out an examination to determine whether or not the household customer is in a position to pay his energy bills and whether he is entitled to social assistance.

Particular attention must be paid to combating energy poverty in the housing sector: rising housing prices in Luxembourg are now a major social challenge. Low-income sections of the population often have the right means to rent poorly maintained homes with low energy performance in old buildings. Therefore, the government specifically encourages the creation of affordable housing. In the housing sector, energy efficiency measures will be designed to improve the national energy balance and living conditions of low-income population groups.

Targeted programmes ("Klimabonus") are being put in place to counter rising carbon prices by creating significant financial incentives for owners to switch from fossil fuels to renewables. This shift to renewable energy will also have to become affordable for low-income people. A 'subsidy for the replacement of a boiler powered by oil oil' makes it possible, in particular, to simplify the transition from a technical and financial point of view. Some support programmes are reinforced by housing support for people with lower incomes ('Topup social Klimabonus').

It should also be pointed out that the already existing expensive living allowance also helps to combat energy poverty. In addition, low-income households can benefit from state housing support in case of rent increases. It should also be noted that the current social assistance legislation stipulates that any person who fulfils the conditions for eligibility for social

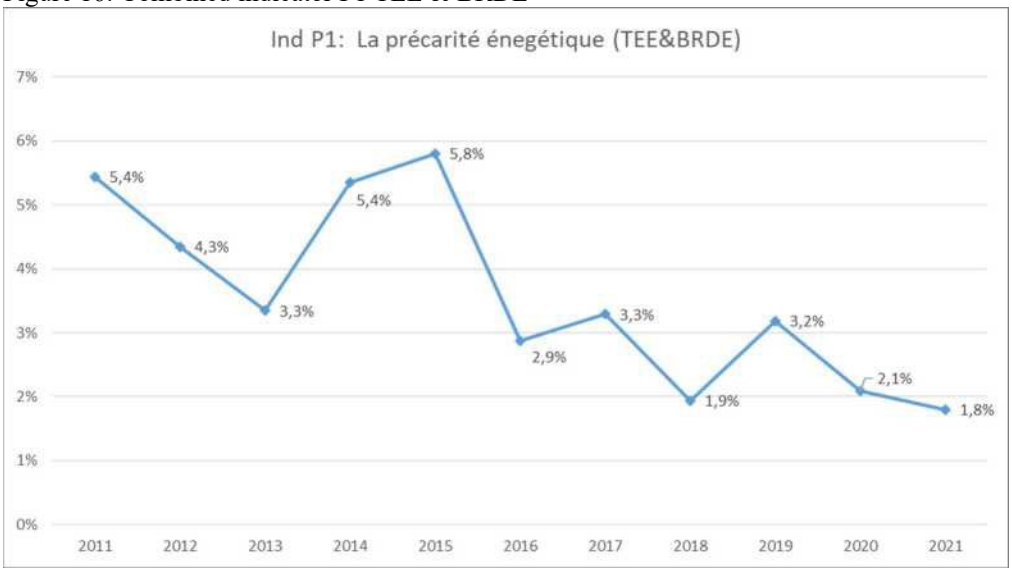
assistance is entitled to a minimum supply of domestic energy under specified conditions, if they are unable to cover the cost of their domestic energy.

Investment efforts in infrastructure development and the introduction of free public transport from 2020 are not only part of transport policy, but also clearly social.

Luxembourg has defined a national indicator for quantifying and monitoring the evolution of energy poverty: the combined indicator TEE &BRDE, which makes it possible to avoid situations of energy waste and situations where the effort rate is acceptable and to take into account the level of poverty in households.

(Comment: the Energy Effort Rate (EER) indicator was not chosen on its own as it is not specific to the issue of energy poverty but may include situations of energy waste and the Dutch Income – High Expenditure (BRDE) indicator was not chosen alone as it includes households with an effort rate deemed acceptable (i.e. above the EEO threshold).)

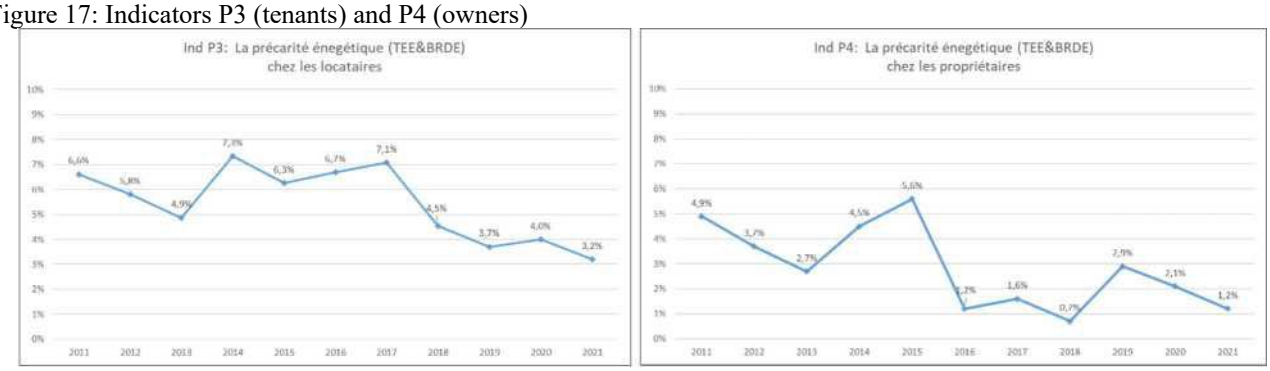
Figure 16: Combined indicator P1 TEE & BRDE



Source: STATEC

The main indicator P1 is complemented by two additional indicators: indicator P3 identifying tenants' energy poverty and indicator P4 identifying energy poverty of owners.

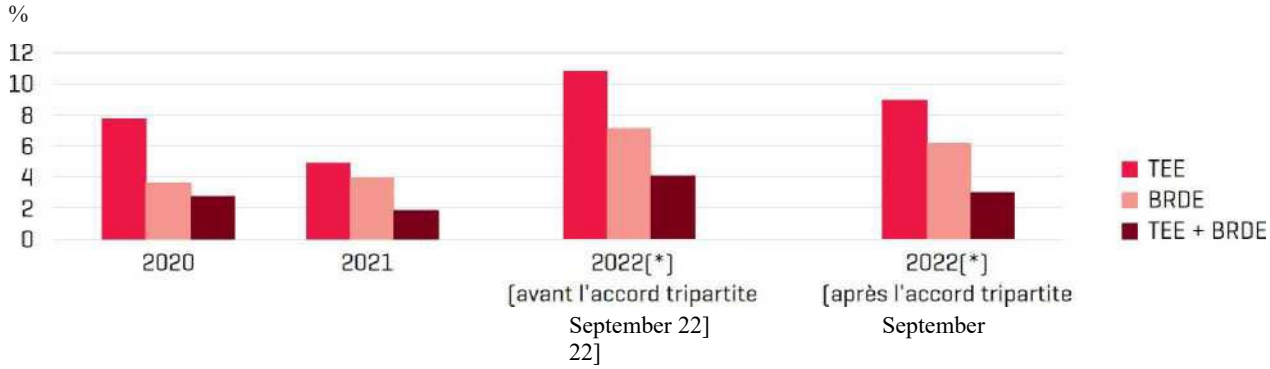
Figure 17: Indicators P3 (tenants) and P4 (owners)



Source : STATEC

Taking into account the energy price forecasts for 2022 and 2023 and household income indexation, the forecasts for energy poverty in 2022 show a sharp increase in the EEO and BRDE. Under the two EEO and BRDE indicators, without recent tripartite measures, 4.1 % of households residing in Luxembourg would fall into energy poverty in 2022 (estimate dependent on many factors such as household energy saving efforts). Taking into account all the measures identified during the September 2022 tripartite negotiations, this figure is reduced to 3.0 %.

Figure 18: Energy poverty in 2020, 2021 and forecast for 2022



[*] forecast until June 2022

Source: STATEC

2.5 Dimension Research, innovation and competitiveness

2.5.1 Introduction

The transition to a society and economy that is compatible with the Paris climate objectives requires fundamental systemic changes in the management of stocks and resource flows, including energy resources, in today's production and living methods, which are highly resource intensive. These transformations will have to be applied at multiple levels, starting with people's behaviours and habits, from individual and collective investment and consumption choices to technological innovations, in order to eliminate GHG emissions and even to reduce from the atmosphere a certain amount of anthropogenic GHG emissions accumulated since the beginning of the industrial era, with the ultimate aim of preserving biogeochemical cycles and ecosystem services that guarantee survival and human well-being.

The scientific and technological disciplines affected to produce and apply the knowledge needed for these systemic transformations are therefore multiple. The problems to be addressed are partly inter- or transdisciplinary requiring close collaboration between public and private R & D & I actors to provide solutions. It follows that public governance of R & D & I must also take an interdisciplinary holistic view, set R & D & I priorities and provide the right incentives to adequately contribute to the ambitious goals of climate neutrality by 2050.

2.5.2 Strategies and thematic objectives

The "National Strategy for Research and Innovation for Luxembourg" of the Ministry of Higher Education of Research (MESR) already16 provides for instruments to promote research geared to a societal mission and to support the development and implementation of policies ("policy support"), with the following elements identified as crucial:

1. "coordinated governance, infrastructure and policies;
2. a regulatory framework and funding instruments that enable research to drive innovation in industry, services and the public sector; and
3. anchoring science in society. '

It also identifies 4 priority areas for interdisciplinary research to prepare Luxembourg for future challenges, three of which are essential for the energy transition, including (area 1) "industrial and service transformation", (area 3) "sustainable and responsible development" and (area 4) "education of the^{21th} century"17. Thus, area 1 includes issues of digitalisation, modelling and materials science and technology. Field 3 explicitly mentions climate change with energy efficiency and smart energy management, but also economic and social development, such as green and sustainable finance, a key lever for the energy transition. Finally, Domain 4, for example, seeks to promote learning methods to develop the skills needed for systemic transformations, applicable also in the context of the energy transition.

These research priorities and support instruments are further detailed in the strategic document of the National Research Fund (NRF) and the MESR, entitled "National Research Priorities for Luxembourg in 2020 and beyond"18. Set up in 1999, the NRF was primarily dedicated to financing public research actors, but in the meantime a range of instruments is in place to support public-private collaborations and thus also industrial research, as well as research activities with public institutions to support policy development and implementation. The NRF also coordinates national research programmes with regional, European and international programmes, bilaterally and multilaterally19. A good integration of the Luxembourg research ecosystem in an international context is crucial given the limited resources and capacities of the country. This allows domestic actors to benefit from foreign collaborations, exchanges and funding. On the other hand, the small size and sovereignty of Luxembourg allow Luxembourg to play the role of 'European' experimentation field for large-

16National Research and Innovation Strategy for Luxembourg. Ministry of Higher Education and Research, 2020
17The link with area 2 of the strategy, "personalised health", is less obvious.
18National Research Priorities for Luxembourg in 2020 and beyond. National Research Fund (FNR), Ministry of Higher Education of Research, 2019
19 International Cooperation Opportunities | FNR – Luxembourg National Research Fund (https://www.fnr.lu/internation-cooperation-opportunities/)

scale projects within and beyond national borders, with simultaneous access to the German, French and Belgian regulatory and socio-economic contexts. Luxembourg can also rely on the presence and outreach of key European institutions for the energy transition, such as the European Investment Bank (EIB) with its Climate Bank Roadmap20, or the Court of Justice of the European Union. Indeed, the regulatory and legal framework is a lever of 1^{era} of importance for the energy transition and climate action.

Private, small, medium and large enterprises are supported in their R & D & I activities by the Ministry of Economy and dedicated budget lines. In addition to funding, companies are advised in their approaches (access to national and European funding, partner search, business creation, etc.) by the National Innovation Agency Luxinnovation. Networking takes place through innovation clusters, driven by Luxinnovation, which also contribute thematically to the energy transition, such as Materials &Manufacturing, Cleantech, Automobility or Wood21. It addresses energy-related concepts such as smart grid, smart mobility, smart buildings and the Internet of things, but also technological developments for renewable energy production (PV), storage (hydrogen) or building materials with a low carbon footprint. Luxinnovation, the University of Luxembourg and LuxProvide jointly manage Luxembourg's National High Performance Computing Competence Centre (HPC). Its mission is to promote the use of HPC related to computing, data analytics or artificial intelligence by industry – in particular SMEs – academia and public administration. A key theme for research stakeholders facilitated by these cutting-edge technologies is Luxembourg's "twin nation", especially for energy systems.

The "National Long-Term Climate Action Strategy" adopted by the Luxembourg Council of Government at COP26 in Glasgow also22 recognises the crucial importance of R & D & I and Luxembourg's potential pioneering role: "While taking advantage of research and innovation at European and global level, Luxembourg is called upon to consolidate and intensify its research and innovation efforts to support the implementation of the transition in the national context. This implies targeted public support, strong entrepreneurial engagement and mobilisation of the whole innovation system, encompassing the public research centres LIST and LISER as well as the University of Luxembourg, Luxinnovation and its innovation clusters such as Luxembourg Cleantech Cluster and private research and innovation centres. The small size of Luxembourg allows it to rapidly deploy and demonstrate key technologies and innovations, thus playing a pioneering role at country level." The R & D & I strategies, measures and activities described in this chapter are crucial for achieving climate neutrality by 2050 and deserve considerable strengthening.

2.5.3 R & D & I funding objectives

Effective R & D & I requires substantial funding and Luxembourg has set ambitious targets in terms of R & D & I budgets. Thus, the MESR states in the national research and innovation strategy for Luxembourg: "In line with the objectives of the Europe 2020 strategy and the government programme 2018-2023, the government will ensure that public investment in research and development is increased to 1 % of GDP. This 1 % target will include public expenditure in the public and private sectors, with public sector spending expected to reach 0.8 % of GDP".

These intentions resulted, in particular, in an increase of EUR 300 million in the State's allocation for the years 2022 to 2025 to public R & D & I actors compared to the period 20182021, bringing the overall allocation to EUR 1,67 billion over this new period23. Luxinnovation's performance contract provides for a State contribution of EUR 50 million for the same period24, in particular to inform and guide Luxembourg public and private organisations towards national and European

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Climate Bank20 Roadmap (https://www.eib.org/fr/about/priorities/climate-action/cbr/index.htm)
21 Luxembourg Cluster Initiative (https://www.luxinnovation.lu/innovate-in-luxembourg/luxembourg-cluster-initiative/)
22Towards climate neutrality in 2050 "– adoption of the National Long-Term Climate Action Strategy – gouvernement.lu//Le Government of Luxembourg
https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2021/10-octobre/29-strategie-nationale- action-climat.html)
2023 European Semester National Reform23 Programme of the Grand Duchy of Luxembourg
(https://gouvernement.lu/dam-assets/documents/actualites/2023/04-avril/28-pnr/20230428-pnr-2023-luxembourg-FINAL.pdf)
24Convention-Luxinnovation Performance contract 5/2022-2025 (https://mesr.gouvernement.lu/dam-assets/documents/multi-annualised agreements and contracts with establishments/CONVENTION-LUXINNOVATION-

funding for their R &Dand innovation activities. These efforts resulted in the allocation of State aid of an order of magnitude of EUR 900 million to undertakings between 2018 and 2022, in various forms25 (see also Measure 518).

However, it is important to note that a precise estimate of funding in relation to the key themes of the NECP is currently not possible, partly because of the wide range of thematic areas but also partly because of the lack of measurement indicators in place. However, the MESR intends to put this monitoring benchmark in place, in particular through the performance contracts of public R & D & I actors. This monitoring should include not only national funding but also European funding such as Horizon Europe, European Territorial Cooperation (Interreg) programmes and European Structural Funds, whose strategic or priority axes make it easier to identify RDI projects linked to the NECP. A measure in the NECP (No 104) makes explicit reference to the Just Transition Fund (JTF) under the ERDF programme and the NECP intends to strengthen the co-financing and coordination of R & D & I activities linked to the NECP themes through the Climate Energy Fund (see measure No 103 and measure in Chapter 3.5). Finally, it is important to mention that energy operators such as Encevo and Sudstroum also support R & D & I projects through dedicated funds, such as the Enovos Foundation26.

2.5.4 Examples of public and private R & D & I activities related to energy transition and climate action

The resources made available and the strategic orientations of governance have enabled public and private R & D & I actors to focus their activities on key issues of the energy transition and to set their own objectives. The encart below shows examples of activities, without claiming any kind of completeness, given the range of possible contributions from different scientific and technological disciplines. However, the examples also illustrate the priority technological objectives, in particular the production and storage of renewable energy with a focus on photovoltaic and green hydrogen and the development and management of smart electricity grids. Reducing the carbon impact of building materials is another key theme. There are also transverse themes such as monitoring, spatial planning and green finance.

Depending on the players, the activities are also located at different levels of TRL (technology readiness level) or upstream or downstream of complex value chains, of which Luxembourg covers only a small part. However, their concrete impacts on the energy transition are difficult to quantify or even impossible to model, even if indicators exist to measure research outputs, such as scientific publications or technological patents.

ENCART: List of RDI activities in Luxembourg related to the energy transition, aimed at illustrating the wide range of topics and the need to mobilise multidisciplinary competences:

- Development of innovative materials and technologies for renewable energy production, e.g. in the photovoltaic laboratory of the University of Luxembourg27 or the production and use of green hydrogen, e.g. at the Paul Wurth Chair at the University of Luxembourg28 or at the materials department of the Luxembourg Institute of Science and Technology (LIST)29.
- Research on the development of bioenergy or the recovery of useful substances from waste water or bio-waste streams, in particular for energy production, e.g. by the Environmental and Industrial Biotechnologies Unit of the LIST30 or by engineers at the University of Luxembourg as part of the Interreg WOW project31.

CONTRAT- DE-PERFORMANCE-5-2022-2025.pdf)
25 Almost EUR 1 billion in state aid to companies over five years (https://www.luxinnovation.eu/fr/news/pres- dun-milliard-deuros-daides-etes-aux-Entises-en-cinq-ans/)
26 Welcome – Enovos Foundation (https://www.fondation-enovos.lu/fr/)
27 Phototaxonomics (https://wwwen.uni.lu/research/fstm/dphyms/research/photovoltaics)
28Prof. Ladewig appointed to Paul Wurth Energy Process Engineering Chair (https://wwwen.uni.lu/university/news/slideshow/prof_ladewig_appointed_to_paul_wurth_energy_process_engineering_flesh)
29 Towards new materials for production | LIST (https://www.list.lu/en/news/towards-new-materials-for- hydrogen-production/)
30 Environmental and Industrial Biotechnologies | LIST (https://www.list.lu/en/environment/environmental-and-industrial-biotechnologies/)
31WOW! Wider business Opportunities for raw materials from Wastewater | Interreg NWE (https://www.nweurope.eu/projects/project-search/wow-wider-business-opportunities-for-raw-materials-from-

- Development of technical and IT solutions for smart, efficient and secure energy networks, with applications for mobility or real estate, e.g. by LIST's Intelligent Clean Energy Systems (ICES) unit32 or the University of Luxembourg's SnT – Interdisciplinary Centre for Security, Reliability and Trust33.
- Research on sustainable construction and circular economy at building level, aiming at using sustainable materials, optimising the construction and deconstruction process to promote recycling and reuse of materials and conserving grey energy, e.g. by the University ArcelorMittal Chair34 or the SUSTAIN research unit of LIST35. Digitalisation (Building Information Modelling – BIM) is an essential tool for the implementation of these concepts, and ICT sciences therefore also contribute to sustainable construction.
- Development of methods and technologies for the continuous monitoring of the effects of climate change and modelling of scenarios to best adapt to a changing environment, e.g. by the Environmental Sensing and Modelling Unit of LIST36. Particular attention is paid to agricultural and forestry activities, but also to the prevention of extreme events or the availability of water37.
- Development of alternative approaches to spatial planning and urban planning, which are less energy and resource intensive, since they are better structured and organised, for example in the context of the project 'Luxembourg in Transition – Territorial Visions for the Future Decarbonised and Resilient of the Luxembourg Functional Region' with the participation of teams from the University of Luxembourg and the LIST38.
- Sustainable finance research programme implemented by the Chair in Sustainable Finance at the University of Luxembourg, covering various topics such as ESG (Environmental, Social and Corporate Governance) (ESG) disclosure and financial reporting, carbon risk measurement and management of mutual funds, or the risk and return of ESG investors' activism39.
- Research on sustainable behaviours': sociological aspects of the emergence of "positive climate" lifestyles and social consequences of the evolution of the energy transition by LISER teams40, but also by the University of Luxembourg and the LIST in collaboration with Encevo on user behaviour41.

R & D & I activities are of course not limited to public research actors. Luxembourg has also seen a wide range of start-ups and SMEs active in the field of clean technologies, in addition to existing innovative companies, addressing topics of the energy transition, such as renewable energy production and storage, smart mobility and real estate or responsible resource management through circular economy principles. Various players, or even sectors, have also set themselves innovation objectives for the energy transition and have developed RDI structures, such as the Neobuild Innovation Hub42 (created for the construction sector by the "Council for the Economic Development of Construction – CDEC" and transformed in 2022 into an EIG with the assistance of the Ministry of the Economy) or Nexxtlab, with the participation

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wastewater/)
32 Intelligent Clean Energy Systems | LIST (https://www.list.lu/en/environment/intelligent-clean-energy-systems/)
33 SNT (https://wwwfr.uni.lu/snt)
34ArcelorMittal Chair of Steel Construction (https://wwwfr.uni.lu/recherche/fstm/arcelormittal_chair_of_steel_construction)
35 Environmental Sustainability Assessment and Circularity | LIST (https://www.list.lu/en/environment/environmental-sustainability-assessment-and-circularity/)
36 Environmental Sensing and Modelling | LIST (https://www.list.lu/en/environment/environmental-sensing-and-modelling/)
37 Observatory for Climate, Environment and Biodiversity | LIST (https://www.list.lu/en/institute/rd-infrastructure/observatory-for-climate-e-and-biodiversity/)
38 Luxembourg in Transition (https://luxembourgintransition.lu/)
39A Chair in Sustainable Finance for Education and Research (https://wwwfr.uni.lu/recherche/highlights/une_chaire_en_finance_durable_pour_l_enseignement_et_la_recherche)
40 Behavioural and expert economics | LISER (https://www.liser.lu/?type=module&id=219) and Urban development and mobility | LISER (https://www.liser.lu/?type=module&id=149)
41Encevo Launches First Joint Research Projects with Uni.lu and LIST (https://wwwen.uni.lu/university/news/slideshow/encevo_launches_first_joint_research_projects_with_uni_lu_and_li(ST)
42 Welcome – Neobuild (http://neobuild.lu/)

of CREOS43.

3 policies and measures

Note on budgetary implications:

The measures contained in the update of the integrated national energy and climate plan will be budgeted in line with the fiscal trajectory and rules of the Stability and Growth Pact. Due to their positive side-effects (air quality, job creation), national measures are at the forefront. Climate protection is an urgent task for the whole of humanity. Therefore, our national and international climate protection commitments are also a budgetary and financial priority. Significant investments will be made for the benefit of future generations.

Measures with a direct impact on public finances will be subject to multi-annual budgeting, as will all capital expenditure. The inter-ministerial committee acting under the Climate Law is responsible for regularly assessing the effectiveness of the measures applied, while respecting the different ministerial competences. These measures will therefore be subject to a qualitative assessment of their impact on the national budget in terms of revenue and expenditure, as well as their effectiveness in relation to national targets in the area of greenhouse gas mitigation, improvement of energy efficiency and development of renewable energy. Positive side effects will also be taken into account. It is therefore perfectly possible that measures are prioritised according to their effectiveness and that the measures concerned are replaced or complemented by more effective measures, where appropriate.

The measures contained in the update of the integrated national energy and climate plan, which have already been adopted and incorporated in a Grand-Ducal law or regulation, will be taken into account in the draft budget for 2024 and in the multi-annual planning.

It goes without saying that the new measures and the reinforced measures contained in the update of the integrated national energy and climate plan have not yet been incorporated into the state budget and that they will have to be subject to the usual budgetary procedure.

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3.1 Decarbonisation dimension

3.1.1 GHG emissions and removals

3.1.1.1 Cross-cutting policies and measures

Successful transition towards climate neutrality in Luxembourg by 2050 at the latest, while respecting intermediate targets in 2030, calls for active, diversified and targeted action. This action requires a robust enabling framework for the coordinated and effective deployment of sectoral policies, strategies and measures, namely:

- ensure effective governance and active participation of all actors in the transition:
  - Climate Law (measure 101)
  - Strengthening climate governance within the government administration (measure 102)
  - Reduce our consumption based carbon footprint (measure 122)
  - Development of monitoring statistics, models and indicators (Measure 123)
- provide the necessary incentives through tax policy:
  - Taxony CO_2 (measure 105)
  - Tax incentives for energy renovation of housing (measure 313)
  - Revised registration tax on road vehicles (measure 420)
  - Revised tax advantage for functional cars (measure 421)
  - Modernisation of the tax rebate for investments made as part of an energy and ecological transition project (measure 519)
- consolidate the pioneering role of the state and municipalities by developing sustainable public procurement:
  - Decarbonisation strategy pursuing the objective of climate neutrality of the state administration as of 2040 (measure 109)
  - Climate Pact 2.0 with municipalities (measure 106), Climate Pact for inter-municipal industrial unions (measure 107), Nature Pact with municipalities (measure 108)
  - Preventive role of the state and municipalities in buildings (measures 319-321)
  - Decarbonation of construction sites (measure 323)
  - Electrification of the state car fleet (measure 413), Full electrification of the RGTR bus network until 2030 (measure 414)
- fostering societal engagement and developing the key role of education and training:
  - Secondary education vocational training in the context of the energy and climate transition (measure 113), Training of a skilled and sufficient workforce in the buildings sector (measure 318)
  - Awareness, information and advice to citizens promoting behavioural change and enabling framework for citizen engagement (measure 114), awareness-raising, information, building guides and advisory services (measure 317), awareness raising, information and advisory services on renewable energy sources (measure 202), awareness raising, information and advisory services on mobility (measure 407)
  - Reduce our consumption based carbon footprint (measure 122)
  - National entity accompanying energy renovation, decarbonisation and installation of photovoltaic installations for residential buildings (measure 327)
  - Scaling up energy and climate transition projects (measure 119)
- mobilising research and fostering innovation:
  - National Centre of Excellence in Research (ncer) for energy transition and climate action (measure 115)
  - Strategic RDI programme for governance of the energy transition and climate action (measure 116)
  - Support the establishment of research chairs and public-private or public/public partnerships with the University of Luxembourg and public research centres (measure 117)
- operating the cross-sectoral coordinating function of territorial and urban planning:
  - Draft PDAT2023: gradual reduction of land take and concentration of development in the most appropriate locations (measure 110)
  - City of quarter hour (measure 111)

The success of the transition called for depends on two key elements: the implementation of a just transition and the provision of appropriate funding.

Societal acceptance will have to be ensured by implementing a just and socially fair transition. Such a transition must not reduce the well-being of citizens, as it is based on the responsibility of the public to facilitate and actively support the transition, and the competitiveness of businesses, which generate wealth and function as a driving force for the transition. With the aim of helping citizens and businesses to make the transition successful and supporting workers to acquire the skills required for green jobs, the update of the NECP

- consolidates the social redistribution of revenue from the CO_2 tax (measure 105): The revenue generated by the CO_2 tax is used fairly to finance climate and energy transition measures and social compensation measures in favour of low-income households by
    - Climate tax credit, and
    - an increase in the cost of living allowance;
- strengthens and expands financial support schemes:
    - Aid schemes Klimabonus Wunnen (measures 307-309)
    - Climate loans scheme (measure 310)
    - Top up social aid scheme Klimabonus Wunnen (measure 311)
    - Aid schemes Klimabonus Mobilitéit (measures 423-424)
    - Social Leasing of Electric Cars (Measure 422)
    - Aid schemes for enterprises (measure 515-519), Fit4Sustainability (measure 513), SME Packages Sustainability (measure 514)
    - Aid scheme for undertakings investing in charging infrastructure for electric vehicles (measure 425)
    - Aid scheme for the acquisition of zero-emission heavy-duty vehicles (measure 426)
    - Just Transition Fund (measure 104)
- amplifies coaching and training:
    - National entity accompanying energy renovation, decarbonisation and installation of photovoltaic installations for residential buildings (measure 327)
    - Assistance to households in energy poverty (measure 329)
    - Climate Pact for Business (SMEs) (Klimapakt fir Betriber) (measure 511)
    - Voluntary Agreement on Decarbonisation and Improving Energy Efficiency in Industry (Measure 504)
    - Vocational training at secondary school level in the context of the energy transition (measure 113)
    - Training of a skilled and sufficient workforce in the buildings sector (measure 318)

In accordance with Regulation (EU) 2023/955 establishing a Social Climate Fund, each Member State will have to establish a "Social Climate Plan" containing a coherent set of existing or new national measures and investments to address the impact of carbon pricing on vulnerable households, vulnerable micro-enterprises and vulnerable transport users. The development of this plan will allow for further analysis and measures for a just transition, in consultation with the social partners. In particular, the impact of the green transition on the labour market and employment can be further analysed with a view to identifying the jobs created, respectively lost during the green transition, and developing/complementing the national skills strategy and the necessary training.

On the other hand, the transition to climate neutrality requires significant public and private investment. The financial challenge is to mobilise investment flows towards green priorities to ensure coherence with climate objectives. On the one hand, the state budget finances increasing public investment in key infrastructure and projects related to mobility or energy and the general decarbonisation of all economic sectors. On the other hand, public finances must help mobilise the private investment needed to make the transition a success (see in particular measure 103 "Climate and Energy Fund" and measure 118 "Use of sustainable and climate finance tools to decarbonise").

In order to achieve the climate objectives, it is important to stress the importance of Regulation (EU) 2020/852 of 18 June 2020 (Taxonomy), which establishes a reference framework for defining which economic activities can be considered

sustainable. It will require large companies to report the taxonomy-compatible portion of their business, with the aim of directing financial flows towards these activities. This is a major step towards decarbonising the financial space, which needs to adapt to new, more transparent and sustainable regulations, and which should lead to GHG emission reductions along the supply chain.

Sustainable finances in Luxembourg include all public or private measures that aim to make financial flows consistent with climate-resilient development and environmental degradation. Sustainable finances also take social and governance aspects into account. In general, a distinction can be drawn between international climate finance (IFI), which meets international commitments on climate finance and international solidarity, the policies and measures deployed by the government to mobilise more private finance and make the national financial position more sustainable, as well as initiatives from the private sector and civil society.

As regards the FCI, Luxembourg is one of the largest donors per head of public population in the world. For the period 2021-2025, Luxembourg made available EUR 220 million for mitigation, adaptation and other cross-cutting measures for developing countries. FCI funds are new and additional funds made available by Luxembourg in addition to its official development assistance, which is equivalent to around 1 % of gross national income in 2022.

At the same time, it is important that public investment is a leverage effect for other sources of financing from the private sector. Thus, support for innovative forms of financing is continued.

Since 2016, in addition to its voluntary budgetary contribution, Luxembourg has launched several important initiatives in the field of climate finance, in collaboration with financial sector partners, including the LU-EIB Climate Finance Platform, a joint initiative with the European Investment Bank (EIB), which aims to mobilise investments in climate change projects, the International Climate Finance Accelerator, a public-private entity that offers financial and operational support to future fund managers to enable them to launch new innovative climate funds. or the City Climate Finance Gap Fund, a trust fund for climate action in cities in developing countries, to name but a few.

Withthe aim of making its financial position more sustainable, a public-private entity, the Luxemburg Sustainable Finance Initiative (LSFI), was set up in 2020 by the relevant ministries, bringing together the relevant actors in the field of sustainable finance. In 2021, the LSFI finalised the national sustainable finance strategy (“Luxembourg Sustainable Finance Strategy”), subsequently adopted by the Council of Government. The LSFI is responsible for the implementation of this strategy and also serves as a platform for discussion on the analysis of the feasibility and impact of the measures stemming from the recommendations of the Luxembourg Sustainable Finance Roadmap (LSFR). In order to be able to assess progress, significant work needs to be done in the field of impact measurement. A review of the strategy in 2024 will be needed in order to assess the relevance of the strategy and the government approach to achieving the objectives set.

Title of the measure	No 101 Climate Law	
Description:	The amended Climate Law of 15 December 2020 establishes the institutional framework and governance of climate policy at national level. It sets the national climate targets, namely the intermediate target of reducing Luxembourg's greenhouse gas emissions (under Regulation (EU) 2018/842) by 55 % by 2030 compared to 2005 and the long-term objective of climate neutrality by 2050 at the latest. It sets sectoral objectives in the following sectors: energy and manufacturing industries, construction; transport; residential and tertiary buildings; agriculture and forestry; waste and waste water treatment. The Grand-Ducal Regulation of 22 June 2022 determines the annual emission allocations for the 5 sectors for the period up to 31 December 2030. In addition, the Climate Law establishes the Climate Action and Energy Transition Platform and the Climate Policy Observatory. In addition, the Climate Law establishes the Climate and Energy Fund and transposes the amended Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the European Union (ETS) into national law.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2020	2050	
Responsible entity/entities	MECDD	
Reference (s)	Amended Climate Law of 15 December 2020; Grand Ducal Regulation of 22 June 2022 determining annual greenhouse gas emission allocations	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2020/12/15/a994/jo	

Title of the measure	No 102 Strengthening climate governance within the government administration	
Description:	The amended Climate Law of 15 December 2020 establishes the legal basis for climate governance at national level, in particular by setting national and sectoral climate targets as well as establishing the Climate Action and Energy Transition Platform and the Climate Policy Observatory. In addition, the Interministerial Committee for Climate Action established by decision of the Council of Government on 14 August 2020 is responsible for inter-ministerial coordination of climate policy. In addition to analysing the annual review of the implementation of climate objectives and proposing new measures necessary to achieve these objectives, one of the tasks entrusted to the Committee is to regularly assess the effectiveness of the measures applied, while respecting the various ministerial powers. This draft update of the NECP is the result of intense inter-ministerial collaboration within the Committee. The compilation and description of the measures have been prepared in thematic working groups by the experts of the ministries represented in the Committee and their respective administrations. A separate working group accompanied the work entrusted to STATEC on the modelling and projections of emissions in the different sectors. Based on experience, climate governance in general and inter-ministerial cooperation in particular will be analysed and strengthened. The planned development of statistics and models (measure 123) will be used in particular to improve the regular evaluation of measures.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2024	n.a.	
Responsible entity/entities	MECDD, all relevant ministerial departments	
Reference (s)	Amended Climate Law of 15 December 2020	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2020/12/15/a994/jo	

Title of the measure	No 103 Climate and Energy Fund	
Description:	The amended Climate Law of 15 December 2020 establishes the Climate and Energy Fund. One of the objectives of the Fund is to contribute to the financing of domestic climate change measures and measures in developing countries. It is financed by allocations from the State budget, part of the autonomous additional excise duty known as the 'CO2 tax', part of the revenue from the tax on road vehicles, the proceeds from the sale of emission credits under the EU scheme for greenhouse gas emission allowance trading, etc. In order to monitor the impact of funding, regular impact assessments will be carried out.	
Type of Instrument	Regulatory, economic	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2020	n.a.	
Responsible entity/entities	MECDD	
Reference (s)	Amended Climate Law of 15 December 2020	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2020/12/15/a994/jo	

Title of the measure	No 104 Just Transition Fund	
Description:	The Just Transition Fund (JTF), one of the pillars of the Just Transition Mechanism, is a new financial instrument of EU cohesion policy. Its main objective is to co-finance projects up to 50 % to support territories most negatively affected by the negative effects of the transition to a climate-neutral economy of the Union by 2050. In Luxembourg, the JTF will be implemented through ERDF and ESF + programmes, each of which has a priority axis dedicated to the JTF. The Grand Duchy of Luxembourg's national allocation for the JTF amounts to a total of approximately EUR 9,2 million, of which approximately 60 % is allocated to the ERDF programme and approximately 40 % to the ESF + programme. While the operational framework of the JTF is governed by the ERDF and ESF + programmes, its strategic framework is governed by the Territorial Just Transition Plan for Luxembourg (TJTP), which is supposed to designate the territory of intervention of the JTF and define the transforming sectors, development objectives and types of eligible operations. This plan was drawn up by the Department of Planning of the Ministry of Energy and Spatial Planning, in close cooperation with the Ministry of the Economy (as the ERDF managing authority) and the Ministry of Labour, Employment and the Social and Solidarity Economy (as ESF + managing authority), and was approved by the European Commission in December 2022. In order to address the transition challenges in the 11 municipalities of the South region, the TJTP aims, first, to mitigate the costs of modernising transforming sectors, to tackle energy poverty and facilitate sustainable local mobility, and, second, to support workers affected by the transition through training.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2023	2029	
Responsible entity/entities	MEA, MECO, MTEESS	
Reference (s)		
Info complementary		

Title of the measure	No 105 Taxes CO_2
Description:	Since 2021, fossil fuels have been subject to the CO_2 tax. The ceilings for the rates of the CO_2 tax are set by the amended Law of 17 December 2010 laying down excise duties and similar taxes on energy products, electricity, manufactured tobacco products, alcohol and alcoholic beverages. The annual rates of the CO_2 tax are laid down by Grand-Ducal regulation and amounted to EUR 20/t CO_2 in 2021 and EUR 25/t CO_2 in 2022. From 1 January 2023, the rate is equivalent to EUR 30/t CO_2. The revenue generated by the CO_2 tax is used fairly to finance climate and energy transition measures and social compensation measures for low-income households, such as the tax credit for the two lower income quintiles (Q1 and Q2) as well as the increase in the cost of living allowance. Activities covered by the EU scheme for greenhouse gas emission allowance trading are exempt from the tax. In view of the national and sectoral climate targets introduced by the Climate Law, the carbon price will continue to be increased annually by EUR 5/t CO_2 to reach a level of EUR 45/t CO_2 in 2026, in line with the target price level of the future EU Emissions Trading System for buildings, road transport and fuels in certain industrial sectors, to be introduced in 2027. As STATEC projections show at this stage that annual increases of EUR 5/t CO2 will continue to be necessary to comply with Luxembourg's cumulative emission budgets for the period 20212030, it is expected that the provisions on the evolution of the CO_2 tax for the period 2027-2030 will be reassessed in 2026. These changes in the CO_2 tax are to be seen as 'on top' of any measures taken by the riparian States, in particular following the introduction of the ETS 2, which could, if necessary, once again influence the price differential for road fuels between Luxembourg and neighbouring regions. An increase in the CO_2 tax of EUR 5 corresponds to an increase in the price of road fuels from 1,1 to 1,2 cents per litre. Member States will be able to exempt entities covered by the extension of the emissions trading scheme provided that they are subject to a national carbon tax at or above the price in the new EU emissions trading system. The government will examine in detail which system will be most beneficial in terms of climate action and social impacts. Subsequently, a decision will be taken on whether or not to maintain the national CO_2 tax system beyond 2026. The clear advantage of the current system is that half of the income from the CO_2 tax is dedicated to social mitigation measures for the most vulnerable households. The Interministerial Committee for Climate Action will closely monitor the implementation of the CO_2 tax, including in particular the effectiveness of the tax in relation to sectoral objectives. It will report quarterly to the Government Council. The government maintains that half of the revenue generated by the CO_2 tax will continue to be allocated to climate protection and energy transition measures and the other half to measures of

	social compensation for low-income households, including an increase in the cost of living allowance and a tax credit called “Climate Tax Credit”. For the year 2023, the tax rate is equivalent to EUR 30/t CO_2 with a corresponding tax credit of EUR 144. After 2023, the amount of the ‘climate tax credit’ will be fixed each year visibly for the citizen through the Income Tax Act and will reflect the evolution of the CO_2 tax.	
Type of Instrument	Taxation	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2021	n.a.	
Responsible entity/entities	MFIN, MECDD, MEA	
Reference (s)	Amended Grand-Ducal Regulation of 17 December 2010 fixing the rates of autonomous excise duty on energy products	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2010/12/17/n1/jo	

Title of the measure	No 106 Climate Pact 2.0 with municipalities	
Description:	Through their commitment to the Climate Pact, the municipalities align themselves with the objectives set out in the government plan and are actively promoting climate protection and the energy transition. On the basis of the experience gathered and taking into account the objectives of the Integrated National Energy and Climate Plan (NECP), three development axes have been identified and identified for the 2.0 Climate Pact: quantification by means of centralised indicators, improvement of the working environment of municipalities and greater integration of citizens, businesses or other local and regional actors. The governance of the 2.0 Climate Pact has been strengthened internally, in particular by entrusting the monitoring of the EAS programme when implementing the general policy of the municipality directly to a member of the College of Mayor and Aldermen. In the future, municipalities will be encouraged to extend the tasks of the Klimaschäffen to just transition aspects. Through a catalogue of 64 measures, municipalities are effectively oriented towards sustainable policy in the areas of energy transition, climate change, circular economy, air quality, adaptation to climate change and mobility. This instrument also includes quantitative key indicators specific to the municipalities that are closely linked to the objectives of the NECP. The catalogue of measures shall be regularly revised to take account of national objectives and regular evaluations of the programme. In return for their commitment, the municipalities receive the assistance of a climate counsellor and subsidies from the State depending on the level of certification obtained. The State shall provide the legislative, financial, technical and advisory framework until 31 December 2030. Klima-Agency is mandated for the operational implementation and continuous development of the programme. The 2.0 Climate Pact also encourages participation in programmes at European level, such as the Covenant of Mayors and the European Green Capital Award, which internationally promote local efforts to improve the environment, the economy and the quality of life in cities.	
Type of Instrument	Voluntary agreement	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	2030	
Responsible entity/entities	MECDD, Klima-Agency	

Reference (s)	Law of 25 June 2021 establishing a 2.0 Climate Pact with the municipalities
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2021/06/25/a482/jo

Title of the measure	No 107 Climate Pact for inter-municipal industrial unions	
Description:	The Climate Pact for inter-municipal industrial trade unions aims to support public bodies and services, in particular in the field of drinking water, wastewater sanitation and waste management, to reduce greenhouse gas emissions related to their activities. As regards the waste water treatment sector, the revision of Directive 91/271/EEC concerning urban waste water treatment foresees inter alia the achievement of energy neutrality in several stages. Thus, the sanitation sector will have to ensure that the total annual energy used comes from renewable sources and reaches: - 50 % at the end of 2030 - 75 % at the end of 2035 - 100 % at the end of 2040 As provided for in the revision of the Urban Waste Water Treatment Directive, this measure of the Climate Pact will support all other inter-municipal industrial unions to gradually achieve climate neutrality. This measure is therefore also in line with the objective of achieving climate neutrality for all public administrations until 2040, as decided by the Chamber of Deputies.	
Type of Instrument	Voluntary agreement	
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, MEA, Klima-Agency	
Reference (s)		
Info complementary		

Title of the measure	No 108 Nature Pact with municipalities	
Description:	Like the Climate Pact, the Nature Pact is an instrument to promote communal and regional initiatives aimed at preserving and restoring biodiversity. Municipalities are important partners of the state in the field of nature protection and natural resources. Through their decisions, they can make a significant contribution to improving the situation of natural areas and biodiversity. The Nature Pact offers municipalities wishing to actively combat biodiversity loss the opportunity to seek state support. By joining it, the municipalities undertake to implement the Nature Pact's catalogue of measures. The catalogue includes nature protection measures in the following areas: "establishment and implementation of a comprehensive strategy", "urban environment", "open landscape environment", "aquatic environment", "forestry environment", and "communication and cooperation". Some measures of the Nature Pact (such as the development of woody vegetation and urban plantations or the creation of integral forest reserves and ageing islands) show significant potential for carbon sequestration. In return for the commitment of the municipalities, the State grants an operating grant to the participating municipalities and covers the costs of the Covenant Nature Advisers. The State shall provide the legislative, financial, technical and advisory framework until 31 December 2030.	
Type of Instrument	Voluntary agreement	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	2030	
Responsible entity/entities	MECDD, Klima-Agency	
Reference (s)	Law of 30 July 2021 establishing a nature pact with municipalities	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2021/07/30/a595/jo	

Title of the measure	No 109 Decarbonisation strategy pursuing the objective of climate neutrality of state administration as of 2040	
Description:	In order to set a good example in the fight against climate change, a strategy to decarbonise the state administration will be developed in cooperation with all relevant stakeholders. The strategy will aim to achieve climate neutrality in the State administration from 2040 and will cover, in particular, the building stock, the car fleet and the public procurement markets in general of the State and public institutions. It will address the organisation and resources needed for its implementation and include an indicative timetable. Regular communication will be organised around the implementation of the strategy and the implementation of flagship projects. The Climate Pact with municipalities will encourage local authorities to pursue similar efforts.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2024	2040	
Responsible entity/entities	MMTP, ABP, MEA, MECDD, MINT, Belval Fund, Kirchberg Urbanisation and Planning Fund	
Reference (s)	Motion 3513 on climate neutrality in public administration by 2040, adopted in the Chamber of Deputies on 29 April 2021	
Info complementary	https://www.chd.lu/fr/motion_resolution/3513	

Title of the measure	No 110 draft PDAT2023: gradual reduction of land take and concentration of development in the most appropriate locations	
Description:	Among the policy objectives of the PDAT2023 project, the first two have a major impact on the reduction of CO_2 emissions: gradual reduction of land take and concentration of development in the most appropriate locations. The first objective is to reduce land take in order to move towards zero in 2050, precisely to preserve agricultural and forest land inter alia for their CO_2 absorption capacity. Combined with multifunctional development while preserving and developing the intra-urban green grid, the concentration of development leads to a significant reduction in motorised mobility needs and an increase in the quality of life. In addition, this approach limits diffuse, costly and detrimental urban development to landscape quality. Finally, anticipatory infrastructure planning is possible as we know where urban developments will take place.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 111 City of Quarterly Hour	
Description:	The concept of the city of a quarter of an hour, which aims to provide essential services necessary for life at a distance of a quarter of an hour on foot or by bicycle from the place of residence, is currently being applied in major metropolitan areas such as Paris, Copenhagen, Milan and Dublin. The draft PDAT2023 provides for the decline of this concept in the three major Luxembourg agglomerations, Nordstad, the Agglo-Centre and the Southern Region. Indeed, in the context of the Covid pandemic, the importance of proximity to such services has been further accentuated and it is therefore necessary to plan cities taking into account the proximity and accessibility of services. The implementation of this concept requires certain densities (critical mass) but also multi-functional spatial planning.	
Type of Instrument	Planning	
State of progress		
Start of implementing	End of implementation	Comments
2024		
Responsible entity/entities	MEA, MINT, MMTP, Communes	
Reference (s)		
Info complementary		

Title of the measure	No 112 Green Belt around Luxembourg City and Interurban Green Zone projects resulting from the international consultation “Luxembourg in Transition”	
Description:	Organised between September 2020 and February 2022, the ‘Luxembourg in Transition’ International Consultation was a process that brought together several international teams made up of specialists in the field to develop projects that would make it possible to achieve the ecological transition of Luxembourg’s functional territory by 2050. As a ‘out of the box’ ideas laboratory, the consultation allowed a wealth of ideas that were supposed to inspire sectoral policies but also to raise awareness among citizens to adapt their behaviour. Of the ideas produced, two ideas are already being implemented: “Green Belt around Luxembourg-City agglomeration” and “Interurban Green Zone”. The first aims to develop a green, natural and agro-food belt around the capital, thus serving a number of objectives, including the re-creation, the development of green infrastructure and the promotion of local consumption. The second project focuses on the space between the agglomerations of Luxembourg City and the Southern Region and aims to preserve the landscape qualities of these areas while promoting the development of agri-food. Both projects are also included in the draft PDAT2023 due to their alignment with the first two policy objectives.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 113 Secondary education vocational training in the context of the energy and climate transition
Description:	The energy and climate transition is largely based on technological measures. In this context, the availability of skilled labour is essential and currently represents one of the biggest challenges in providing the necessary means to achieve the climate objectives. The orientation towards vocational training takes place at the end of the 5th class (3th year of general secondary education) upon advice from the classroom, depending on the educational performance and interests of the pupil. There are three training pathways leading to the following qualifications: certificate of professional competence (CCP), diploma of professional competence (DAP) and diploma in technician (DT). In order to ensure a match between school curricula, course content and challenges related to the skills required for the energy and climate transition, the curricula shall be developed and updated by the curriculum teams, in partnership with the representatives of the professional chambers, the Chamber of Employees, and sectoral representatives of the training companies. The systematic and regular evaluation of the programmes in consultation with the representatives of the professional chambers in the context of the Vocational Training Steering Group makes it possible to define updating needs and strategic objectives. In this context, the demand for skills for the energy and climate transition has led to the introduction of new programmes in the short term (DT Smart Technologies, including the specialisations “Smart Buildings and Energies”, “Smart Energy”) and the introduction of additional certifications as part of initial training diplomas, e.g. handling of refrigeration units containing fluorinated greenhouse gases (“Kälteschein”). In general, the aim is to expand the provision of training in the field of sustainable development, in order to meet, at least in part, the need for skills and skilled labour in sectors linked to the green transition and to extend the provision of up- skilling programmes for anyone wishing to train or deepen their energy and climate skills. It is also imperative to introduce reskilling programmes in the field of skills related to the green transition, aimed at the target group of jobseekers and employees at risk of losing their jobs, in order to promote reintegration and retention in employment, together with ADEM. Similarly, to continue investing in the offer of retraining to offer new opportunities and opportunities for jobseekers without a recognised qualification. In addition to these public initiatives, it is also appropriate to seek or even strengthen partnerships with private initiatives from civil society in order to promote the development of a broad and diversified training offer.

	In addition, it is appropriate to launch a national initiative to enhance the value of craft jobs in occupations linked to the objectives of the NECP. In this context, the professional chambers, the federations of craftsmen and the relevant ministries come together to draw up a programme which, on the one hand, highlights the strategic importance of crafts and, on the other hand, aims to encourage students to actively opt for craft training in the fields of energy and climate transition.	
Type of Instrument	Education	
State of progress	Implementation, Analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MENEJ	
Reference (s)		
Info complementary		

Title of the measure	No 114 Citizens' awareness, information and advice promoting behavioural change and enabling framework for citizen engagement
Description:	Klima-Agency supports all societal actors in their commitment to climate protection and energy transition. Thus, Klima-Agency's activities target the reduction of energy consumption, the promotion of renewable energies, sustainable housing and mobility, as well as the management of natural resources and the implementation of the circular economy. The behavioural part of life styles is one of the priority levers for a carbon-neutral society. In this context, Klima-Agency is advancing the cross-cutting mainstreaming of climate change in all its activities and projects with the objective of addressing concretely the themes/concepts of "resilience", "sobriety" and "adaptation to climate change" at the level of its various target groups (see measure 122 on the consumption based carbon footprint). This includes an evaluation of Klima-Agency's communication approach, in particular by producing more short and regular television or radio broadcasts to reach as many viewers as possible. These spots could also be used on social media in the form of short condensed clips or infographics. In addition, Klima-Agency will communicate more clearly on the competences of the various public institutions and administrations in order to facilitate access to information on the various regulations and laws in force and the various subsidies in place. In the context of the 2.0 Climate Pact, Klima-Agence and its partners are also mobilising municipalities to raise awareness and encourage their fellow citizens to reflect more on their lifestyle and to make more use of models of citizens' initiatives such as the sharing economy, energy communities, community gardens, etc. Klima-Agency will offer local authorities seminars/information workshops to promote and facilitate a sustainable lifestyle and, together with its partners, will provide relevant trainers. An approach could be the setting up of a "climate awareness" workshop specifically adapted to the local and regional context. At the end of these workshops, the participants would receive a certificate ("Klimala hrerschein"). In developing these measures, Klima-Agency will also rely on research programmes of the University of Luxembourg, LISER and LIST. In general, citizen engagement can be further facilitated by defining an enabling framework and conditions based on the experience of civil society organisations promoting this engagement. In addition, the government will provide a carbon footprint calculator to raise awareness of the greenhouse gas reduction potential of behavioural changes. Digital tools such as virtual applications or networks will be explored to facilitate the learning process and the exchange of best practices (see measure 122 on the consumption based carbon footprint). Information on climate change, decarbonisation and carbon footprint, as well as information on

	climate-related strategies and initiatives will also be made available to the general public on the new website klima.lu. It should be noted that awareness raising and education must not be limited to highlighting lifestyles that are not in line with climate objectives or the consequences of consumption behaviour. Instead, they should promote a change in values, for example by encouraging solidarity, sharing practices and sobriety. To this end, support for social sciences and psychology is essential.	
Type of Instrument	Information	
State of progress	Implementation, Analysis	
Start of implementing	End of implementation	Comments
		Continuous implementation
Responsible entity/entities	MECDD, MEA, Klima-Agency	
Reference (s)		
Info complementary		

Title of the measure	No 115 National Centre of Excellence in Research (ncer) for energy transition and climate action	
Description:	At the beginning of 2023, the MESR and the NRF presented a new project for the energy transition. They are expected to provide a structuring framework and funding to bring research excellence together around a mission of important societal interest, encouraging high-level cross-disciplinary research and cross-sectoral collaboration. The theme of ncer will be focused on digitalisation and the introduction of a digital twin at national level to speed up the energy transition and climate action. The projects are funded by the NRF on the basis of an independent international evaluation for a maximum period of eight years and therefore represent long-term investments in the framework of national research priorities. The maximum amount of funding for a ncer is EUR 15 million over 5-8 years. There are also variable own contributions from research institutions. The ncer promotes transdisciplinary research and close collaboration with public and private actors. In the context of the energy transition and a national digital twin, it will be essential to include social components of change management, territorial organisation and the combination of competences for green finance and the regulatory and legal framework. While the "digital twin" technological project is currently led by LIST and SnT, MESR plans to strengthen the above elements by also involving LISER for socio-economic research activities and the establishment of real world laboratories related to a just climate transition, social learning and governance.	
Type of Instrument	Research, economics	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	2030	When the nuck comes to an end, it is supposed to be structurally anchored in its fastening institutions.
Responsible entity/entities	MESR, FNR, MEA	
Reference (s)		
Info complementary	https://www.fnr.lu/funding-instruments/ncer/	

Title of the measure	N° 116 Strategic RDI programme for the governance of the energy transition and climate action	
Description:	Luxembourg already has an important and multidisciplinary ecosystem of public and private R & D & I actors that can contribute to the energy transition and climate action. Thematic development strategies have also been put in place by various actors, including the MESR and the NRF, and substantial budgets can be mobilised. However, due to the lack of centralised governance in relation to the topic, RDI activities are poorly coordinated. The energy transition is an important 1st step in this direction, with a focus on digitalisation. In order to address other priority topics of energy transition and climate action in a structured, grouped and targeted way, integrating social and societal aspects in an interdisciplinary way, a strategic research agenda for societal, industrial and regulatory transfer will be put in place. This programme will be placed under the governance of the Ministries responsible for climate action and energy and will support interdisciplinary projects, including spatial planning aspects. Part of the budget for the programme will come from the Climate and Energy Fund. In order to ensure coordination with other activities and high-quality professional management of research work, close collaboration will be sought with the NRF, in particular through a public-public partnership. Industrial coordination will be carried out with the help of Luxinnovation, in order to identify synergies with R & D & I support and funding actions in enterprises, in particular SMEs, and to develop experimental projects. The programme will take advantage of Luxembourg's specific features as a ground for multinational experimentation and foster collaboration with international actors and European institutions. This centralised governance and coordination will make it possible to identify and make better use of past, ongoing and future collaborative public-private R & D & I projects, in particular for the strategic orientation of the programme.	
Type of Instrument	Research, Budget	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MECDD, MEA, MESR, FNR	
Reference (s)	Amended Climate Law of 15 December 2020	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2020/12/15/a994/jo	

Title of the measure	No 117 Support for the establishment of research chairs and public-private or public-public partnerships at the University of Luxembourg and at public research centres	
Description:	In order to succeed in the energy transition, Luxembourg needs advanced skills and sufficient and skilled labour for complex technological tasks. The University of Luxembourg already offers training in this field at various levels, such as the Bachelor en Engineering – Energy and Environment (Uni.lu) and the Master's in Sustainable Development (Uni.lu) – Energy and Environment Subsidiary (MDD) developed in co-graduate by the University of Luxembourg and the University of Liège (Campus Arlon). In addition, the University of Luxembourg will develop its activities and expertise in the field of sustainability with a new Interdisciplinary Research Centre (IC) on sustainable environmental systems with a distinct interdisciplinary approach, a holistic view of disciplines and missions, an international reputation and local impact. Similarly, the Luxembourg Institute of Science and Technology (LIST) is also very active in the field of environmental research and the Luxembourg Institute of Socio-Economic Research (LISER) will be able to contribute to the socio-economic consequences of the energy transition. The aim of this measure is to support the various actors of public research in their efforts to create leverage effects in the areas of research described above through research chairs and public-private or public-public partnerships by helping them to identify the industrial or public partners and other sources of funding that can contribute to the creation of the desired leverage effects. The priority R & D & I topics already identified by MEA and MECDD to support the energy transition and climate action are coupled energy systems, construction with bio-based materials and landscaping. The priority R & D & I topics already identified by MEA and MECDD to support the energy transition and climate action are coupled energy systems, construction with bio-based materials and landscaping.	
Type of Instrument	Research, Education	
State of progress	Planned.	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MESR, MEA, MECDD	
Reference (s)		

Info complementary	

Title of the measure	No 118 Use of sustainable and climate finance tools to decarbonise
Description:	Climate and sustainable finance From 2021 to 2025, a total of EUR 220 million is made available for international climate finance, which aims at a balanced distribution between climate change mitigation, adaptation and resilience, as well as recently loss and damage. In addition, in accordance with the Climate Law of 15 December 2020, the Climate and Energy Fund (see measure 103) allows national climate projects in the field of sustainable finance to be financed through innovative mechanisms and instruments. Blended finance By leveraging public funds to reduce the risk of private investment, blending can help catalyse additional capital for climate solutions. Luxembourg is already acting as a catalyst to boost sustainable investment, notably with the "Klimapakt fir Betriber", the "International Climate Finance Accelerator" and the "Luxembourg-EIB Climate Finance Platform". Luxembourg will explore the possibility of expanding its blending offer. Significant funding potential in the area of retail banking exists and could be considered in the future. Green mortgages Green mortgages can encourage a borrower to buy an energy-efficient building or renovate an existing building to improve its energy performance. For example, the 'climate loans' scheme (measure 310), subsidised by the State, provides support for energy renovation by reducing the interest rate. The Luxembourg government will explore ways to reduce technical and social barriers to green mortgages, in particular by proposing recommendations to financial institutions based on the energy classes of buildings (in compliance with the General Data Protection Regulation (GDPR)). Green Budgeting Green budgeting is about integrating sustainability considerations into the national budgetary process and can be a powerful tool to finance the transition to a more sustainable economy. Luxembourg has already taken steps to integrate the principles of green budgeting into its public finance management practices, in particular as regards NECP expenditure. Luxembourg continues to explore how green budgeting practices can be further developed through, inter alia, the regular budget, special funds and public procurement. For example, the Luxembourg government issued a first sustainable sovereign bond in 2020 worth EUR 1,5 billion to finance and refinance at least 65 sustainable investments. In doing so, Luxembourg was the first European country and the first AAA-rated country in the world to issue a sustainable sovereign bond. Raising awareness of climate finance in the financial sector and the general public Raising awareness of climate finance in the Luxembourg financial sector is a key component in achieving the climate objectives. As a result, the Luxembourg Sustainable Finance Initiative (LSFI) was created in 2020 with

	one of its aims is to raise awareness, promote and support the development of sustainable finance initiatives in Luxembourg. In the same vein, a strategic partnership with the University of Luxembourg was concluded in 2020 to create a research project in sustainable finance, including a Master's programme to train talent in climate and sustainable finance. The government will continue to support the awareness of the financial sector and the general public.	
Type of Instrument	Regulatory, Information, Economic	
State of progress	Implementation, Analysis	
Start of implementing	End of implementation	Comments
2020	n.a.	
Responsible entity/entities	MECDD, MEA, MFIN	
Reference (s)		
Info complementary		

Title of the measure	No.119 Scaling up energy and climate transition projects	
Description:	Local energy and climate transition projects are important to initiate production and consumption patterns and new solutions compatible with climate protection. However, one of the biggest challenges of the green transition is the scaling up of these initiatives, pilot projects and best practices, while integrating environmental, socio-economic and good management aspects ("Upscaling"). To facilitate this, a coalition of public, private and civil society actors is needed. The fundamental objective is to stimulate and optimise demonstrative projects that contribute to an exemplary framework for the development of concepts and guidelines, in order to facilitate a wider deployment of innovative and transformative approaches in Luxembourg and the region.	
Type of Instrument	Planning	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, MEA, MECO,	
Reference (s)		
Info complementary		

Title of the measure	No 122 Reducing our carbon footprint based on consumption
Description:	There is a consensus among scientists that climate protection is also linked to cultural change: behavioural change, moderation of lifestyles, promotion of the common good, etc. The success of many other measures also depends on the willingness of the population to change behaviour. In addition to production-based GHG emissions accounting, as anchored in international GHG inventory conventions, consumption based accounting provides important information on how different aspects of our lifestyle, such as our consumption of mobility, housing, food and goods, contribute to our carbon footprint. Indeed, the consumption based carbon footprint takes into account global GHG emissions due to what we consume in Luxembourg, while the national production based inventory only includes GHG emissions that have been emitted in Luxembourg. The carbon footprint based on consumption therefore includes indirect GHG emissions occurring outside Luxembourg. By putting in place the necessary means, the government will establish a consumption-based approach to calculate the carbon footprint to include these indirect emissions. This approach allows the calculation of life cycle GHG emissions of a product or process, such as life cycle GHG emissions associated with different construction materials. In addition, this approach will facilitate the development of measures to reduce the carbon footprint of consumption, including by encouraging behavioural change and sobriety. In addition, the government will provide a carbon footprint calculator to raise awareness of the GHG reduction potential of behavioural change (measure 114). Combined with information on how certain actions can reduce a person's carbon footprint, carbon footprint is an important tool to help citizens reduce their climate impact. The government will explore how applications can be made available to citizens to determine their own carbon footprint and the climate impact of the different actions they can undertake, such as promoting public transport or changing diet. Such applications can also facilitate the reduction of consumption-related emissions by encouraging repair, sharing economy and second-hand markets. The information will also be available on the new klima.lu website (measure 114).
Type of Instrument	Information, Research
State of progress	Under analysis

Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, MEA	
Reference (s)		
Additional info		

Title of the measure	No 123 Development of monitoring statistics, models and indicators	
Description:	The projections prepared by STATEC for the update of the NECP are a first step to quantify economic and technological trends, as well as measures adopted at national and international level. The objective is to monitor energy production, consumption and direct emissions with short deadlines. To achieve this, statistics based on administrative or survey data need to be improved and multiplied. The collection and provision of new data sources to STATEC will thus allow quantified monitoring of measures and regular monitoring in relation to climate and energy objectives. They will also further develop STATEC's projection models, whose granularity is currently limited by the unavailability of certain data. Beyond the direct emissions approach, data on emissions associated with imported goods and services could be collected (indirect emissions), so that emissions can be estimated over the whole value chain (see also measure 122).	
Type of Instrument	Planning, Information	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023		continuous implementation
Responsible entity/entities	STATEC, MECDD, MEA, MECO, MMTP, AEV, SER	
Reference (s)	Law of 10 July 2011 on the organisation of the National Institute of Statistics and Studies	
Info complementary		

3.1.1.2 Buildings

Measures to decarbonise buildings are closely linked to measures to improve the energy efficiency of buildings, including through energy remediation measures, as any reduction in fossil energy consumption means a reduction in GHG emissions.

At the level of buildings, decarbonisation through electrification through heat pump is the most important alternative to fossil fuels, notably because part of the (renewable) electricity can be produced at national level and due to the significant energy efficiency gain, as most of the energy made available for heating and domestic hot water through a heat pump comes from the environment (ambient energy).

Any new construction (residential and functional buildings) must comply with the requirements of the amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings, which defines the national "nZEB" level (nearly-zero Energy Building): thanks to the continuous evolution of regulatory ambitions and requirements since the entry into force of the first regulation on the energy performance of residential buildings in 2007 and functional buildings in 2010, and thanks to the parallel evolution of the skills of the construction sector in Luxembourg to implement these ambitions, Luxembourg's nZEB is now one of the most ambitious in Europe and ensures that any new construction for which this regulation applies is automatically highly energy efficient and decarbonised due to the fact that the heat pump is the reference technology for the installation of heat and domestic hot water.

The measures provided for at building level vary depending on whether they are residential or functional buildings and are also specific to the sector concerned, namely the public sector, the professional sector and the private sector.

The public sector is redefined in the context of the revision (expected in 2023) of the Energy Efficiency Directive (EED), since it will no longer be only central government buildings that are covered, but all state buildings and municipal buildings. The EED, which is currently being revised, includes more ambitious energy renovation obligations for public sector buildings (measure 303). It is important to take into account in this context the need for additional resources at public sector level to be able to implement these European obligations. With regard to existing buildings in the professional sector, bonds are announced (measure 304); the timetable for these obligations will be defined when the Directive is transposed into national law and the sector (CoC, CoM) will be consulted, as well as possible private sector incentives for energy renovation before the mandatory phase will be analysed.

With regard to existing housing, the approach to energy efficiency (energy remediation) and decarbonisation (replacing fossil heaters with non-fossil alternatives) is based on voluntary participation, accompanied by support mechanisms (subsidies) and awareness-raising, information and assistance to households; awareness raising focuses on the advantages of improving energy efficiency (such as reducing energy consumption and thereby costs, improving comfort, upgrading the building stock (possibly with an extension of the living area), etc.) and decarbonisation (measures to combat global warming, reducing greenhouse gas emissions, independence of fossil fuels and the very volatile prices of such energy, the possibility of on-site production and self-consumption of electricity, etc.); the various subsidy schemes (such as state aid (Klimabonus (No 307), climate loans (No 310), individual housing aid (No 311), aid for stone (No 312), tax incentives (No 313), etc.), aid offered by electricity and natural gas suppliers under the energy efficiency obligation scheme and municipal aid) are revised regularly and can be mostly combined and combined, in order to make energy remediation and decarbonisation measures economically attractive and accessible to all households.

The energy renovation of worst-performing residential buildings and special assistance to vulnerable households are specifically targeted and will be targeted primarily by the future national body supporting energy renovation, decarbonisation and the implementation of photovoltaic installations for residential buildings (measure No 327), whose future tasks and working methodology are developed inter alia as part of the pilot project for the renovation of 'zesumme renovéieren' districts in Differdange (measure No 328).

Title of the measure	No 301 Regulation on the energy performance of buildings	
Description:	In 2021, the regulatory framework for the energy performance of residential and functional buildings was adapted with the aim of incorporating the various provisions for residential and functional buildings into a single Grand-Ducal Regulation. In particular, this Regulation defines the model of the reference building that is used to define the energy efficiency requirements of individual buildings. The Regulation also defines the environmental performance indicators (CO_{2eq}) and other minimum requirements to be met such as pretubing for charging stations or photovoltaic installations, as well as the calculation methodology and the content of the energy performance certificate. Revisions and adaptations are planned, in particular as regards the adaptation of energy classes for residential buildings, the definition of a nZEB energy performance level for energy renovation (based on the cost-optimal performance method (EPBD)) with a view to the introduction of minimum energy performance standards (MEPS) and certain renovation obligations (in particular for the public sector), the installation of photovoltaic panels at the level of the reference building for dwellings, the obligation (in the form of minimum requirements) to install photovoltaic panels "on the entire surface of the roof" and the reform of the energy performance certificate into an environmental performance certificate, based on the (ongoing) revision of the EU Energy Performance of Buildings Directive. Definition of a level of energy performance $nZEB_{renovation}$, as part of the revision of the EPBD and the introduction of minimum energy performance standards (MEPS), taking due account of cost-effectiveness (proportionality) and technical feasibility, as provided for in the Directive; this $nZEB_{renovation}$ level will be the minimum requirement for future renovation obligations (notably for the public sector). In relation to the European taxonomy (classification of economic activities with a favourable impact on the environment) and the resulting requirements for financial institutions, Luxembourg will consider, as part of the revision of the same Directive, making recommendations based on the energy classes of buildings available to banks (in compliance with the General Data Protection Regulation (GDPR)).	
Type of Instrument	Regulatory	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2021	n.a.	existing regulations since 2007 (residential buildings)/2010 (buildings)

		functional) and regularly adapted, in particular on the basis of updates to the European EPBD (+ EED) Directive
Responsible entity/entities	MEA	
Reference (s)	Amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2021/06/09/a439/jo	

Title of the measure	No 302 Decarbonisation of buildings: phase out of fossil heating
Description:	In view of the objective of decarbonising buildings, i.e. reducing greenhouse gas emissions, it is essential to replace all fossil energy heating installations with decarbonised heating systems in the medium term. This includes all heating and domestic hot water systems. A voluntary approach In the first phase, the government promotes a voluntary approach, providing citizens and businesses with a wide range of easy-to-implement and coordinated solutions at national, regional and local level. Collective solutions such as systematic district renovations and decarbonised heat networks will be massively developed, in collaboration with the municipalities and the consultancy and crafts sector. Similarly, skills at the level of the actors involved will continue to be developed and strengthened in the light of current and future decarbonised alternative technologies (heat pumps and district heating networks are targeted as a priority in the context of the decarbonisation of buildings). These measures will complement the existing substantial aid schemes, such as the existing State aid scheme "Klimabonus" (including the "Masuttersatzprogramm" bonus increasing aid for the replacement of an existing fossil fuel boiler and, where appropriate, the social top-up on Klimabonus aid), as well as, where appropriate, aid offered by municipalities and certain private actors, such as obligated parties (electricity and natural gas suppliers) under the energy efficiency obligation scheme (EEOS). The government will set up a national monitoring of the decarbonisation of buildings to monitor the annual evolution of replacing fossil heaters with decarbonised alternatives compared to the decarbonisation trajectory (based on annual targets) needed in the context of national greenhouse gas emission reduction targets. If the voluntary approach is sufficient and effective, it will be maintained and there will be no need to move to a prohibition approach. Prohibition approach Should the voluntary approach prove to be insufficient or too slow, it is envisaged to allow the replacement of heating installations in the existing heritage (for all types of buildings, both functional and residential) exclusively with heating installations which are operated with a minimum of 70 % renewable energy, i.e. where at least 70 % of the useful heat demand over the year is covered by renewable energy (authorised hybrid systems). In order to give visibility to the evolution of the requirements, this phase-out will, where appropriate, be announced in advance by legislation/regulation with a transitional phase and precise effective dates for fuel oil boilers and natural gas boilers.

	The fossil phase-out is not an obligation to replace a (fossil) heating installation that is still in good working order; the phase-out shall apply at the time of the replacement of an existing boiler which is either out of use or is no longer authorised to operate on the basis of the regulations in force. The current substantial aid schemes will remain in place after the start of the mandatory phase-out, in particular aid for replacing a heating plant with a renewable energy installation, with the aim of offsetting part of the possible additional costs in relation to replacement by a fossil boiler, such as the 'Klimabonus' State aid scheme (including the 'Masuttersatzprogramm' bonus increasing the aid granted in the event of the replacement of a boiler powered by existing fossil fuel and, where appropriate, the social top-up on Klimabonus aid), and, where appropriate, aid offered by municipalities and certain private actors, such as obligated parties (electricity and natural gas suppliers) under the Energy Efficiency Obligation Scheme (EEOS). Exceptionally, an obligation to renovate a building for energy purposes or a ban on replacing a fossil boiler with a new fossil energy boiler resulting from a NECP measure may be waived where the costs related to the complexity of the works, necessary for its implementation, are disproportionate to the CO2 emission reduction$_{potential}$. These exceptions will be specified in the legislation on obligations and prohibitions. Complementary accompanying (financial and/or technical) solutions will be analysed and communicated with the future regulation on the fossil phase-out, in order to cover extreme cases with technical implementation difficulties or difficulties in financing alternatives to fossil solutions. It is envisaged to make it compulsory to set up a stock of 'troubleshooting' heating installations, which may be used as an intermediate/transitional solution (some weeks to a few months) in the event of unforeseen failure on an existing (fossil) boiler. The emergency repair installation will cover the time needed to size, select, control and install a new heating installation meeting the fossil phase out requirements. Troubleshooting heating installations may be fossil-based installations (natural gas or heating oil, depending on the defective existing boiler (availability of the fuel in question)), electric heaters, heat pumps or combined systems. The setting up of such a breakdown stock will be defined, where appropriate, in close consultation with the sector.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments

		A proactive approach with monitoring the evolution of decarbonisation; a prohibition approach is only envisaged if the voluntary approach proves insufficient or too slow.
Responsible entity/entities	MEA, MECDD, MECO (and Self-Employed), MLOG, Klima-Agence, OAI, Chambre des Métiers and Fédération des Artisans, Commons	
Reference (s)	Klimabonus Regulation, Energy Efficiency Obligation Scheme (EEOS), amended Law of 5 August 1993 on the rational use of energy + amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings, etc.	
Info complementary		

Title of the measure	No 303 Energy renovation obligation for public buildings (owned by a public body)
Description:	Introduction of an obligation to renovate certain categories of buildings on the basis of the future requirements of the European EED and EPBD Directives (revisions in progress, publication expected in 2023). Public buildings - by public body we mean the state and municipalities, the exact definition to be taken into account at European level is being revised (EED: 'public bodies' means national, regional or local authorities and entities directly financed and administered by these authorities but not having industrial or commercial characteristics); - all public buildings over 250 m^2 of useful floor area (heated or cooled) owned by a public body are concerned and which are not nZEB (nearly-zero energy building) buildings at 1.1.2024; - for buildings used by a public body but not owned by it, public bodies are required to negotiate with the owner for the renovation of the building; - all types of public buildings, i.e. residential and non-residential buildings, will be subject to a renovation obligation; - at least 3 % of the total surface area (heated or cooled) will be renovated per year; - the level of energy performance to be achieved after$_{renovation}$ will be the specific nZEB renovation level (nZEB level for building renovation) defined at national level with due regard to cost-effectiveness (proportionality) and technical feasibility as foreseen by the Directive; - all buildings concerned will have to be renovated (at nZEB$_{renovation}$level) until 2040 at the latest; - under renovation obligations, less stringent rules are envisaged for certain categories of buildings, such as protected buildings (protected heritage). Exceptionally, an obligation to renovate a building for energy purposes or a ban on replacing a fossil boiler with a new fossil energy boiler resulting from a NECP measure may be waived where the costs related to the complexity of the works, necessary for its implementation, are disproportionate to the CO2 emission reduction$_{potential}$. These exceptions will be specified in the legislation on obligations and prohibitions. The details will be defined by the EED – Energy Efficiency Directive (Article 6), which is currently being revised (publication expected in 2023) and which will be the basis for transposition in Luxembourg. When transposing the Directive into national law, the need for additional resources at public sector level will be taken into account by the Government.

Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
		depending on the requirements of the EED + EPBD Directives under revision/transposition deadlines; start of implementation is not yet definitively known, not before 2025
Responsible entity/entities	MEA, MMTP, MINT, ABP and municipalities	
Reference (s)	Amended Law of 5 August 1993 on the rational use of energy + amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings	
Info complementary		

Title of the measure	No 304 Energy renovation obligation for functional buildings
Description:	Introduction of an obligation to renovate certain categories of buildings on the basis of the future requirements of the European EED and EPBD Directives (revisions in progress, publication expected in 2023). Functional buildings - concerns all buildings defined as 'functional buildings' in accordance with the regulations on the energy performance of buildings; - introduction of Minimum Energy Performance Standards (MEPS); - all functional buildings must meet a minimum energy performance from a certain deadline; - the level of energy performance to be achieved after renovation will be defined at national level with due regard to cost-effectiveness (proportionality) and technical feasibility as provided for in the Directive; - under renovation obligations, less stringent rules are envisaged for certain categories of buildings, such as protected buildings (protected heritage); - the timetable for taking effect of the obligations may vary depending on the sector concerned and the type of building. Exceptionally, an obligation to renovate a building for energy purposes or a ban on replacing a fossil boiler with a new fossil energy boiler resulting from a NECP measure may be waived where the costs related to the complexity of the works, necessary for its implementation, are disproportionate to the CO2 emission reduction$_{potential}$. These exceptions will be specified in the legislation on obligations and prohibitions. The details will be defined by the EPBD – Energy Performance of Buildings Directive, which is currently being revised (publication expected in 2023) and which will be the basis for transposition in Luxembourg, with national targets and requirements defined. (Article 9 EPBD recast: introduction of MEPS (Minimum Energy Performance Standards): '... energy performance challenges to be set on the basis of the national non-residential building stock (thresholds may be set at a level corresponding to a specific energy performance class)...' the MEPS shall at least ensure that: - all non-domestic buildings are below (i) 15 % threshold as of 1 January 2030 (ii) 25 % threshold as of 1 January 2034' When transposing the Directive into national law, the sectors concerned will be consulted (CoA, CoM), in particular on the timetable for future obligations and possible private sector incentives for energy renovation before the mandatory phase.

Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
		depending on the requirements of the EED + EPBD Directives under revision/transposition deadlines; start of implementation is not yet definitively known, not before 2025
Responsible entity/entities	MEA, MECO (and Self-Employed)	
Reference (s)	Amended Law of 5 August 1993 on the rational use of energy + amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings	
Info complementary		

Title of the measure	No 305 An energy renovation obligation for residential buildings is not envisaged in Luxembourg	
Description:	An obligation to renovate residential buildings is not envisaged in Luxembourg. The European EPBD, which is currently being revised (expected to be published in 2023), provides for renovation obligations for residential buildings, in the form of 'MEPS' (Minimum Energy Performance Standards): <... MEPs for residential multi-apartment buildings (> 10 building units) to be set based on a national linear trajectory for the gradual renewal, in line with national roadmap for 2030, 2040 and 2050 targets (zero-emission building stock by 2050)...'. Luxembourg will be obliged to achieve the results on the basis of these 'MEPS' requirements (i.e. there will be a European obligation at Member State level), but this obligation does not automatically mean an obligation for the owners of the dwellings concerned (individuals or companies). An obligation to renovate residential buildings is not envisaged in Luxembourg; Luxembourg continues to focus on an incentive for renovation, through policies and incentives such as 'Klimabonus' state aid and the energy efficiency obligation scheme and through the creation of a new national entity to support energy renovation, decarbonisation and the implementation of photovoltaic installations for residential buildings (see measure No 327).	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
		depending on the requirements of the revised EED + EPBD Directives/transposition deadlines; start of implementation is not yet known, not before 2025
Responsible entity/entities	MEA	
Reference (s)	Amended Law of 5 August 1993 on the rational use of energy + the amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings	
Info complementary		

Title of the measure	No 306 PRIMe House aid scheme 2017	
Description:	Under the PRIMe House scheme of 2017, projects initiated between 2017 and 2021 were eligible for financial support for the construction of sustainable housing, the sustainable energy renovation of housing, the installation of technical installations promoting renewable energy sources in housing and energy advice.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2017	2021	
Responsible entity/entities	MECDD, MEA	
Reference (s)	Grand Ducal Regulation of 23 December 2016 establishing an aid scheme to promote sustainability, rational use of energy and renewable energy in housing	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2016/12/23/n40/consolide/20210401	

<table>
<tr><td>Title of the measure</td><td colspan="2">No 307 Klimabonus Wunnen aid scheme</td></tr>
<tr><td>Description:</td><td colspan="2">Since 2022, the aid scheme “Klimabonus Wunnen” has increased financial support for the construction of sustainable housing, the sustainable energy renovation of housing, the installation of technical installations promoting renewable energy sources in housing and energy advice. The current scheme covers projects initiated between 2022 and 2025.
The main changes compared to the previous scheme (PRIMe House) are a simplified procedure for accessing aid, the reinforced promotion of eco-insulation materials, further encouragement to replace old fossil-based boilers, the eligibility of hybrid air-to-water and air-to-water heat pumps in existing buildings and the promotion of self-consumption for photovoltaic installations with a higher subsidy and the inclusion of a battery in the eligible costs. In detail, the amendments concern the following points:
Energy renovation:
- increase in subsidies for energy measures and advice
- stronger focus on green materials
- administrative simplification
- introduction of the possibility to implement individual measures without the use of full energy advice.
Technical installations (renewable energy):
- increase in subsidies
- supplementary premium for replacing an existing boiler fuelled with fossil fuel
- new additional bonus and bonus for the installation of a heat pump in an existing building
- increase of the bonus for photovoltaic installations and eligibility of a storage battery in self-consumption mode
- additional premium for the installation of a particulate filter for wood heaters.
It should be noted that energy suppliers and some municipalities also offer additional aid in relation to the “Klimabonus Wunnen” scheme. The aid simulator of Klima-Agence combines all these aids and provides an overview by measure in this context.</td></tr>
<tr><td>Type of Instrument</td><td colspan="2">ØEconomy</td></tr>
<tr><td>State of progress</td><td colspan="2">Implemented</td></tr>
<tr><td>Start of implementing</td><td>End of implementation</td><td>Comments</td></tr>
<tr><td>2022</td><td>2025</td><td>regular changes during implementation</td></tr>
<tr><td>Responsible entity/entities</td><td colspan="2">MECDD, MEA</td></tr>
</table>

Reference (s)	Grand Ducal Regulation of 7 April 2022 establishing an aid scheme to promote sustainability, rational use of energy and renewable energy in housing
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2022/04/07/a180/jo

Title of the measure	No 308 Digitalisation of Klimabonus aid scheme	
Description:	In order to simplify and speed up access to State aid under the 'Klimabonus' scheme, simplification and digitalisation of application forms and procedures for applying for aid are a priority. Digitalisation is a necessity to facilitate and speed up access to aid and is part of the state's efforts to simplify administration and digitalise processes.	
Type of Instrument	ØEconomy	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, MEA, MDIGI	
Reference (s)	Grand Ducal Regulation of 7 April 2022 establishing an aid scheme to promote sustainability, rational use of energy and renewable energy in housing	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2022/04/07/a180/jo	

Title of the measure	No 309 Pre-financing under the Klimabonus Wunnen scheme	
Description:	Access to finance remains an insurmountable barrier for some people who wish to carry out energy renovation, heat system change (decarbonisation) or photovoltaic installations. With a view to a just energy transition and in order to make it possible for people who are not eligible or who are difficult to qualify for climate loans or conventional bank loans to have access to such projects, the State will consider the advisability of prefinancing mechanisms. This analysis will also take into account the tasks to be defined for the future national support entity for energy renovation, decarbonisation and implementation of photovoltaic installations for residential buildings (see measure 327).	
Type of Instrument	ØEconomy	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, MEA, Klima-Agency	
Reference (s)		
Info complementary		

Title of the measure	No 310 Climate Loans Scheme	
Description:	In order to facilitate the financing of energy renovation of housing and the installation of technical installations exploiting renewable energy sources (except photovoltaics), financial aid in the form of an 'interest subsidy' is granted to owners (natural persons) of a dwelling. The dwelling must serve as a main permanent dwelling, be over 10 years of age and are located in Luxembourg. In addition to the interest subsidy, a State guarantee may be requested if the applicant does not have sufficient guarantees.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2017	n.a.	repeal upon entry into force of the draft law on individual housing support (No 7938)
Responsible entity/entities	MLOG	
Reference (s)	Law of 8 June 2022 on aid for climate loans	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2022/06/08/a286/jo	

Title of the measure	No 311 Individual housing aid scheme	
Description:	The draft Act on Individual Housing Aid (No 7938) provides for individual housing support linked to income conditions: - energy renovation improvement premium as a supplement to the financial support granted under the "Klimabonus Wunnen" scheme (eligible households up to the income corresponding to the median living standard (dec. 5); maximum amount of premium: 100 % of aid under the Klimabonus Wunnen scheme) ("top up social") - climate loans – in this case a State guarantee and an interest subsidy for climate loans – in connection with the energy renovation of a dwelling; these provisions will take over the 'climate loans' aid scheme.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
		draft Law No 7938 tabled at the end of December 2021
Responsible entity/entities	MLOG	
Reference (s)	Draft Act on Individual Housing Aid (No 7938)	
Info complementary	https://chd.lu/wps/portal/public/Accueil/TravailALaChambre Research/RoleDesAffaires? action = doDocpaDetails & backto =/ WPS/portal/public/Accueil/actualite & id = 7938	

Title of the measure	No 312 Aid scheme for stone	
Description:	The amended law of 25 February 1979 on housing assistance and the draft law on affordable housing (No 7937) offer state financial contributions to municipalities to encourage the creation of affordable housing. Eligible costs for this aid are land acquisition costs, ordinary development (infrastructure works), construction and (energy) renovation and installation of technical installations. The Ministry of Housing provides a "Terms of Reference for the Development of Affordable Housing" which brings together recommendations on urbanisation, architecture and economicity. The Ministry of Housing has set up an internal commission, the Commission d'Accompanement des Aides à la stone (Commission d'Accompanement des Aides à la stone), to inform the construction projects for which an application for aid for stone has been submitted.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
		draft Law No 7937 tabled at the end of December 2021
Responsible entity/entities	MLOG	
Reference (s)	Amended law of 25 February 1979 on housing assistance and draft law on affordable housing amending the law of 25 February 1979 on housing assistance (No 7937)	
Info complementary	AmendedAct of 25 February 1979 on housing assistance: https://logement.public.lu/fr/legislations.html Tender specifications: https://logement.public.lu/fr/professionnels/promoteurs- social/aides-etatiques0/demande-aides-a-la-pierre.html	

Title of the measure	No 313 Tax incentives for energy renovation of housing	
Description:	To promote energy renovation, a depreciation rate of 6 % over 10 years is granted for any investment in sustainable energy renovation of rented housing benefiting from financial support from the “Klimabonus Wunnen” scheme. Moreover, housing renovation works (not limited to energy renovation) benefit from the capped application of the super-reduced VAT rate of 3 %.	
Type of Instrument	Taxation	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	n.a.	(VAT rate of 3 % introduced already before 2021)
Responsible entity/entities	MFIN, MEA, MLOG	
Reference (s)	Amended Act of 4 December 1967 on Income Tax (IRL); Amended Law of 5 August 1969 on value added tax	
Info complementary	https://impotsdirects.public.lu/fr/legislation/LIR.html	

Title of the measure	No 314 Aid scheme for municipalities	
Description:	Municipal administrations, associations of municipalities and public institutions under the supervision of municipalities may receive financial aid for energy efficiency projects (including energy renovation of existing functional municipal buildings, renovation of public lighting, energy optimisation study for municipal and urban development projects) and renewable energy (including solar energy, heat pumps, automatic wood heating, biomass cogeneration plants, district heating networks supplied by renewable energy sources and/or recovered heat). Since 2021, the aid scheme has been financed through the Climate and Energy Fund. The current regime will be reviewed and strengthened to better support municipalities in their decarbonisation efforts.	
Type of Instrument	ØEconomy	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2021	n.a.	planned revision and reinforcement of the current regime
Responsible entity/entities	MECDD, MEA	
Reference (s)	Circular No 3969 of 5 March 2021 – Climate and Energy Fund	
Info complementary	https://www.klima-agence.lu/fr/FCE	

Title of the measure	No 315 Promoting sustainable construction	
Description:	Sustainable construction with the three dimensions and objectives of economic feasibility, societal benefits and respect for the ecosystem limits of our planet is a vast area of work that mobilises multiple skills and sectors of activity. This interdisciplinarity also generates complexity and knowledge is often distributed and unconnected. The MMTP, MEA and MECDD mandated CRTI-B to update and modernise the Sustainable Construction and Renovation Guide in the form of an electronic portal (NOBA.lu), in order to centralise knowledge and share best practices in sustainable construction in Luxembourg. The guide should make it possible to promote key aspects relating to sustainable construction, existing tools such as the reformed LENOZ certification, with implications for the initial and continuing training of stakeholders. Specific emphasis is placed on the environmental impact of construction and human health. The guide is developed through working groups, involving public and private experts from the entire construction value chain, in addition to CRTI-B sectoral stakeholders. In 2020, CRTI-B also concluded a collaboration agreement with the National Council for Sustainable Construction (CNCD), in order to align priorities and bring forces together for the benefit of the sector.	
Type of Instrument	Information	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
2021	2023	1st version of the online guide in 2023, continuous development
Responsible entity/entities	MEA, MECDD, MLOG, MMTP, MECO (Self-Employed), CRTI-B	
Reference (s)	Coalition agreement 2018-2023	
Info complementary	Sustainable Construction Guide | The Luxembourg Construction Portal (crtib.lu)	

Title of the measure	No 316 Long-term Building Renovation Strategy	
Description:	In 2020, the Ministry of Energy finalised its LTRS (LTRS) strategy, proposing measures to frame and facilitate energy renovation in Luxembourg. The aim was to carry out an in-depth analysis of the building stock in Luxembourg and to draw conclusions on the development of the typology and energy consumption of buildings in the long term. Based on the data collected, a set of different measures has been defined to accelerate the energy renovation of the building stock. At the regulatory level, certain measures have been implemented (such as the obligation to set up a dedicated works fund and an adaptation of decision-making quorums in buildings in co-ownership); a critical analysis of municipal planning instruments to remove barriers to the renovation or installation of solar energy is being finalised and the results and proposals will be shared with the relevant municipalities and ministries. In addition to these regulatory measures, there are other proposals such as the introduction of an individual roadmap for the gradual renovation of the energy performance certificate or the regular adaptation of economic and fiscal instruments to take account of market developments and stakeholders' needs. A regular update (every 5 years) of the long-term building renovation strategy is mandatory at European level; the name of this strategy changes with the revision of the EED Directive (expected in 2023), the LTRS will become the National Building Renovation Plan (NBRP), a national building renovation plan; the final details will be known as soon as the revised Directive is published and will be the basis for transposition in Luxembourg.	
Type of Instrument	Planning	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
2020	n.a.	gradual implementation of the strategy and regular update of the strategy (following Article 3 of the EPBD under review (2023))
Responsible entity/entities	MEA, Klima-Agency	
Reference (s)	Langfristige Renovierungsstrategie Luxemburg, MEA 2020	
Info complementary	https://mea.gouvernement.lu/dam-assets/energie/energie-effizienz/lu-ltrs-2020.pdf	

Title of the measure	No 317 Building awareness, information, guides and consultancy services	
Description:	Klima-Agency offers a multitude of services to raise awareness and inform different stakeholders about buildings. For owners of residential buildings (and tenants), Klima-Agence offers its basic advisory service with the aim of providing an initial overview of renovation opportunities and available financial support (including through its aid simulator and an energy renovation simulator in the near future). When advising, the Klima-Agency advisor can also inform about the energy performance certificate (EPC), the energy assessment of the mandatory Heizungscheck heating system, and measures for optimising and modernising the heating system. Klima-Agency regularly launches awareness-raising campaigns, usually in cooperation with the responsible ministry (s), on various topical issues such as the introduction of a new support scheme, renewable energy, etc. The measures taken by the municipalities are governed by the 2.0 Climate Pact, which promotes measures aimed, inter alia, at the renovation of municipal buildings. A specialist energy renovation advisor assists municipalities at strategic level in this context. For companies, the 'Klimapakt fir Betriber' proposes measures to improve, in particular, the energy performance of the buildings of the companies concerned. A guide to the energy renovation of a building in co-ownership is being developed. This guide will be made available to owners of co-owned dwellings, liquidators and consultancies in order to support them from the outset of a renovation project. The aim of this guide is to facilitate understanding of the different stages of a renovation project, to guide professionals in the development of a comprehensive, pre-defined service offer for the study, monitoring and implementation of (energy) renovation works in co-ownership (concerns residential and combined (residential/functional) buildings) and to highlight the national regulatory framework reflecting financial measures and support.	
Type of Instrument	Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
		continuous implementation
Responsible entity/entities	MEA, MECDD, MLOG, MECO (Self-Employed), Klima-Agence	
Reference (s)		
Info complementary	https://www.klima-agence.lu/fr	

Title of the measure	No 318 Training of a skilled and sufficient workforce in the buildings sector
Description:	Craft enterprises as well as consultancy firms and architects (designers), particularly in the construction sectors (new construction and energy renovation), the industrial sector, the mobility/electro-mobility sectors and others, are facing significant technological change and are in urgent need of new skills related to the energy transition; companies that are able to meet these challenges will have access to new activities and will be able to actively contribute to the NECP objectives, notably in the area of energy efficiency, renewable energy and decarbonisation. As regards continuous vocational training (Up-skilling), the National Continuous Vocational Training Centres (CNFPC), the Chambre des Métiers (CdM), the Federation of Crafts with its Technical Engineering and Completion Centres (CdC-GTB/PAR), the Institut de Formation Sectoriel du Bâtiment (IFSB) and other private stakeholders regularly provide theoretical and practical training for craftsmen and energy advisers on various topical issues related to the energy transition, such as regulatory changes, challenges regarding new skills to be acquired, access to various qualifications (“Nohalteg an d’Zukunft +”) and implementation of innovative solutions. The IAB, in cooperation with training stakeholders, offers specific training on the design and planning, study and promotion of new innovative solutions, architectural integration of energy transition technologies, etc. These training courses are targeted primarily at the design and architects represented by the IAB. In order to ensure that training programmes for the different levels of competence and areas concerned correspond to the challenges relating to the objectives of the NECP, a systematic and regular evaluation of these programmes in consultation with the actors on the ground and the ministry (s) concerned, in the form of a national initiative bringing together all relevant actors, is necessary. To complement this training offer, it is also necessary to continue investing in re-skilling offers to offer job seekers opportunities in other sectors. For example, installers and heaters are increasingly trying to move away from fossil fuel heating systems to modern systems such as heat pumps. In order to facilitate access to continuous training at company level, the possibility of financial support and incentives for training related to the energy transition, such as skills bridges for staff in the construction sector, will be analysed.
Type of Instrument	Education
State of progress	Implementation, Analysis

Start of implementing	End of implementation	Comments
Responsible entity/entities	MENEJ, MEA, Other (s)	
Reference (s)		
Info complementary	https://www.cnfpc.lu; https://www.lifelong-learning.lu; https://www.cdm.lu; https://www.ifsb.lu; https://www.cdc-gtb.lu; https://www.neobuild.lu; https://www.eacademy.lu; https://www.houseoftraining.lu/;	

Title of the measure	No 319 Preventive role of the State in relation to buildings (see also No 303)	
Description:	In order to guarantee the pioneering role of the State in relation to buildings, the Public Buildings Administration shall ensure that all new public buildings are designed and constructed in an exemplary manner. In recent years, new public buildings have already been heated as far as possible by heat pumps or wood-energy boilers and are equipped with photovoltaic installations. With the legislation of June 2021 on the energy performance of buildings, this becomes the norm in Luxembourg and the State will go further in terms of its pioneering role, namely the construction of buildings with positive energy and the maximum use of the surface on the roof available for photovoltaic installations. According to the energy efficiency strategy of the Public Buildings Administration, based on the European Energy Efficiency Directive (EED), 3 % of the surface area of central government buildings has been renovated per year in recent years and this requirement will be maintained in the new Directive, i.e. there is an obligation to renovate at least 3 % of the surface area of the buildings per year and this requirement will be further strengthened as the level to be achieved by renovation will be the nearly-zero energy building (nZEB) and its application will be extended to the entire public sector, i.e. all public buildings (plus only the central state). The definition of the public sector will be adapted with the revision of the Directive and will henceforth include the State and the municipalities ("public bodies" means national, regional or local authorities and entities directly financed and administered by these authorities but not having industrial or commercial character). Exemplary building renovation and construction will play a key role in the decarbonisation strategy pursuing the objective of climate neutrality of the state administration as of 2040.	
Type of Instrument	Budget, Information	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
		continuous implementation
Responsible entity/entities	MMTP, ABP, MEA	
Reference (s)	European Energy Efficiency Directive Motion 3513 on climate neutrality in public administration by 2040, adopted in the Chamber of Deputies on 29 April 2021	
Info complementary		

Title of the measure	No 320 Pioneer role of the public sector in energy efficiency	
Description:	In the context of the pioneering role of the public sector in energy efficiency, the European Energy Efficiency Directive (EED, Article 5, Public sector leading on energy efficiency), which is currently under revision, provides for a 1.9 % reduction in final energy consumption per year in the whole public sector, i.e. an annual improvement in energy efficiency, with a transitional phase of 2 years during which the targets will be indicative. This obligation to improve energy efficiency applies to all activities of the public sector. The definition of the public sector will be adapted with the revision of the Directive and will henceforth include the State and the municipalities; for municipalities there will be phasing-in, i.e. municipalities with a population of more than 50.000 will be taken into account from 1.1.2027 and municipalities with a population of more than 5.000 from 1.1.2030. The obligation to renovate certain categories of buildings owned by the public sector is complementary to this obligation to improve energy efficiency in general, in the sense that any energy renovation will also contribute to achieving the objective of improving energy efficiency in general.	
Type of Instrument	Budget, Information	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MMTP, ABP, MEA, MINT, Communes	
Reference (s)	European Energy Efficiency Directive (Revision 2023)	
Info complementary		

Title of the measure	No 321 Primary role of municipalities with regard to buildings	
Description:	The 2.0 Climate Pact gives municipalities an attractive framework to support them in their pioneering role in the exemplary renovation of the municipal building stock and the construction of new sustainable municipal buildings. To this end, the municipality applies the highest criteria in terms of energy, ecology and resource saving and sustainable adaptation to climate change in the construction, renovation and management/use of its buildings. In this context, municipalities receive financial support from the Climate and Energy Fund. They also benefit from the 'Klimabonus Wunnen' regime when they renovate or build owner-owned housing. This pioneering and exemplary role of municipalities will be strengthened and made mandatory by the future requirements of the European Energy Efficiency Directive (EED), in the sense that "public bodies" no longer concern only the State but also the municipalities. The requirement based on the European Energy Efficiency Directive (EED) to renovate at least 3 % of the surface area of buildings per year will henceforth apply not only to state buildings but also to municipal buildings, and this requirement will be strengthened, since the level to be achieved by renovation will be the nearly-zero energy building (nZEB). The definition of the public sector will be adapted with the revision of the Directive and will henceforth include the State and the municipalities ("public bodies" means national, regional or local authorities and entities directly financed and administered by these authorities but not having industrial or commercial character). In addition to obligations regarding their own buildings, municipalities can encourage their citizens to renovate energy by promoting available state aid and offering their own municipal support programmes.	
Type of Instrument	Economic, Voluntary Agreement, Information	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
		continuous implementation
Responsible entity/entities	MECDD, MEA, MINT, Communes, Klima-Agency	
Reference (s)		
Info complementary		

Title of the measure	No 322 Reduction of the environmental impacts of construction	
Description:	The Ministries of Energy and the Environment have issued a “Construction Road Map Bas Carbone – Luxembourg”. Through a series of projects and in close cooperation with the construction sector, the programme aims to develop and implement the tools needed to achieve carbon neutrality in the sector in 2050. The programme focuses on “embedded emissions” (emissions related to the production phases of construction materials, construction phases and subsequent demolition/deconstruction) of construction and renovation projects, with the energy performance of buildings even being addressed by other NECP measures. A close link between the life-cycle carbon footprint of a building (the calculation of which will become mandatory under the proposed recast of the Energy Performance of Buildings Directive (EPBD)) and GHG emission reduction targets at national level is envisaged. While the Roadmap targets GHG emissions in 1, the tools will allow for more comprehensive life cycle assessments, taking into account other environmental impacts as well as human health aspects. Beyond the development of methods and tools, a central point in the roadmap is the identification of concrete solutions to reduce the carbon footprint of buildings, such as design that is more material efficient or less impactful (e.g. bio-based), design for modular use and extension of use, or design for deconstruction and reuse of products and materials. Keeping existing as much as possible during conversions and renovations also helps to reduce material intensity. Reducing soil excavations or better managing soil supply and demand makes it possible to influence transport needs.	
Type of Instrument	Regulatory	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
2022	2024	1st phase, the regulatory framework will be developed at a later stage
Responsible entity/entities	MEA, MECDD, MLOG, MMTP, MECO (and middle classes)	
Reference (s)	Road sheet Construction Bas Carbone	
Info complementary	https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2023/06-juin/14-turmes-construction-decarbone.html	

Title of the measure	No 323 Decarbonation of construction sites	
Description:	In the holistic approach to managing environmental impacts and in particular GHG emissions from the construction sector over the entire useful life cycle of the building (see measure "Reduction of environmental impacts of construction"), it is important to take action at all stages. The construction phase of the building generates direct emissions through trucks and machinery, used on construction sites and used for demolition, excavation of land, transport of land and materials, and production and finishing of buildings. The decarbonisation of construction sites takes place in 1 through the electrification of trucks and machinery, as demonstrated by initiatives these include: the of the city Oslo (https://www.klimaoslo.no/kategori/english/). In addition to GHG emissions, emissions of exhaust gas noise and pollutants are being eliminated at the same time, important assets in both urban and rural areas, as these emissions are harmful to human health and to fauna and flora. For the supply of energy to machinery that is already electric, such as cranes or tools, and for charging trucks and vans, it is important to provide construction site operators with a connection to the electricity grid, even before construction starts, in order to minimise the use of mobile oil-fired electric generators. Operators in the construction sector can be encouraged to invest in these new technologies through (1) public contracts promoting the electrification of state and municipal yards, and (2) aid schemes to be put in place for electric construction and transport machinery. These measures will be analysed and implemented gradually.	
Type of Instrument	Planning, economics, other	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2023	n.a.	Continuous development
Responsible entity/entities	MEA, MMTP, MECDD, MECO (and Self-Employed Classes)	
Reference (s)	Road sheet Construction Bas Carbone	
Info complementary	https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2023/06-juin/14-turmes-construction-decarbone.html	

Title of the measure	No 324 Minimum energy performance requirements for rented dwellings (owner incentives)	
Description:	In order to give an advantage to owners of rented dwellings to carry out energy renovations, it is envisaged to introduce minimum requirements for the energy performance class of any dwelling that is rented out or is to be rented out. These minimum requirements will be defined taking into account cost effectiveness (proportionality of renovation measures) and technical feasibility. To clarify that owners are eligible for the various aid and incentives (state or other) available for this type of energy renovation works. It is therefore intended to create a link between the energy performance class of a rented dwelling and the right to rent and/or the maximum permissible rent. This type of incentive is preferable to the idea of involving an owner directly in the energy costs (heating + ECS) to be borne by the tenant.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, MLOG	
Reference (s)		
Info complementary		

Title of the measure	No 325 Facilitation of energy works in buildings in co-ownership	
Descriptio No	By the Law of 30 June 2022 amending the amended Law of 16 May 1975 on the status of co-ownership of buildings built on in order to introduce a works fund, facilitating elements were introduced in the field of buildings in co-ownership. Previously requiring a majority of three-quarters, the following works can now be decided by a simple majority of the co-owners: Energy renovation/Gainage/Reinstallation of renewable energy generation and storage facilities in the common parts. This law also introduces the obligation to set up a works fund in co-ownership.	
Type of instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity (ies)	MEA, MLOG	
Reference (s)		
Complementary information	https://legilux.public.lu/eli/etat/leg/loi/2022/06/30/a347/jo	
	https://logement.public.lu/fr/proprietaire/copropriete.html#:~:text=La%20loi%20instaure% 20One% 20fonds,% 201st% 20ao% C3 % BBT% 202023	

Title of the measure	No 326 Harmonisation of urban planning rules	
Description:	Urban planning rules may vary from one municipality to another with different levels of restrictions. The Ministry of Energy and Spatial Planning is currently analysing a multitude of special development plans and building regulations, and will propose, after an analysis of the reductions, respectively standard formulations concerning the installation of photovoltaic power stations, the installation of plug-in-PV power stations, the installation of heat pumps and energy renovations. These proposals for simplification and harmonisation will be made available to municipalities by the Ministry of the Interior and will serve as a model for municipalities; they are intended to guide and guide the municipal authorities when drawing up their rules on buildings and to create a degree of uniformity in the rules applicable between municipalities; the adoption of proposals under their regulations falls within the competence of the municipalities (municipal autonomy).	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, MINT, Communes	
Reference (s)		
Info complementary		

Title of the measure	No 327 National entity accompanying energy renovation, decarbonisation and installation of photovoltaic installations for residential buildings
Description:	Energy renovation and decarbonisation of the stock of buildings is essential in order to achieve national targets for reducing greenhouse gas emissions, improving energy efficiency and producing renewable electricity. The proposal for a recast of the European Energy Performance of Buildings Directive (EPBD) provides for targets for the gradual energy renovation of buildings. The objectives are based on minimum energy performance standards (MEPS) to be achieved per building type and according to a specific timetable. The first buildings initially targeted are the worst-performing buildings. While this proposal targets residential buildings at more than 10 housing units, Luxembourg is considering extending the support for energy renovation for all low-energy residential buildings. As soon as the EPBD is formally recast, performance levels and expiry dates will be defined at national level. In order to structure and accompany this type of project, Luxembourg plans to set up a 'national support entity for energy renovation, decarbonisation and installation of photovoltaic installations for residential buildings'. The structure of this entity will be defined taking into account existing national structures (such as the Klima-Agency). Clarify that this entity will not compete with players active on the domestic market, but will include such actors (e.g. accredited energy advisors or IAB members/consultancy firms) in the context of coaching and other services offered to customers (comparable to the management of advisors active under the Climate Pact for Common); the future organisation of the entity will be defined in consultation with the industry and stakeholders. This measure is one of the structural measures identified at the level of the long-term renovation strategy. The main objective is to provide structured and comprehensive assistance to owners of low energy performance residential buildings, in terms of identifying improvement potentials, planning, financing (taking into account all existing support schemes) and carrying out energy renovation, decarbonisation and photovoltaic installation measures. The initiative targets all owners of residential buildings (whether rented or not) who undertake to carry out such works. The support will be based on a voluntary commitment by the owners. The roles of this new entity will include, but are not limited to: — identification of residential buildings with low energy performance (based on nationally defined performance levels) (based on EPCs);

	- the establishment of a national/local typology of targeted residential buildings, in order to standardise and simplify the identification of potentials and measures to be implemented, with a focus on deep energy renovation; - raising awareness and empowering the owners of the targeted buildings, in cooperation with other stakeholders (municipalities, social offices, INPA, obligated parties, etc.); - management and provision of energy renovation advisers/accompanying staff (provision based on accredited advisers and/or members of the IAB/consultancy firms active on the Luxembourg market); - full project management for the implementation of the targeted measures (energy renovation, decarbonisation and implementation of photovoltaic installations); - quality assurance at the level of energy renovation advisers/accompanying persons (certification); - taking account of the various types of aid available in the context of the targeted work; - specific consideration of European state aid rules if companies (owners of targeted buildings) are concerned; In this context, the experiences of the pilot project for the renovation of neighbourhoods launched in the City of Differdange (see measure 328) will be taken into account when defining the structure and tasks of such an entity.	
Type of Instrument	Regulatory	
State of progress	Definition in progress	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, Klima-Agency	
Reference (s)		
Info complementary		

Title of the measure	N° 328 Pilot project “Rehabilitation of neighbourhoods – Differdange”	
Description:	As a result of the long-term building renovation strategy, a ‘district renovation’ pilot project is being launched in Differdange. Preparatory work and preliminary analysis started in 2022 and the official launch of the project is scheduled for early 2023. The objective of the pilot project is to increase the rate of renovations in the most energy friendly neighbourhoods, with a focus on deep renovation, structuring and intensifying advice and support to the owners of the buildings concerned throughout the renovation process. The development of a typology of single-family houses is at the heart of the project. It will thus be possible to identify the specific energy savings needs and potentials for each type of building and thus propose specific energy renovation measures for each type of house, taking into account State aid ‘Klimabonus Wunnen’, any municipal aid and other private aid (energy efficiency obligation scheme). The project is being carried out in cooperation with the National Institute for Architectural Heritage (INPA) to remove barriers to energy renovation of the various types of buildings protected at municipal level. This is done by aligning the measures proposed by an energy adviser with the requirements of heritage protection. Another aspect of the project is awareness raising and information for residents through enhanced advisory services and tailored support for Klimabonus aid applications. On the basis of the experience of this project, a standardised approach at national level will be developed for the concerted mobilisation of renovation potential in other municipalities and regions of the country (see measure 327).	
Type of Instrument	Research	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, Klima-Agency	
Reference (s)		
Info complementary		

Title of the measure	N° 329 Assistance to households in energy poverty	
Description:	The programme ‘Assistance to households in energy poverty’ aims to better support low-income and energy poor households, i.e. households that do not have sufficient means to heat their homes properly and/or could not pay their bills for electricity, gas, water or heating due to a lack of financial means in the last 12 months. Targeted households are selected, contacted and made aware of this specific support offer by the social welfare offices. The households concerned have the possibility to benefit from a personalised energy advice from Klima-Agency, as well as a subsidy for the replacement of one or more energy-intensive household appliances and/or the acquisition of one or more new efficient appliances (refrigerator, freezer, dishwasher, washing machine and drier). This service aims to inform and raise awareness among households and improve their situation and quality of life.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2017	and Others	Implementation: 2017; adapted conditions: 2022
Responsible entity/entities	MFAMIGR, MEA, MECDD, Klima-Agency	
Reference (s)		
Info complementary		

3.1.1.3 Transport &Mobility

Title of the measure	No 401 National Mobility Plan 2035	
Description:	The 2035 National Mobility Plan (NMP 2035) proposes an overall concept capable of managing 40 % more travel than in 2017. It implements the approaches advocated by the Sustainable Mobility Strategy Modu 2.0, i.e. moving from a catch-up approach to a logic of anticipating future demand. Two principles are applied. The first is to focus on people's mobility before looking for solutions for vehicle mobility. The aim is to put in place quality alternatives. The second is to make efficient use of infrastructure. Rather than planning the networks of the different modes of transport separately, the aim is to find multimodal synergies, to seek compact solutions, and to favour strengthening an existing supply rather than doubling infrastructure. In general, the idea is to drag transit traffic to the main network, relieve city centres as much as possible in order to be able to adapt them to urban transport modes – bus or tram, cycling and walking – which are the only ones able to manage the traffic flows planned for 2035 in urban areas. The 2035 MNP is first and foremost a coherent approach to known projects and multimodal optimisation of ongoing planning. However, when developing the concept of global mobility, it appeared that some pieces were missing from the puzzle. Thus, it includes a compendium of all projects at national level needed to ensure mobility in 2035 and achieve the modal shares targeted, taking into account cross-border mobility. It will be broken down in several regional studies which will elaborate the details of the projects at local level and add additional measures. The MNP is updated at a five-yearly rate.	
Type of Instrument	Planning	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2022	2035	
Responsible entity/entities	MMTP	
Reference (s)	MNP 2035 – National Mobility Plan (MMTP, 2022)	
Info complementary	https://transports.public.lu/fr/contexte/strategie/pnm-2035.html	

Title of the measure	No 402 Module 2.0	
Description:	The Modu 2.0 brochure is an information tool for planning sustainable mobility. It thus distinguishes 4 mobility actors (state, municipalities, businesses and citizens) and makes specific recommendations for each actor using a mobility toolkit. In addition, it illustrates the method of future planning by which Luxembourg can move from a catch-up logic to a forward-looking approach by developing a sustainable mobility concept for 2035 that is consistent with the country's growth scenarios and financial means.	
Type of Instrument	Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2018	2025	
Responsible entity/entities	MMTP	
Reference (s)	MODU 2.0 – Sustainable Mobility Strategy (MDDI, 2018)	
Info complementary	https://transports.public.lu/fr/contexte/strategie/modu2.html/	

Title of the measure	No 403 MMUST and MOBIMPACT	
Description:	Funded under the Interreg V A Greater Region programme, the MMUST project (Multimodal Model and Cross-Border Mobility Scenarios) aims to develop a tool to support decision making and evaluation of transport policies for cross-border mobility at the heart of the Greater Region. MMUST can assess the effect of infrastructure and other measures such as teleworking or urban development measures on mobility flows by distinguishing between different modes. The MOBIMPACT tool adds an additional evaluation layer, taking into account the external costs and benefits of a project evaluated by MMUST.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2018	n.a.	continuous implementation
Responsible entity/entities	MMTP	
Reference (s)		
Info complementary	https://www.mmust.eu/	

Title of the measure	No 404 Promotion of active mobility	
Description:	The national cycle network is planned and built by the MMTP and will be extended from 650 km to 1.100 km. Extensions of communal networks may be subsidised at 30 % if they constitute a connection to the national network. The MMTP provides planning aid (veloplange.lu) to municipalities and consultancies and provides technical support to the municipalities. The number of secure bicycle parking areas will be gradually increased in the coming years. In order to improve orientation, all national cycle paths will be equipped with signage.	
Type of Instrument	Planning, Budget	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2015	2035	continuous implementation
Responsible entity/entities	MMTP	
Reference (s)		
Info complementary	https://veloplangen.lu/	

Title of the measure	No 405 Promotion of public transport	
Description:	Between 2018 and 2027, the State will invest EUR 3,9 billion in the development of railway infrastructure. Capacity will be substantially increased (MNP 2035). Furthermore, the strengthening of direct rail connections and the creation of new links to cities in neighbouring countries are being planned in partnership with the authorities of the neighbouring countries. The extension of the tram network in the City of Luxembourg continues. The RGTR bus network is regularly optimised. The bus network in the canton of Esch-sur- Alzette will be reorganised with the arrival of the fast tram on a new trading hub in the south of the country. Buses will be prioritised on three high service corridors until 2035 (MNP 2035). The exchange of information between the different modes of transport will be improved in order to provide a better quality of service. Since March 2020, public transport has been free of charge in Luxembourg. An extension of free travel over a radius of 5 km around the borders is being analysed.	
Type of Instrument	Planning, Budget	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2018	2035	continuous implementation
Responsible entity/entities	MMTP	
Reference (s)		
Info complementary		

Title of the measure	No 406 Promotion of innovative mobility services	
Description:	To make carpooling more attractive, carpooling will be implemented on certain motorways in the country (A1, A3, A4 and A6) (MNP 2035). Carsharing will be further promoted as a way to reduce the number of individual cars parked in neighbourhoods.	
Type of Instrument	Planning, Information	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2022	2035	
Responsible entity/entities	MMTP	
Reference (s)		
Info complementary		

Title of the measure	No 407 Mobility awareness, information and advisory services	
Description:	MMTP offers mobility plans undertaken. It is a tool to help companies to better organise the mobility of their employees. Municipalities may request technical support and co-financing of municipal mobility studies. Mobility.lu (Mobilitéitszentral) is continuously improved to provide better access to public transport. The MECO is committed to applying the principles of circularity and sustainability through smart management of economic activity areas coupled with the implementation of quality services and infrastructure. A co-creative process is being developed to involve the various key players in order to ensure a wide uptake of these new solutions. In the field of mobility, coherent planning with national objectives and the integration of new concepts into its implementation will improve the quality of the offer, thereby encouraging users to test new services and adopt new habits, e.g. by increasing the use of innovative and smart mobility solutions – while helping to increase the attractiveness of sites.	
Type of Instrument	Information, Planning	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
		continuous implementation
Responsible entity/entities	MMTP, MECO, Other (s)	
Reference (s)		
Info complementary	https://www.mobiliteit.lu/fr/	

Title of the measure	No 408 Establishing a framework for teleworking	
Description:	As the progressive digitalisation of work makes it easier to decouple work from the workplace, teleworking is becoming a good practice to accompany a society in transition, strengthening the resilience of the economy and having the potential to significantly reduce mobility needs and all associated nuisances. Remote working, including videoconferencing, makes it possible to reduce commuting and business travel both inside and outside the country. To facilitate teleworking for all employees in Luxembourg, a legislative framework has been created to define the framework conditions and arrangements for teleworking. In addition, some arrangements have been made to organise teleworking in the public service. In order to consolidate the legal basis, the Ministry of Civil Service has prepared a draft law accompanied by a Grand-Ducal Regulation which is currently in the legislative procedure. In the field of taxation, it is the double taxation conventions ("tax treaties") which Luxembourg has concluded with its three neighbouring countries which determine the rules concerning the right of taxation of the Contracting States. The three tax treaties provide for tolerance thresholds, i.e. a certain number of days per fiscal year, concerning the right to tax for cross-border workers. These tolerance thresholds are also used by cross-border workers in order to be able to telework without being taxed in their State of residence. The respective tolerance thresholds are currently 34 days for tax treaties with Belgium and France. The forecast for Germany is still 19 days, but will increase to 34 days as of 2024. As regards social security, a framework agreement has been reached at European level. This allows for less than 50 % teleworking time (instead of the usual 25 %) for employees in the countries of employment and residence who are signatories to the Framework Agreement which will apply on[1] July 2023. Luxembourg signed the agreement on 5 June 2023, as did Germany (17 May 2023) and Belgium (6 June 2023). France has not yet taken a position on the signing of this framework agreement.	
Type of Instrument	Regulations/bi-/multilateral agreements or conventions	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
		Continuous implementation
Responsible entity/entities	MTEESS, MFIN, MSS, MFP, MEA	
Reference (s)	Law of 1 April 2022 amending Articles L. 414-3 and L. 414-9 of the Labour Code. Agreement of 20 October 2020 on the legal regime of teleworking	

Framework agreement teleworking on social security

Info complementary	Work: Law of 1 April 2022 amending Articles L. 414-3 and L. 414-9 of the Labour Code: https://legilux.public.lu/eli/etat/leg/loi/2022/04/01/a172/jo; Agreement of 20 October 2020 on the legal regime of teleworking: https://itm.public.lu/dam-assets/fr/publications/conventions- groups/codicille/cct-teletravail.pdf Social security: Official website of the teleworking framework agreement on social security: https://socialsecurity.belgium.be/fr/activites-internationales/teletravail- Turkeer-ds-lue-lee-et-Swiss; Signature of the teleworking framework agreement on social security: https://mss.gouvernement.lu/fr/actualites.gouvernement%2Bfr%2Bactualites%2Btoutes_actualites% 2Bcommuniques% 2B2023 % 2B06-June% 2B06-haagen-accord-telelab-frontières s.html; Information on the implementation of the Framework Agreement: https://mss.gouvernement.lu/fr/actualites.gouvernement%2Bfr%2Bactualites%2Btoutes_actualites% 2Bcommuniques% 2B2023 % 2B06-June% 2B20-declaration-telework. html

Title of the measure	No 409 Restriction of the need for mobility – promotion of co-working areas	
Description:	Between 2017 and 2019, the Department of Spatial Planning (dater) set up the inter-ministerial working group on limiting the need for mobility in order to develop one of the strategic recommendations of the study The Third Industrial Revolution Strategy in the field of mobility. The working group focused its reflections on how to establish co-working spaces-close to borders and multimodal hubs in order to significantly reduce cross-border commuting on a daily basis. Thus, in addition to the Belval site as a short-term pilot project, the list of potential sites included in October 2019 Rodange (station), Mertert, Bettembourg (station), ZAE Grass, Frisange and Nordstad. In particular, the latter site has potential for the devolution of public administrations. In view of the increase in co-working spaces by private actors without State intervention and/or contribution, and while knowing that the State cannot oppose market initiatives, the WG proposed several roles that the State could have in promoting such spaces. These approaches include, inter alia, launching a survey of public service staff on daily journeys and their preferences between teleworking at home and working in a co-working space, and the possibility of creating a co-development area on a border in which Luxembourg's tax system applies. Another proposal is to systematically take into account the possibility of creating co-working spacesin the context of discussions on the devolution of State administrations in agglomerations outside the City of Luxembourg, concerning the need for offices at State level and at the level of planning and refurbishment of stations located close to the borders.	
Type of Instrument		
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities		
Reference (s)		
Info complementary		

Title of the measure	No 410 Promotion of electrification of Luxembourg registered car fleet	
Description:	To speed up the electrification of the car fleet in Luxembourg, a set of measures has been introduced, such as: - the establishment and operation of the basic public load infrastructure Chargy by system operators; - the promotion of the network of private charging points through financial support and the introduction of minimum requirements in the context of regulating the energy performance of buildings; - the introduction of an aid scheme for companies investing in public or private infrastructure, either by means of a call for projects or by simple application (only SMEs); - the introduction of financial aid for electric vehicles (cars and vans); - extensive electrification of public vehicle fleets; - the introduction of complementary promotion measures such as the Stroum beweegt initiative; - supporting municipalities with regard to the establishment of a charging infrastructure; - the extension of the Klima-Agency advisory service; - adaptation of the highway code to allow the driving of non-thermal N1 vehicles exceeding 3.500 kg (but not exceeding 4.250 kg) with the category B licence; - and the authorisation at Benelux level to exceed the maximum authorised mass of zero-emission commercial vehicles and motor cars to compensate for the additional weight of batteries.	
Type of Instrument	Regulatory, economic, fiscal, voluntary agreement, information, planning	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
		continuous implementation
Responsible entity/entities	MMTP, MEA, MECDD, MECO, Klima-Agence	
Reference (s)		
Info complementary		

Title of the measure	No 411 Implementation of a public charge infrastructure	
Description:	In order to anticipate the needs of electro-mobility, the government organised in 2015 the deployment of a single national infrastructure of 800 public charging stations. This network called Chargy is managed by the network managers who install charging points on the 'P + R' relay car parks, public car parks and public roads (at least one per municipality). Following developments in the deployment of electro-mobility, 88 terminals have been converted into ultra-fast SuperChargy terminals with a load power of between 150 kW and 350 kW, which are spread over 19 stations. This measure ends with the installation of these 800 terminals and is complemented by the aid scheme for companies investing in charging infrastructure.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2016	2023	
Responsible entity/entities	MMTP, MEA	
Reference (s)	Amended Grand-Ducal Regulation of 3 December 2015 on public infrastructure related to electric mobility	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2015/12/03/n2/jo	

Title of the measure	No 412 Electrification of the fleet of contracting authorities and contracting entities (State, municipalities, municipal associations, etc.)	
Description:	Contracting authorities and contracting entities shall, when procuring certain road vehicles through public procurement, take into account the life cycle energy and environmental impacts of those vehicles, including energy consumption and emissions of CO and certain pollutants, in order to promote and stimulate the market for clean and energy-efficient vehicles. For each contracting authority or contracting entity, a minimum percentage of clean vehicles in all the vehicles tendered for must be obtained during reference periods of five years. These minimum targets are applicable to different modes of public procurement, including purchase, leasing, rental and service contracts.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	n.a.	
Responsible entity/entities	MMTP, MINT	
Reference (s)	Grand-Ducal Regulation of 2 November 2021 on the promotion of clean road vehicles in support of low-emission mobility	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2021/11/02/a772/jo	

Title of the measure	No 413 Electrification of the state car fleet	
Description:	Since 2018, the purchase of rechargeable electric cars (BEV or, where applicable, PHEV) has been prescribed for state services. The purchase of cars with a combustion engine is only allowed in very exceptional cases or for specific vehicles on the basis of a detailed justification. BEV and PHEV cars are purchased centrally under the responsibility of the Ministry of Mobility and Public Works.	
Type of Instrument	Voluntary agreement	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2018	n.a.	
Responsible entity/entities	MFIN, MMTP, MECDD	
Reference (s)	Budget circular on the acquisition of vehicles	
Info complementary		

Title of the measure	No 414 Full electrification of the RGTR bus network until 2030	
Description:	The General Road Transport Scheme (RGTR) has set itself the objective of electrifying (BEV, PHEV or FCEV) until 2030 all buses and coaches in its fleet. In the public contract launched in 2020 50 % of kilometres, electric vehicles will be used. It should be noted that Directive (EU) 2019/1161 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles sets for Luxembourg a rate of 45 % of clean buses in invitations to tender between 2021 and 2026 and a rate of 65 % between 2026 and 2030. In view of the initiatives already undertaken by the various operators and the objectives announced by them, the first steps are being taken in order to achieve the objectives set by the Directive.	
Type of Instrument	Other	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	2030	
Responsible entity/entities	MMTP	
Reference (s)		
Info complementary		

Title of the measure	No 415 Obligation to incorporate sustainable biofuels into road fuels
Description:	The amended Law of 17 December 2010 laying down excise duties and similar taxes on energy products sets the rate of incorporation of biofuels into road fuels, expressed on the basis of the energy content of the fuels. This rate is normally adjusted annually by means of the budget law. For 2022 and 2023, due to the energy crisis, it is set at 8.00 %, with the article of the Act stipulating that: "Operators discharging petrol and road diesel for consumption must demonstrate the use of biofuels, within the meaning of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, which comply with the sustainability criteria set out therein, at a rate of at least 8.00 %, calculated on the basis of the energy content of the fuels. Renewable electricity released for consumption for electric mobility by operators at their service stations may be counted in accordance with the provisions of Directive (EU) 2018/2001. The share of energy from biofuels produced from cereal and other starch rich crops, sugars and oil crops, and from crops grown as main crops primarily for energy purposes on agricultural land, shall not exceed 5 % of the biofuels released for consumption, calculated on the basis of the energy content of the fuels." From 31 December 2023 and until 31 December 2030 at the latest, the limit of high indirect land-use change-risk biofuels, bioliquids and biomass fuels for which the production area grows significantly on land with high carbon stock shall gradually decrease to 0 % by the end of 2030. The contribution of advanced biofuels and biogas produced from feedstock listed in Part A of Annex IX to Directive 2018/2001 as a share of final energy consumption in transport shall be at least 0.2 % in 2022 and at least 1 % in 2025 and at least 3.5 % in 2030. The decarbonisation of the transport sector plays a key role in reducing greenhouse gas emissions by 2030 and towards full decarbonisation by 2050. Luxembourg targets by now for the transport sector a share of renewable energy of at least 25 %, based on the initial NECP scenario, which takes into account multipliers for electro-mobility and 'double-counting' biofuels, on the one hand, thanks to the incorporation of biofuels that remain necessary until the complete replacement of the thermal engine. It should be noted that already in the integrated national energy and climate plan, the ambition was well above the 14 % set out in the recast Directive on the promotion of the use of energy from renewable sources. Finally, Luxembourg has also introduced a limit of 5 % for the use of first generation biofuels to promote the use of second-generation biofuels considered more sustainable. In addition to biofuels, the supply of renewable electricity in the transport sector is a major asset and all azimut efforts point to a considerable increase in the percentage of electric cars in the car fleet to XX% by 2030. The transport sector remains a major consumer of energy, so reducing fossil fuel consumption is essential to meet the various objectives.

	for the share of renewable energy and the reduction of greenhouse gas emissions. Alongside biofuels and electrification, renewable hydrogen will play an important role for transport that is not suitable for electrification. More details can be found on the hydrogen strategy. Measures to decarbonise the transport sector are manifold and it will not be enough to replace one energy carrier with another, but also through measures to reduce the use of individual transport by continuing to promote soft mobility and public transport.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2022	2050	adjustment of the blend rate from year to year
Responsible entity/entities	MEA, MFIN	
Reference (s)	Amended Law of 17 December 2010 laying down excise duties and similar taxes on energy products, electricity, manufactured tobacco products, alcohol and alcoholic beverages	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2010/12/17/n2/jo	

Title of the measure	No 416 Biomethane in the transport sector	
Description:	Analysis and study of the technical-economic aspects of the use of biomethane in the transport sector, in particular the need for financing for small-scale use, for example tractors in agriculture and, on a larger scale, in the field of passenger and freight transport companies to decarbonise transport vehicles which are currently difficult to decarbonise.	
Type of Instrument	Planning	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2022	2023	
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No. 417 Sustainable aviation fuels at national airport	
Description:	The FF55 ReFuelEU Aviation initiative proposes that in 2025/30/35/40/45/50 all EU airports with more than one million passengers or 100.000 tonnes of freight will be obliged to include in their total fuel consumption at least 2 %/6 %/20 %/32 %/38 %/63 %/of SAF (Sustainable Aviation Fuels), of which a share of 0 %/0.7 %/5 %/8 %/11 %/28 % is made up of synthetic fuels.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2025	2050	
Responsible entity/entities	MMTP, Luxembourg Airport Company	
Reference (s)		
Info complementary		

Title of the measure	No 418 Alternative Fuels Infrastructure Deployment	
Description:	The National Policy Framework for Alternative Fuels Market Development and the Deployment of the Alternative Fuels Infrastructure (version 2019, published in January 2020), adopted pursuant to Directive 2014/94/EU on the deployment of alternative fuels infrastructure, contains a state of play of the market for alternative fuels in Luxembourg, quantified targets for the deployment of publicly accessible infrastructure, and measures to achieve these objectives. Under FF55, it is proposed to replace the Directive by a Regulation (EU) on the deployment of alternative fuels infrastructure, including binding targets for the deployment of infrastructure. One of the objectives is the establishment of a first hydrogen service station for hydrogen-powered light-duty and heavy-duty vehicles.	
Type of Instrument	Planning	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2022	n.a.	continuous implementation
Responsible entity/entities	MMTP, MEA	
Reference (s)		
Info complementary		

Title of the measure	No 419 Tax on road vehicles	
Description:	Since 1 January 2007 CO_2 emissions have been taken into account in the calculation of the road vehicle tax. For vehicles registered from 1 January 2001 onwards, the calculation shall be based on the CO_2 emissions (NEDC value, combined value) and the fuel used. For vehicles registered for the first time from 1 January 2021, the calculation shall be based on the WLTP value of CO_2 emissions (combined value) and the fuel used.	
Type of Instrument	Taxation	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2007	n.a.	amendment of the law in December 2020
Responsible entity/entities	MFIN, MMTP, MECDD	
Reference (s)	Amended law of 22 December 2006 promoting retention in employment and laying down special measures in the field of social security and environmental policy	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2020/12/15/a1001/jo	

Title of the measure	No 420 Revised registration tax on road vehicles	
Description:	Currently, in Luxembourg, vehicle registration tax is only used to finance the administrative task of registration by SNCA. Several Member States, including France and Sweden, apply a first registration tax which depends on the CO_2 emissions of the vehicle and which can be negative or positive. Experience shows that this system is successful in strongly incentivising the registration of new zero-emission cars, while remaining budget neutral. The advisability of revising the registration system on the basis of existing schemes in other Member States, with a view to possible implementation from 2025, will be considered. By making CO2 zero-emission vehicles$_{more}$ attractive compared to vehicles powered by combustion engines, such a fiscal instrument could further accelerate the transition to zero-rolling CO_2 vehicles before the entry into force in 2035 of the ban on the placing on the market of new fossil fuelled vehicles in the EU. In order to ensure the long-term fiscal sustainability of the system, when electrification of the car fleet is more advanced, consideration should be given to selective taxation of electric vehicles taking into account environmental and social criteria.	
Type of Instrument	Taxation	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2025	n.a.	
Responsible entity/entities	MFIN, MMTP, MECDD	
Reference (s)		
Info complementary		

Title of the measure	No 421 Tax advantage for official cars	
Description:	For any new leasing contract entered into since 1 January 2017, the benefit in kind is calculated on the basis of the type of motor (petrol, diesel, electric) and the CO_2 emissions of the official car. It is staggered so that low CO_2 (BEV or PHEV) cars are favoured over petrol or diesel cars. Zero rolling emission cars (BEV and FECV) benefit from a very advantageous rate. Diesel cars are penalised compared to other engines. For any car registered since 1 January 2021, the benefit in kind is also calculated on the basis of WLTP values (instead of NEDC values). From 2023, the rate will be increased by + 0.2 % for the majority of categories of cars with CO_2 emissions exceeding 80 g/km. For cars with CO_2 emissions of 80 g/km or less, there will be no adjustment to the rates currently applicable. The maximum rate of 1.8 % will apply to cars with CO_2 emissions above 130 g/km (currently 150 g/km). For official cars newly registered as of 1 January 2025 and for which no contract will be signed before 31 December 2024, the flat-rate scheme will be simplified and particularly favourable to CO2 zero-emission$_{cars}$.	
Type of Instrument	Taxation	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2017	n.a.	amendment of the rules in May 2022
Responsible entity/entities	MFIN, MMTP	
Reference (s)	Amended Grand-Ducal Regulation of 23 December 2016 implementing Article 104 (3) of the amended Law of 4 December 1967 on income tax	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2022/05/12/a256/jo	

Title of the measure	No 422 Leasing social car	
Description:	The 100 % electric car is now an effective and well-tested instrument to reduce the carbon footprint of individual motorised mobility. The supply of pure electric car models continues to grow, but the difference in the purchase price of such a vehicle compared to a thermal car remains significant. Even if existing aid schemes of up to EUR 8,000 are partially successful in bridging this difference, a large number of disadvantaged households are not able to buy a 100 % electric car. In order to facilitate the financing of such a vehicle for the most disadvantaged households, a social leasing system for long-term leasing contracts will be studied. Leaving no one behind in the transition to cleaner mobility is essential in order to achieve the collective environmental challenge facing society. This social measure is consistent with the measures of the 2035 National Mobility Plan, which provides, on the one hand, for a modal shift towards modes of transport other than private cars, such as public transport, active mobility or car sharing, but nevertheless recognises the role of the car, especially in rural areas for medium- and long-distance journeys. The primary objective of social car leasing would be to give disadvantaged households the possibility of replacing their thermal motor car against a zero CO-rolling car and thus be able to contribute to the electrification of the car fleet and the reduction of the carbon footprint of the transport sector. It is first proposed that a study be carried out involving all stakeholders, in particular social welfare offices and leasing companies, with a view to identifying the potential, modalities and opportunities of introducing such a social car leasing scheme, while taking account of the possibilities offered by car sharing.	
Type of Instrument	ØEconomy	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MMTP, MFAMIGR, MECDD, MFIN	
Reference (s)		
Info complementary		

Title of the measure	No 423 Aid scheme for zero-emission vehicles of CO_2	
Description:	To accelerate the transition to zero-emission mobility, a maximum premium of EUR 8.000 is proposed for zero-emission vehicles of CO_2, including 100 % electric cars (EVB), hydrogen fuel cell cars (FCEV) and 100 % electric vans and hydrogen fuel cell vans. This premium may vary depending on the energy consumption, power and size of the vehicle in question. The current regime applies to orders placed until 31.03.24. In addition, financial support is available for cycles (conventional and pedelec25) and light vehicles (motorcycles, quadricycle and mopeds) 100 %, applicable to bicycles, for all invoices up to 31.3.2024.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2019	2024	extended aid scheme with several amendments
Responsible entity/entities	MECDD, MMTP, MEA	
Reference (s)	Amended Grand-Ducal Regulation of 7 March 2019 introducing financial aid for the promotion of zero- and low-CO2 road vehicles	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2019/03/07/a183/jo	

Title of the measure	No 424 Aid scheme for the installation of private charging points for electric vehicles	
Description:	To support the deployment of electro-mobility and promote home loading, financial assistance for the installation of charging points in single-family houses and residences was introduced in 2020. This measure supports the installation of single terminals, 'smart' terminals and intelligent charging systems in multi-family buildings. An extension of the programme was adopted by the government and entered into force in 2023. This extension will also provide adaptations, in particular to facilitate the installation of centralised solutions in the co-properties.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2020	2023	
Responsible entity/entities	MEA, MECDD, MMTP	
Reference (s)	Grand-Ducal Regulation of 19 August 2020 introducing financial aid for the installation of private charging points for electric vehicles	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2020/08/19/a702/jo	

Title of the measure	No 425 Aid scheme for undertakings investing in charging infrastructure for electric vehicles	
Description:	To complement the public utility network and support the transition of vehicle fleets in companies, an aid scheme offering three financial support measures for companies has been introduced: - aid awarded following a competitive tender (call for projects) for companies investing in publicly accessible charging infrastructure or private charging infrastructure of a certain size (175 kW); - aid for small and medium-sized enterprises investing in private load infrastructure dedicated to their economic activities. - support to owners of the public utility infrastructure (Chargy and SuperChargy). It should be noted that an important eligibility condition for public terminals is their supply from 100 % renewable sources.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2022		
Responsible entity/entities	MEA, MECO	
Reference (s)	Law of 26 July 2022 on the aid scheme for undertakings investing in charging infrastructure for electric vehicles	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2022/07/26/a395/jo	

Title of the measure	No 426 Aid scheme for the acquisition of zero-emission heavy-duty vehicles	
Description:	Following the tripartite agreement reached on 31 March 2022, the government introduced in April 2023 new support for companies investing in zero-emission heavy-duty vehicles (N2 and N3). To this end, a comparative study of the different alternative propulsion technologies was launched in autumn 2022. This study allowed the government to take an informed decision on the choice of the most suitable propulsion technology to stimulate the decarbonisation of the logistics sector in Luxembourg. The aid scheme was introduced by setting up a temporary measure in the form of a pilot project, on the basis of the amended Law of 15 December 2017 on an aid scheme for environmental protection. Medium weight and heavy-duty trucks equipped with zero greenhouse gas emission engines, such as pure electric vehicles and hydrogen fuel cell vehicles, are eligible for this support. In addition, vehicles equipped with an internal combustion engine with CO2 emissions of less than 1 g/kWh are also eligible, as well as solutions for converting existing thermal vehicles into zero-rolling vehicles. The pilot project is in place for a transitional period for the revision of State aid rules at European level. The aim is to further encourage companies to invest in zero-greenhouse gas emission technologies to reduce the environmental impact of their road freight transport activities. It should be noted that vans (category N1) are already eligible under the existing aid scheme for zero-emission vehicles (amended Grand-Ducal Regulation of 7 March 2019).	
Type of Instrument	ØEconomy	
State of progress	Implementation	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MECO, MECDD, MEA, MMTP, MFIN	
Reference (s)	My Gude: Aid for zero-emission vehicles	
Info complementary	https://guichet.public.lu/fr/entreprises/financement-aides/aides-environment/vehicules-zero-emission/aide-vehicules-zero-emission.html	

Title of the measure	No 427 Decarbonisation strategy for freight transport and logistics	
Description:	The Working Group on Logistics and Energy Transition will establish a strategy for the decarbonisation of the logistics sector, framed in a European context. It will draw up an inventory of the characteristics of the logistics sector in Luxembourg. It will assess the importance of different sub-sectors (such as the "last mile delivery" in Luxembourg and the Greater Region, the inward and outward flows of dedicated infrastructure and areas of activity and the use of combined rail-road transport) and the distances travelled by the different sub-sectors. It will develop an initial assessment of the different options for a zero carbon strategy (biofuels, electric or renewable hydrogen motorisation, IT/AI optimisation) and infrastructure needs (e.g. electric chargers for HGVs respectively) and, where appropriate, policy instruments facilitating the shift towards a zero-carbon logistics sector. In view of the Tripartite Agreement of March 2022, it was decided to implement an aid scheme for the acquisition of clean heavy-duty vehicles (see measure 426).	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MMTP, MEA, MECO, MECDD, MFIN	
Reference (s)		
Info complementary		

Title of the measure	No 428 Eurovignette	
Description:	The amended Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures provides that all transport vehicles will be taxed on the basis of their rolling pollution rate, but also on the basis of the number of kilometres made within the EU and no longer over the duration of the journey. In addition, zero and low rolling emission engines are planned to be preferred. Transposition of this new Eurovignette Directive in Luxembourg.	
Type of Instrument	Taxation	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MMTP	
Reference (s)		
Info complementary		

Title of the measure	No 429 Facilitating the installation of charging stations	
Description:	A large number of initiatives have already been taken to develop a charging infrastructure that meets the needs of existing and future users, such as the establishment of a public charging infrastructure (Chargy and SuperChargy), different support schemes for the installation of terminals, or the Stroum beweegt initiative. In order to further accelerate the development of the necessary charging infrastructure, particularly in areas of activity, buildings in co-ownership, residences or on construction sites, this measure will first identify and analyse existing obstacles. Secondly, the corresponding measures will be devised to remove these obstacles and to facilitate the installation of terminals for these cases.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 430 Motorised Traffic Speed Reductions
Description:	Speed reductions in motorised traffic have proved their worth, both from the point of view of road safety and noise and emissions of fine and greenhouse particulate matter. While, at peak times, road congestion has the effect of reducing the actual speed below the maximum authorised speeds, these, combined with road space adjustments and police checks, have a definite effect on speeds in uncongested situations. On the motorway network, a limit of 90 km/h is already in place in tunnels. On certain sections of the A6 motorway, a limitation of 90 km/h at peak times has had a beneficial effect on road safety and traffic fluidity. This practice, which is widespread on peri-urban motorways, which are characterised not only by high traffic loads but also by the very low distance between exchangers and the sensitivity of residents to noise pollution, should be tested in other sectors of the motorway network, in particular the bypass of the city of Luxembourg. As a general rule, speed limits must be understandable to drivers and must be capable of being controlled by law enforcement forces, otherwise they do not have the desired result. These principles, which are preferable to generalised speed limits, apply both outside and in urban areas. In urban areas, the vast majority of roads in the Grand Duchy are already limited to 30 km/h, or even occasionally to 20 km/h. These are mainly communal roads in residential areas, which are not intended to carry transit traffic. Since 2015, restrictions of 30 km/h have also been allowed on sections of state roads in localities. However, it is essential that these sections, like all the areas known to be de-escalated, should be adapted accordingly by the municipality. In these areas, the driver of a motor vehicle should have the impression of being only a visitor in an urban area which is primarily intended for neighbourhood or locality life. Physical adjustments of the road, including shrinkage or elevations, force the driver to reduce his speed. The classification of the road network, as recommended by the 2035 National Mobility Plan, distinguishes between roads which are intended to carry significant traffic loads (so-called connecting roads), those with very low transit traffic and mainly local roads (so-called distribution roads) and those serving only the local service of the district itself. On the first, generally state, limits of 30 km/h remain possible on sections of some 200 metres at centre or school level. At the request of the municipalities and on condition that they restructure them accordingly, the State distribution routes can be cleaned up on much longer sections. Finally, the local service streets are generally already eased. With this pragmatic approach, which is not limited to reducing the speeds displayed on traffic signs, but aims to reduce the speeds actually operated by drivers, the government contributes to road safety and the limitation of greenhouse gases linked to excessive speeds of thermal motor vehicles.

Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MMTP	
Reference (s)		
Info complementary		

Title of the measure	No 431 Scheme for greenhouse gas emission allowance trading (ETS) – aviation	
Description:	The amended Climate Law of 15 December 2020 transposes into national law the amended Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the European Union (ETS/ETS). The ETS currently applies to power generation installations, manufacturing installations and aviation (intra-European flights). It should be noted that at the end of 2022 an agreement was reached between the co-legislators on the reform of the ETS rules applicable to the aviation sector. Emission allowances will be fully auctioned from 2026 onwards. The ETS will apply to intra-European flights, while CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) will apply to extra-European flights to and from third countries participating in CORSIA from 2022 to 2027. When emissions from flights outside Europe reach levels above 85 % of 2019 levels, they will have to be offset by corresponding carbon credits.	
Type of Instrument	Regulatory	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2005	2030	Directive as amended several times; Agreement reached at the end of 2022 between the co-legislators for a new reform
Responsible entity/entities	MECDD, EVA	
Reference (s)	Amended Climate Law of 15 December 2020	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2020/12/15/a994/jo	

3.1.1.4 Industry

The decarbonisation of Luxembourg's industry goes hand in hand with maintaining the competitiveness of companies in this sector in the long term. In this context, it is important to see Luxembourg companies in the face of their overall competition in Europe and outside Europe.

Decarbonisation, energy efficiency and renewable energy are taken into account in a complementary way and are all important.

Given the exceptional efforts needed in the context of decarbonisation, State aid will be essential and the more conventional investment aid (CAPEX) will be supplemented in the future by operating aid (OPEX) in line with the European State aid guidelines (measures Nos 512 to 519).

The voluntary agreement on improving energy efficiency in Luxembourg's industry (measure No 503) is an important tool for the major players in the sector (around fifty companies) and has proved its worth for many years with a focus on energy efficiency; this agreement is currently being revised (measure 504) and will henceforth focus on decarbonisation, energy efficiency and the production and use of renewable energy.

Companies that are not targeted by the voluntary agreement, in particular SMEs, are targeted more specifically by the New Business Climate Pact (No 511), Luxinnovation's FIT4X programmes (No 513) and the SME Packages Sustainability (No 514) with the aim of coordinated consultation and implementation of projects and activities of different actors and the management of certain new programmes in support of the common objective of climate protection and energy transition by businesses. The Climate for Business Pact provides for a voluntary commitment of companies to monitor their decarbonisation and energy transition efforts in the long term.

Title of the measure	No 501 greenhouse gas emission allowance trading scheme (ETS/ETS)	
Description:	The amended Climate Law of 15 December 2020 transposes into national law the amended Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the European Union (ETS/ETS). The ETS currently applies to power generation installations, manufacturing installations and aviation (intra-European flights). The current target is to reduce greenhouse gas emissions under the scope by 43 % by 2030 compared to 2005 at EU level. It should be noted that at the end of 2022 an agreement was reached between the co-legislators on the reform of the ETS. The two main aspects of the reform are the increase of the reduction target from 43 % to 62 % and the inclusion of new sectors, including road transport and buildings, in a dedicated 'second ETS' from 2027 onwards. The introduction of a carbon border adjustment mechanism will prevent the risk of carbon leakage.	
Type of Instrument	Regulatory	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2005	2030	Directive as amended several times; Agreement reached at the end of 2022 between the co-legislators for a new reform
Responsible entity/entities	MECDD, EVA	
Reference (s)	Amended Climate Law of 15 December 2020	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2020/12/15/a994/jo	

Title of the measure	No 502 Aid scheme to compensate for the additional costs associated with the ETS system for the period 2021-2030	
Description:	The aid scheme, which forms part of the European Union's greenhouse gas trading scheme, helps to cover part of the indirect emission costs incurred in the financial years 2021 to 2030 by companies exposed to a genuine risk of carbon leakage, thus helping to combat global warming while preserving the competitiveness of European industry. It is thus fully in line with the European Green Deal, which sets a target of a 55 % reduction in greenhouse gas emissions by 2030, and the new EU industrial strategy that aims to decarbonise all its sectors of the economy, in particular energy-intensive ones. In return, companies must undergo an energy audit as provided for in the amended Law of 5 August 1993 on the rational use of energy and implement measures to reduce their carbon footprint if they do not qualify as small and medium-sized enterprises. The aid is targeted at undertakings that carry out an industrial activity on the territory of Luxembourg, in sectors and subsectors deemed to be exposed to a significant risk of carbon leakage due to the costs of the EU greenhouse gas emission allowance trading scheme, reflected in electricity prices.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	2030	
Responsible entity/entities	MECO	
Reference (s)	Law of 15 July 2022 establishing an aid scheme in the context of the greenhouse gas emission allowance trading scheme for the period 2021-2030	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2022/07/15/a356/jo	

Title of the measure	No 503 Voluntary agreement on improving energy efficiency in industry (up to and including 2023)	
Description:	In 2021, the government concluded an agreement with the Luxembourg Industry Federation (Fedil) committing the member companies to reach the common target of 4.5 % improvement in overall energy efficiency of all participants until the end of 2023. Since 1996, this agreement has been regularly renewed to strengthen the commitment of the various members. Under this agreement, the member undertakings undertake to implement a number of measures, including the establishment of energy management, the carrying out of an energy audit, continuous training, etc. In return, the government proposes advantages, in particular in the context of the European Directive on the taxation of energy products and electricity. Around 50 energy-intensive enterprises from the industrial and tertiary sectors are involved in the current period.	
Type of Instrument	Voluntary agreement	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	2023	renewal of the agreement several times since 1996
Responsible entity/entities	MEA, MECDD, Fedil, Klima-Agency	
Reference (s)	Amended GDR of 31 March 2010 on the compensation mechanism in the context of the electricity market design	
Info complementary	https://www.klima-agence.lu/fr/accord-volontaire-fedil	

Title of the measure	N° 504 Voluntary Agreement on Decarbonisation and Improving Energy Efficiency in Industry (from 2024)	
Description:	The Voluntary Agreement (VA) with industry will be revised and renewed for the period 2024-2030. The scope will be extended to include the decarbonisation dimension as a complement to energy efficiency. For example, companies will have to commit to a combined objective of reducing their greenhouse gas emissions, improving their energy efficiency and producing or even self-consuming renewable energy. The revision of the AV will be based on a legal analysis of the possibilities for advantages granted to companies that adhere to the AV (and comply with their commitments) under European state aid rules. In this context, the adaptation of the existing CO_2 tax with a view to introducing a progressive CO_2 tax for companies that are members of the voluntary agreement will be analysed, in order to increase the incentive for these companies to invest in decarbonisation projects.	
Type of Instrument	Voluntary agreement	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2024	2030	
Responsible entity/entities	MEA, MECDD, MECO, Fedil, Klima-Agency	
Reference (s)	Amended GDR of 31 March 2010 on the compensation mechanism in the context of the electricity market design	
Info complementary		

Title of the measure	No 505 Energy audits mandatory for companies	
Description:	On the basis of Article 8 of the European Energy Efficiency Directive EED UE/2012/27, an obligation to carry out an energy audit every 4 years was introduced for large companies (non-SMEs) already in 2015. The idea of this obligation is to make companies aware of energy saving potentials, identifying specific potentials for improving energy efficiency in the company. Undertakings are encouraged to implement the measures thus identified, to the extent that they are profitable, in particular through the "energy efficiency" aid proposed by the Ministry of the Economy in the context of investment aid for environmental protection and, where appropriate, financial and non-financial incentives offered by the obligated parties under the energy efficiency obligation scheme. The first deadline for such an audit was 10 December 2016. Energy audits are to be carried out exclusively by persons approved by the Minister responsible for energy and must: - be based on up-to-date, measured and traceable operational data on energy consumption and, for electricity, load profiles; - include a detailed examination of the energy consumption profile of buildings or groups of buildings, as well as of industrial operations or installations, including transport; - use, as far as possible, life-cycle cost analysis rather than simple payback periods to take into account long-term savings, residual values of long-term investments and discount rates; - be proportionate and sufficiently representative to provide a reliable picture of overall energy performance and to identify the most significant potential for improvement in a secure manner.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2016	n.a.	revision planned for 2023/2024 (depending on finalisation of EED revision)
Responsible entity/entities	MEA, Klima-Agency	
Reference (s)	Law of 5 July 2016 amending the amended Law of 5 August 1993 on the rational use of energy	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2016/07/05/n2/jo	

Title of the measure	N° 506 Compulsory energy audits for enterprises (Revision EED 2023)	
Description:	The obligation to carry out an energy audit for companies meeting certain criteria will be revised on the basis of the revision of the Energy Efficiency Directive (EED) scheduled for 2023. The eligibility criterion will no longer be the classification of the enterprise on the basis of its size (SME or non-SME), but the level of annual energy consumption. If the level exceeds 10 TJ (2.78 GWh) there is an audit obligation and if it exceeds 85 TJ (23.6 GWh) there is an obligation to set up an energy management system. EPCs (Energy Performance Contracting) will be taken into account. The revision of the EED Directive requires the companies concerned to carry out a concrete action plan on the basis of the measures identified in the energy audit and to draw up a plan for the implementation of the measures in so far as they are technically and economically feasible. These plans should be published, where appropriate, in the annual report of companies and made public under certain conditions (protection of sensitive and confidential data). An obligation to carry out the measures identified in the energy audit will be introduced, depending in particular on break-even points; a calculation methodology and different conditions will be defined under this obligation, taking into account, for example, the financial aid and incentives applicable when implementing the measures. The content of the energy audit will be reviewed to include in particular the identification of the company's decarbonisation potential, in addition to the energy aspects (energy efficiency and photovoltaic power generation potential for self-consumption). In addition to this obligation, SMEs and in general all companies not obliged to carry out a regulatory audit will be encouraged to carry out energy audits under the New Business Climate Pact ("Klimapakt fir Betriber").	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2023	n.a.	implementation of the revision planned for 2023/2024 (depending on the finalisation of the EED revision) revision of national legislation in the context of the transposition of the revised EED Directive (expected in 2023)
Responsible entity/entities	MEA, MECO, Klima-Agency, Fedil	
Reference (s)	Law of 5 July 2016 amending the amended Law of 5 August 1993 on the rational use of energy	
Info complementary		

Title of the measure	No 507 Energy audit and monitoring/optimisation obligation for functional buildings with a surface area greater than 1.000 m^2	
Description:	As a logical consequence of the results observed, particularly at the level of functional buildings, in the context of the national energy saving campaign 'zesumme spueren – zesummenhalen' implemented from autumn 2022 onwards, and in order to ensure the perennity of the measures implemented in this context (and of future measures with the same objective), a monitoring and optimisation obligation is introduced for functional buildings with a surface area greater than 1.000 m^2. Targeted buildings and conditions: - the obligation applies to all owners for their functional buildings > 1.000 m^2 regardless of the status of the owner (public authority or private actor); - if a building is covered by the obligation to carry out an energy audit based on the consumption of the company (owner) (PAMs #506), this obligation also covers the obligation for buildings > 1.000 m^2; - identify potential improvements (energy efficiency, in particular in terms of optimisation of instructions (HVAC) and decarbonisation (building suitable for the implementation of a heat pump (heating output temperature less than or equal to 55 °C, separate CIE); - prioritisation of the implementation of identified measures based on feasibility and return on investment; - obligation to carry out energy efficiency measures with a return on investment (ROI) less than 5 years old (including all applicable State subsidies and private incentives for the implementation of the measures); - the rules for implementing this measure will be drawn up after consultation with the sectors concerned as regards the timetable for the entry into force of the obligation, with priority being given to administrative buildings in the service sector.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, MECO (and Self-Employed)	
Reference (s)	Law of 5 July 2016 amending the amended law of 5 August 1993 onthe rational use of energy	

Info complementary	

Title of the measure	No 508 Obligation to decarbonise through an accelerated fossil phase-out for functional buildings with a surface area greater than 1.000 m^2	
Description:	An accelerated fossil phase-out decarbonisation obligation for functional buildings with a surface area equal to or greater than 1.000 m^2 that are adapted for replacing fossil energy heating with a heat pump (PAC) based on the starting temperature of the heating system below or equal to 55 °C (separate domestic hot water (ECS) production). Targeted buildings and conditions: - additional obligation to audit/monitor PAMs #506 and #507; - the obligation applies to all owners for their functional buildings > 1.000 m^2 regardless of the status of the owner (public authority or private actor); - all functional buildings > 1.000 m^2; - obligation to replace fossil-based heating with heating with one or more heat pump (s) for any functional building that is designed/adapted to operate with a starting heating temperature below or equal to 55 °C; - the production of domestic hot water (ECS) is considered separately, the starting temperature condition of 55 °C or less applies only to the heating circuit (s) of the building; - obligation to replace fossil heating, if applicable, with a decarbonised heat pump solution within 4 years for any fossil boiler aged 5 years or older (compared to the date of commissioning of the existing boiler); - the rules for the implementation of this measure will be drawn up after consultation with the sectors concerned as regards the timetable for the entry into force of the obligation, with priority being given to administrative buildings in the service sector. Exceptionally, an obligation to renovate a building for energy purposes or a ban on replacing a fossil boiler with a new fossil energy boiler resulting from a NECP measure may be waived where the costs related to the complexity of the works, necessary for its implementation, are disproportionate to the CO2 emission $reduction_{potential}$. These exceptions will be specified in the legislation on obligations and prohibitions.	
Type of Instrument		
State of progress		
Start of implementing	End of implementation	Comments

Responsible entity/entities	MEA, MECO (and Self-Employed)
Reference (s)	
Info complementary	

Title of the measure	No 509 obligations to monitor and improve energy efficiency for data centres	
Description:	In view of the significant changes in the energy needs of the data centre sector, it is envisaged to introduce a (European) obligation to monitor energy consumption for data centres (on the basis of the revision of the EED Directive, scheduled for 2023). Obligation to provide information on consumption data (defined in the context of the revision of the EED for energy demand data centres of 500 kW or more (a delegated act of the European Commission (December 2023) will define the details of the obligation and serve as a basis for transposition into national law) Obligation to use waste heat for data centres with an energy demand of more than 1 MW under discussion at the level of the revision of the EED (Article 24). Encouraging data centres of more than 1 MW to take account of the best practices set out in the most recent version of the European Code of Conduct on Data Center Energy Efficiency. In addition to this obligation to monitor at European level on the basis of the EED and in parallel with the European Commission's analyses provided for in the revised EED (Article 11) with a view to future obligations to improve energy efficiency, Luxembourg will analyse the potential and impact of obligations at national level to improve energy efficiency in practice on the sector.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2023	n.a.	implementation of the revision planned for 2023/2024 (depending on the finalisation of the EED revision)
Responsible entity/entities	MEA, MECO	
Reference (s)		
Info complementary		

Title of the measure	N° 510 Industry Decarbonisation Roadmap	
Description:	In close cooperation with industry companies, a first version of a Luxembourg Industry Decarbonisation Roadmap is established to support manufacturing companies to decarbonise their activities, contribute to national climate and energy objectives and meet the requirements of the EU Emissions Trading System (ETS/ETS). To this end, the Roadmap identifies and assesses the levers and potential for decarbonisation in manufacturing (as currently quantifiable). Secondly, it proposes a set of policy measures to facilitate the implementation of potentials and the transformation of the industrial sector. In this respect, the annual needs for renewable electricity and hydrogen are estimated. It should be noted that the roadmap reflects the current state of play regarding projects to decarbonise manufacturing, a state which will evolve over time. This roadmap will evolve as new decarbonisation projects are identified and quantified or projects that have already been identified are updated and updated regularly over the coming years. The bottom-up approach of this roadmap (based on concrete projects) will be complemented by a top-down analysis of potentials by 2040/2050. The identification of concrete decarbonisation potentials per company and the feasibility of their implementation are also an important aspect in the context of the New Climate Pact for Business (Klimapakt fir Betriber), in particular through the Fit4Sustainability programme.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2022	n.a.	regular updating
Responsible entity/entities	MEA, MECDD, MECO, Fedil	
Reference (s)		
Info complementary		

Title of the measure	N° 511 Climate Pact for Business (SMEs) (Klimapakt fir Betriber)	
Description:	Climate Pact for Business – Supporting businesses in decarbonisation and green transition through a structured and coordinated approach. The Business Climate Pact (KPB – Klimapakt fir Betriber), specifically targeted at SMEs, is a strategic orientation platform for coordinated consultation and implementation of projects and activities of different actors, as well as for the management of certain new programmes in support of the common objective of climate protection and energy transition by businesses. It provides for a voluntary commitment of companies to monitor their decarbonisation and energy transition efforts in the long term. The KPB includes both existing and under development as well as programmes or accompanying measures still to be created as required, in line with State aid rules. The KPB provides the overview and coherence of all available services to support businesses and the economy in their decarbonisation and energy transition: advising, providing a toolkit, co-fundingsolutions and connecting key players and businesses with each other. The KPB is led by a steering committee and managed by Luxinnovation and Klima-Agency agencies. The Steering Committee is composed of MECO, MEA, MECDD, Klima-Agence, Luxinnovation, FDA, FEDIL, CdM, CdC, CLC.	
Type of Instrument	Voluntary agreement	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	2030	
Responsible entity/entities	MEA, MECDD, MECO (and Self-Employed), Klima-Agence, Luxinnovation	
Reference (s)		
Info complementary		

Title of the measure	No 512 Enterprise aid scheme – environmental protection	
Description:	The scheme supports environmental protection measures in order to incentivise companies to use natural resources rationally and to reduce the environmental footprint of their production activities. Specifically targeted are measures to go beyond environmental standards, early adaptation to future environmental standards, energy efficiency, promotion of energy from renewable sources, high-efficiency cogeneration, efficient district heating and cooling, remediation of contaminated sites, recycling and re-use of waste, energy infrastructure and environmental studies. Undertakings making investments in eco-technologies or in environmentally friendly processes may receive specific aid, the aid rate of which varies according to the type of investment and the size of the undertaking. Any investment with a high return and/or reduced return time is not eligible. The aid is granted in the form of capital grants or interest subsidies and is intended for all undertakings and natural persons with authorisation to establish themselves.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2017	n.a.	revision foreseen in 2023
Responsible entity/entities	MECO, MEA	
Reference (s)	Amended Law of 15 December 2017 on an aid scheme for environmental protection	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2017/12/15/a1108/consolide/20201221	

Title of the measure	No. 513 Fit4Sustainability	
Description:	This support and co-funding programme offers companies the opportunity to have an assessment of the environmental impact of their activities carried out, which will be supplemented by various recommendations to reduce this environmental impact. The environmental impact assessment may cover the following aspects: decarbonisation, water, circularity. It is addressed to all undertakings which have a registered office in Luxembourg and which carry out an economic activity as their principal occupation. The aid is granted in the form of a capital grant.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	n.a.	
Responsible entity/entities	Meco, Luxinnovation	
Reference (s)	Amended Law of 15 December 2017 on an aid scheme for environmental protection	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2017/12/15/a1108/consolide/20201221	

Title of the measure	No 514 SME Packages Sustainability	
Description:	Programme and aid for identifying a practical solution to reduce the environmental impact of SMEs and to generate savings by reducing energy or water consumption, improving waste management or reducing the carbon footprint.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2022		
Responsible entity/entities	Meco (Self-Employed), Chamber of Commerce, Chamber of Trades, House of Entrepreneurship	
Reference (s)	Amended Law of 9 August 2018 on an aid scheme for small and medium-sized enterprises	
Info complementary	https://guichet.public.lu/fr/entreprises/financement-aides/regime-sme-packages/sme-packages-sustainability.html	

Title of the measure	No 515 Enterprise aid scheme – environmental protection (Revision)	
Description:	The review of the aid scheme exploits the opportunities offered by the revised State aid rules (General Block Exemption Regulation (GBER) and Guidelines on State aid for the climate, energy and environment (CEEAG)) and follows an assessment of new opportunities in the field of decarbonisation, transport and charging infrastructure, hydrogen production, CCU (carbon capture and utilisation), energy performance contracting and the transition to a circular economy. The aid could take the form of a capital grant, a repayable advance, an interest subsidy or contracts for difference (Contracts for Difference (CfD)) and Carbon Contracts for Difference (CCfD). Certain aid will be granted on the basis of competitive tendering in order to have the greatest environmental impact thanks to the minimum aid required.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	implementation of the revision planned for 2023
Responsible entity/entities	MECO, MEA	
Reference (s)		
Info complementary		

Title of the measure	No 516 Operating aid related to contracts for differences	
Description:	Operating aid linked to Contracts for Difference (CfD) and Carbon Contracts for Difference (CCfD) makes it possible to bridge the profitability differential between a more profitable carbon project and a decarbonised project by setting a reference price based, for example, on the evolution of the carbon price. Contracts for Difference may also involve reimbursements by the beneficiaries to taxpayers or consumers for periods in which the reference price exceeds the strike price.	
Type of Instrument	ØEconomy	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECO, MEA	
Reference (s)		
Info complementary		

Title of the measure	No 517 Risk Sharing Facility for Energy Efficiency and Decarbonisation of Enterprises Projects	
Description:	The de-risking instrument will make it possible to develop major energy efficiency and decarbonisation projects/investments and will be developed together with commercial banks, SNCI and energy suppliers.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities	Meco, MEA, SNCI, commercial banks	
Reference (s)		
Info complementary		

Title of the measure	No 518 Aid scheme for enterprises – research, development and innovation	
Description:	The aid scheme supports investments or research, development and innovation and related activities (e.g. hydrogen or CCU (carbon capture and utilisation) projects). The scheme provides incentives for companies to invest in the development of new services or products and in the improvement of production processes, on the one hand, and multi-sectoral specialisation in priority axes (e.g. sustainable technologies), on the other hand, and foster state-of-the-art innovation capacities in areas of excellence. In addition, the scheme further encourages partnerships between private sector companies and public research laboratories. Companies and private research organisations carrying out research and development (R &D) projects may receive aid in the form of grants or repayable advances. The aid may cover a percentage of eligible costs which varies according to the size of the undertaking and the type of project or programme. The aid is intended for private undertakings and research organisations established in Luxembourg and concerns the following activities: experimental development, fundamental research and industrial research.	
Type of Instrument	ØEconomy	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2017	n.a.	revision on the basis of the GBER planned for 2023
Responsible entity/entities	MECO	
Reference (s)	Law of 17 May 2017 on the promotion of research, development and innovation	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2017/05/17/a544/consolide/20201221	

Title of the measure	No 519 Modernisation of the tax rebate for investments made as part of an energy and ecological transition project	
Description:	In implementation of the Tripartite Agreement of 28 September 2022, the Government will adapt the existing framework for the tax rebate for investment in order to substantially modernise it, in particular with a view to promoting investments made by companies as part of an energy and ecological transition project. This rearrangement will have a constant budgetary impact. A draft law will be tabled in 2023 with a view to entry into force from 2024. The law will specify the specific characteristics of eligible investments and a certificate issued by a third authority or body certifying the level, reality and compliance of eligible investments will be made available to the Direct Contributions Administration at the time of submission of the tax return.	
Type of Instrument	Taxation	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2024	n.a.	
Responsible entity/entities	MFIN, MECO	
Reference (s)	Tripartite Agreement of 28 September 2022 Amended Law of 4 December 1967 on income tax	
Info complementary		

Title of the measure	No 520 Revision of legislation to speed up permitting procedures for decarbonisation projects	
Description:	As decarbonisation projects are of major importance to counter climate change, the relevant legislation will be reviewed in order to identify situations where an individual authorisation is not required or could be replaced by other legislative means or where the procedures for obtaining such an authorisation could be lighter, accelerated or even prioritised. The above analyses will be coordinated by the MECDD. If legislative texts are adapted, work on them will be started by the respective competent authorities.	
Type of Instrument	Regulatory	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MECDD, MTEESS, MINT	
Reference (s)		
Info complementary		

Title of the measure	No 521 Circular Economy Strategy “Kreeslafwirtschaft Lëtzebuerg”	
Description:	Our society’s overconsumption of resources generates significant GHG emissions along the product value chain, from raw material extraction to waste disposal. Smart application of the principles of the circular economy (CE) – reducing the material footprint (and thus carbon), extending use and sharing, re-use, reuse and recycling or using cascades for biological resources – is essential to achieve carbon neutrality. In 2021, the ‘Kreeslafwirtschaft Lëtzebuerg’ strategy was presented, describing the tools and methodological approaches to define EC roadmaps for key sectors (Fit4Sustainability programme, Product Circularity Data Sheet, GBER Resource Centres, etc.). An electronic portal has been set up which explains the strategy and toolbox and identifies the key actors to implement these roadmaps, including state and municipal administrations, businesses, societal impact societies (SIS) and citizens.	
Type of Instrument	Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2020	2021	Continuous development
Responsible entity/entities	MEA, MECO, MECDD, MFIN, MTEESS, MPC	
Reference (s)	Circular Economy Strategy Luxembourg, MEA, MECO, MECDD 2021	
Info complementary	https://economie-circulaire.public.lu/fr.html https://economie-circulaire.public.lu/dam-assets/publications/2021/Strategie-economie-circular – Luxembourg-FR.pdf	

Title of the measure	No 522 Public-private CCU and DAC research hub (Analysis of the need, potential and technical and economic feasibility of carbon capture and use (CCU) technologies of direct air capture (DAC) respectively)	
Description:	In view of the undeniable scientific evidence of the need for negative GHG emissions in order to achieve the climate neutrality objective, the Government is aware of the importance of the subject of carbon capture and use (CCU) technologies, respectively direct air capture (DAC) technologies, and therefore proposes to analyse the subject in a holistic manner. Ideally, a public-private research hub bringing together public research and industry stakeholders will be able to carry out such an analysis, establish an appropriate strategy and accompany the implementation of pilot projects and the deployment of selected technologies. In particular, the analysis of DAC and CCU will have to consider the following factors: - Quantification of unavoidable emissions from certain sectors and hence of the need for these technologies. - Assessment of needs and potential, advantages and disadvantages to conclude on the technical and economic feasibility of the different DAC and CCU technologies that can generate negative emissions. - A proposal for guidelines for a possible subsidy instrument enabling these still immature technologies to be deployed and become more mature. (The price of these technologies is currently well above the current price of CO_2certificates). - A proposal for a methodology following a life-cycle assessment approach to assess negative GHG emissions and other environmental impacts Luxembourg will promote a cooperation and consultation approach at European level.	
Type of Instrument	Research	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2024		
Responsible entity/entities	MESR, MEA, MECDD, MECO	
Reference (s)		
Info complementary		

Title of the measure	No 523 Regulation No 517/2014 (F-Gas II) for the reduction of emissions of fluorinated greenhouse gases	
Description:	Regulation No 517/2014 (F- Gas II), which entered into force on 1 January 2015, repeals and replaces Regulation No 842/2006 ('F-Gas'). It is based on the following provisions: - strengthening the obligations relating to the containment of equipment (leakage checks, repair obligations), the certification of personnel handling HFCs and the obligation to recover during maintenance and dismantling of equipment; - the introduction of a mechanism for progressively reducing the quantities of HFCs placed on the market from 2015 to 2030 through a quota system. In 2030, the total amount of HFCs placed on the market, equivalent CO_2, shall correspond to 21 % of the average level between 2009 and 2012; - sectoral bans on the placing on the market of products and equipment containing fluorinated greenhouse gases exceeding a certain GWP; - a ban on the maintenance of refrigeration facilities with GWP fluids above 2 500 as from 1 January 2020. This also applies to heat pumps. (note: proposal for a revision of Regulation (EU) No 517/2014 on fluorinated greenhouse gases tabulated by the European Commission in April 2022)	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2015	2030	National law without a defined end date
Responsible entity/entities	MECDD, EVA	
Reference (s)	Act of 22 June 2016 a) laying down certain detailed rules and penalties of Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006; b) Client	
Info complementary	http://data.legilux.public.lu/eli/etat/leg/loi/2016/06/22/n1/jo	

Title of the measure	No 524 Reinforcing the regulations on checking the leakage of refrigeration, climate and thermodynamic equipment	
Description:	The Grand-Ducal Regulation of 22 June 2016 on (a) checks on refrigeration, air conditioning and heat pump equipment running on refrigerants such as HFCs, HCFCs or CFCs; (b) the inspection of air-conditioning systems strengthens Luxembourg's legislation on checking the leakage of refrigeration, climate and thermodynamic equipment, supplementing the provisions of the European F-Gas II Regulation. In particular, it requires increased frequency of leakage checks, specifies technical measures for carrying out the checks and requires large equipment to be equipped with an automated leak detection system. This measure helps to limit fugitive emissions from this equipment.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2016		
Responsible entity/entities	MECDD, EVA	
Reference (s)	Grand Ducal Regulation of 22 June 2016 on (a) checks of refrigeration, air conditioning and heat pump equipment operating on refrigerant HFC, HCFCs or CFCs; (b) inspection of air-conditioning systems.	
Info complementary	http://data.legilux.public.lu/eli/etat/leg/rgd/2016/06/22/n3/jo	

Title of the measure	No 525 Ratification of the Kigali Amendment	
Description:	Luxembourg ratified the Kigali Amendment to the Montreal Protocol on 16 November, 2 017. While the Kigali Amendment broadly supports the same objectives as the European F-gas II Regulation, it covers a larger commitment period until 2036 (the F-gas II Regulation runs until 2030).	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2017	2036	
Responsible entity/entities	MECDD, EVA	
Reference (s)	Law of 28 July 2017 approving the Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in Kigali on 15 October 2016.	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2017/07/28/a705/jo	

Title of the measure	No. 526 Advice to companies for the replacement of their HFC-fuelled equipment with HFC-free equipment and collective recovery of discontinuous appliances – SuperDrecksKëscht action	
Description:	In addition to the recovery of air conditioning appliances and refrigerants, SuperDrecksKëscht ® advises companies in their conversion to environmentally friendly refrigerant fluids. The Board focused on taking into account the prohibition on the use of all partially halogenated refrigerating fluids that reduce the ozone layer (HCFCs), in accordance with Regulation (EC) No 1005/2009, and on the prevention of fluorinated gases, in accordance with Regulation (EC) No 842/2006. As a result, it is hoped to contribute to the reduction of the significant global warming potential of fluorinated gases and to increase awareness and acceptance of alternatives for refrigerant and air-conditioning fluid.	
Type of Instrument	Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, AEV, SuperDrecksKëscht	
Reference (s)		
Info complementary	https://sdk.lu/de/die-behandlung-von-kuhlgeraten/	

Title of the measure	No. 527 Prohibition of certain fluorinated gases in air conditioning systems in motor vehicles	
Description:	Directive 2006/40/EC prohibits the use of fluorinated gases with GWP higher than 150 in air conditioning systems in motor vehicles. Since 1 January 2011, air conditioning in all new types of vehicles has to be operated with a refrigerant with a GWP of less than 150. Since 1 January 2017, this ban applies to all new vehicles. This implies for car manufacturers to replace refrigerant gas R-134a (GWP = 430) with R-1234yf gas (GWP = 4).	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2008	n.a.	
Responsible entity/entities	MMTP, SNCH, SNCA	
Reference (s)		
Info complementary	http://data.europa.eu/eli/dir/2006/40/oj	

Title of the measure	No 528 Proposal to strengthen EU Regulation 517/2014 (F-Gas) (II) for the reduction of emissions of fluorinated greenhouse gases	
Description:	Based on the findings of an evaluation of the Regulation, the European Commission has set itself the following objectives for the review: (1) Achieve further reductions in F-gas emissions to contribute to the achievement of the 55 % target by 2030 and net carbon neutrality by 2050. (2) Fully align with the amended Kigali Protocol. (3) Facilitate the strengthening of implementation and enforcement of illegal trade, the functioning of the quota system and training needs on alternatives to F-gases. (4) Improve monitoring and reporting to fill existing gaps and improve the process and quality of data for compliance. (5) Improve clarity and internal coherence to promote better implementation and understanding of the rules.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, EVA	
Reference (s)	Proposal for a regulation of the European Parliament and of the Council on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) No 517/2014	
Info complementary		

3.1.1.5 pieces of waste

Title of the measure	No 601 Wastes and PNGDR	
Description:	The law provides the legal basis for overall resource management. In addition to protecting humans and the environment during product production and waste management, emphasis is placed on improving the use of materials (see waste hierarchy and circular economy strategy). At the same time, the laws establish framework conditions for waste management, including national and local administration and responsibilities, as well as technical and legal aspects (polluter pays principle; EPR channels). The legal basis has been thoroughly reformed to ensure that the transition from waste management to a circular economy is reflected in the legal framework. The ban on landfilling of untreated municipal waste, which aims to reduce landfill gases (including methane) by 2030, is an important step in the climate reform. A new aspect is the extension of extended producer responsibility schemes. In order to improve resource management, the consumption of disposable plastic products is also reassessed. A revision of the PNGDR approved by the Government in 2018 will be launched in 2023.	
Type of Instrument	Regulatory, Planning	
State of progress		
Start of implementing	End of implementation	Comments
2018	n.a.	A new plan to be drawn up in 2024
Responsible entity/entities	MECDD, AEV, MECO, MEA	
Reference (s)	National Waste and Resource Management Plan	
Info complementary	https://environnement.public.lu/dam-Assets/documents/offall_a_Resourcen/PNGD/plan/PNGD.pdf	

Title of the measure	No 602 Support to a circular economy “Null Offall Lëtzebuerg”	
Description:	The strategy is linked to the implementation of the EU directives of the circular economy package and is at the same time a step forward in the PNGDR. The objective of waste policy is to promote the circular economy in order to preserve natural resources. Waste prevention and reuse is therefore systematically before recycling and therefore this ambition goes beyond waste management. The strategy puts particular emphasis on the prevention of food waste.	
Type of Instrument	Regulatory, Planning	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2020	n.a.	
Responsible entity/entities	MECDD, EVA	
Reference (s)	Null-Offall strategy	
Info complementary	https://luxembourg.public.lu/fr/societe-et-culture/developpement-durable/null-offall-strategie-recyclage-economie-circulaire.html	

Title of the measure	No 603 Circular Economy Strategy “Kreeslafwirtschaft Lëtzebuerg”	
Description:	The strategy is the regulatory framework to increase resource and material efficiency taking into account the life-cycle principle, with the aim of achieving a comprehensive and low GHG emission circular economy. Several actions accompany this measure: creation of a favourable financial framework (Fit4Circularity Support Programme); awareness raising, education and training; research, development and innovation; product Circularity Data Set initiative for the digital management of stocks and flows of goods; use of circular economy indicators to help businesses and consumers/users make decisions; circular Economy Portal.	
Type of Instrument	Planning	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
2021	n.a.	
Responsible entity/entities	MECDD, MECO, MEA, AEV	
Reference (s)	Circular Economy Strategy in Luxembourg	
Info complementary	https://economie-circulaire.public.lu/fr/strategy.html	

Title of the measure	No 604 Incineration of waste	
Description:	The Syndicat intercommunal des déchets Sidor (Syndicat intercommunal des déchets Sidor), which brings together 34 municipalities in central and southern Luxembourg, makes an energy value for municipal waste and collects energy (heat distributed in Leudelange and Gasperich/Cloche d'Or; electricity injected into the public grid). When the Muertendall landfill is closed (scheduled for 2030), municipal waste mixed with SIGRE and SIDEC will have to be heat-treated by SIDOR. The installation, which was modernised in 2011, will require renovation work after 2030, inter alia in order to be able to accept these additional quantities of waste. The target groups are SIDOR municipal waste and in the medium term from Luxembourg as a whole.	
Type of Instrument	Regulatory, economic	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1976	n.a.	
Responsible entity/entities	MECDD, EVA	
Reference (s)	Articles of Association for the management of waste from households and similar waste in the municipalities of the cantons of Luxembourg, Esch and Capellen established by Grand-Ducal Decree of 18 June 1971	
Info complementary	https://www.sidor.lu/	

Title of the measure	No. 605 Methane Recovery Systems	
Description:	Methane recovery systems were installed in 2000 and 2002 in the landfill sites Muertendall (managed by SIGRE) and Fridhaff (managed by SIDEC). The gas captured on site is either flared or used for the generation of electricity and heat (combustion in a cogeneration plant). For some time, the recovered gas has decreased in quality so that it has to be burned with a torch. Gas recovery must be continued after the closure of the landfill (Fridhaff has been closed since 2015, Muertendall is scheduled to close in 2030).	
Type of Instrument	Regulatory, economic	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2020		
Responsible entity/entities	MECDD, EVA	
Reference (s)		
Info complementary		

Title of the measure	No 606 Valuation of greenery waste	
Description:	Wood-rich waste is collected and stored separately for recovery as a fuel source in wood chips or biomass plants. The pollutants produced during combustion are filtered into the combustion gases. The burning of green waste in the open air is prohibited for health and environmental reasons and is the subject of legal proceedings laid down in the Grand-Ducal Regulation of 18 December 2015.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2015	n.a.	
Responsible entity/entities	MECDD, EVA	
Reference (s)		
Info complementary		

Title of the measure	No 607 Valuation of organic waste	
Description:	Bio-waste is collected separately for the purpose of recycling organic substances and nutrients in composting or anaerobic digestion facilities (biogas plants) with the use of biogas followed by material recovery of compost or resulting ferment. The network of biogas installations increased over the period 2010-2015 to 24 installations in 2022. In addition, several installations, including Minett-Kompost, were connected to the natural gas distribution network in accordance with the Decree of 15 December 2011. The rates of separate collection of organic waste are increased and processed in fermentation facilities in order to increase biogas production.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2011	n.a.	Linked to the slurry premium (agriculture) and the market premium (energy)
Responsible entity/entities	MECDD, EVA	
Reference (s)		
Info complementary		

Title of the measure	No 608 Reduction of single-use materials	
Description:	Directive (EU) 2019/904 is implemented as part of the EU circular economy package. The EU ban on single-use plastic products aims to reduce fossil-based greenhouse gas emissions during their treatment (e.g. during incineration of plastic in residual waste or as an alternative fuel) as well as plastic waste. In this way, the plastic fraction is reduced in waste.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021	n.a.	
Responsible entity/entities	MECDD, EVA	
Reference (s)	Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment	
Info complementary		

Title of the measure	No 609 Discharge	
Description:	The modern landfill site requirements of Directive 1999/31/EC on the landfill of waste, which aim to prevent or reduce environmental damage caused by the landfilling of municipal waste, were transposed into national legislation by the Grand-Ducal Regulation of 24 February 2003, as amended and corrected by the Grand-Ducal Regulation of 17 February 2006. In order to reduce methane emissions, the reform of the national waste law provides for a ban on landfilling as of 2030. Half-time, in line with the national implementation of Directive 1999/31/EC on the landfill of waste, waste streams are subject to aerobic treatment before landfilling in order to accelerate their decomposition. This treatment has been applied systematically since 1993 by SIGRE to Muertendall. At SIDEC in Fridhaff, an installation was set up in 2007 (the SIDEC landfill is in the meantime closed). Landfilling of waste is stopped from 2030 onwards. Recycling of waste to reduce the amount of waste disposed of is increased by incineration with energy recovery.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1993	2030	
Responsible entity/entities	MECDD, EVA	
Reference (s)		
Info complementary		

Title of the measure	No 610 Inert discharge	
Description:	Chapter 4 of the 'Null Offall Veterie' includes 4 Axes for the prevention and management of construction waste: design buildings as depots of materials, promote methods of construction avoiding excavations, extend the utility cycle of buildings, create markets for construction products and materials	
Type of Instrument	Planning, Rules	
State of progress		
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, EVA	
Reference (s)		
Info complementary		

Title of the measure	No. 611 Waste water management	
Description:	Sound management of urban waste water requires that its collection and transport to scrubbing stations is carried out under the best possible conditions. The construction of separate networks (wastewater and rainwater) will be an important measure for the coming years (SWW 9). In addition, the construction of sanitation works to protect watercourses during rainy periods, in particular with the establishment of storm ponds and rainwater retention basins (SWW 4 and SWW 5).	
Type of Instrument	Regulatory, Planning	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
2022	2027	
Responsible entity/entities	MECDD, AGE, Wastewater Municipalities/Trade Unions	
Reference (s)	Amended Water Act of 19 December 2008; Rhine and Meuse River Basin Management Plan (Luxembourgish parts) and programme of measures (2021-2027)	
Info complementary	https://eau.gouvernement.lu/fr/administration/directives/Directive-cadre-sur-leau/3e-cycle- (2021-2027)/elaboration-du-3e-plan-manestion-document — final.html	

Title of the measure	No 612 Wastewater drainage	
Description:	The primary objective of prioritising urban water management measures is to connect to a public biological treatment plant those areas which are not yet in place, that is to say, those whose waste water is discharged into the natural receiving environment without purification or only after mechanical treatment. Here it may be necessary to build a new biological treatment plant to replace one or more mechanical treatment plants (SWW 1: Construction of STEP) and to carry out measurements on the sewerage system (SWW 9: and SWW 4: Storm basin). Modernisation and extension of existing biological treatment plants (SWW 2: Extension/adaptation of STEP) is another priority to ensure appropriate treatment of the collected waste water also in the future.	
Type of Instrument	Regulatory, Planning	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2015	2021	
Responsible entity/entities	MECDD, AGE, Wastewater Municipalities/Trade Unions	
Reference (s)	Amended Water Act of 19 December 2008; Rhine and Meuse River Basin Management Plan (Luxembourgish parts) and programme of measures (2015-2021)	
Info complementary	https://eau.gouvernement.lu/fr/administration/directives/Directive-cadre-sur-leau/2e-cycle- (2015-2021)/Hydrographic disc plan/—version-francaise.html	

Title of the measure	No 613 Wastewater drainage	
Description:	The primary aim of prioritising urban water management measures is to connect all localities to a public biological treatment plant. This requires the replacement of mechanical scrubbing stations and their expansion and modernisation. (SWW 1 and SWW2) In order to address the issue of micropollutants, equipping a quaternary treatment level at the main scrubbing stations is a priority for the coming years. (SWW 11)	
Type of Instrument	Regulatory, Planning	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
2022	2027	
Responsible entity/entities	MECDD, AGE, Wastewater Municipalities/Trade Unions	
Reference (s)	Amended Water Act of 19 December 2008; Rhine and Meuse River Basin Management Plan (Luxembourgish parts) and programme of measures (2021-2027)	
Info complementary	https://eau.gouvernement.lu/fr/administration/directives/Directive-cadre-sur-leau/3e-cycle- (2021-2027)/elaboration-du-3e-plan-manestion-document — final.html	

Title of the measure	No 614 Sewage Sludge Recovery Strategy	
Description:	An integrated strategy for the treatment of sewage sludge is developed to ensure safe disposal/recovery and to respond to the steady increase in the volume of sewage sludge. Decentralised fluidified bed treatment plants are planned and built, while strengthening the cooperation of all actors to ensure management at national level.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, EVA, AGE, Wastewater Municipalities/Trade Unions	
Reference (s)		
Info complementary		

3.1.1.6 agriculture

Title of the measure	No 701 Aid to reduce the livestock load	
Description:	This intervention encourages a reduction in the number of cattle present on the holding. Fewer animals also mean less methane emissions during digestion, as well as less slurry and manure. This measure contributes to improving its feed autonomy.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	CAP (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 2.02.550 (measure 550)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 702 Aid for the use of food additives to reduce methane emissions from digestion	
Description:	This intervention encourages the use of food additives primarily in dairy cows with the aim of reducing methane emissions from digestion. The first food additives are expected to be authorised soon. However, before introducing this measure, it must be ensured that the use of such products is authorised and that the reduction is proven, without, however, having a negative impact on animal health and welfare or generating harmful effects on the environment.	
Type of Instrument	ØEconomy	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
		CAP (2023-2027), implemented after 2024
Responsible entity/entities	MA, SER	
Reference (s)		
Info complementary	In February 2022, the use of such an additive was recognised in the EU for dairy cows (Daily News 23/02/2022 (europa.eu)).	

Title of the measure	No 703 Aid for the conversion and maintenance of organic farming	
Description:	The objective of the intervention is to promote and promote organic agricultural production. This type of agriculture renounces the use of mineral fertilisers. Organic production follows the principle of a circular system. Extended rotations with sowing protein crops or grasslands, as well as the input of organic matter into the soil contribute to carbon sequestration.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1997	n.a.	Included in the CAP since 1996; ; adapted conditions from 2021
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 2.02.543 (measure 543)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 704 Aid for manure injection and composting	
Description:	This measure allows for improvements in ammonia and nitriacal losses and in the overall recovery of organic matter as a result of the use of special equipment. Through direct burial or pre-composting respectively, the actions contribute significantly to a reduction of ammonia emissions and as a result of indirect N2O. The technique of composting manure represents various environmental benefits. Among other things, the urea and ammoniacal nitrogen contained in the manure is reinserted into the microbial mass. Losses of spreading are virtually zero, as nitrogen from the compositions is almost entirely present in organic, non-volatile form. Although this measure is aimed at reducing air emissions, better use of livestock manure is also a consequence of this measure.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2002	n.a.	CAP: from 2002; adapted conditions from 2020
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 2.02.544 (measure 544)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 705 Support for the integration of manure (eco-scheme)	
Description:	With this measure, the farmer undertakes to incorporate the manure within four hours of spreading. Rapid incorporation after spreading allows improvements in ammonia and nitriacal losses and in the recovery of manure and as a result of indirect N2O. Although this measure is aimed at reducing air emissions, better use of livestock manure is also a consequence of this measure.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	CAP (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 1.02.518 (measure 518)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 706 Premium for sustainable and environmentally-friendly agriculture	
Description:	The aim of this programme is to motivate the vast majority of farmers to put in place elements of landscape structure, to apply better farming practices and to promote sustainable agriculture. Commitment for all areas of the holding. The new premium (applicable from 2023) sees stricter conditions, such as a reduction in cattle load to 1,8 LU/ha instead of 2 LU/ha or the introduction of the residual nitrogen limit of 100 kg Nmin after the harvest of but.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1996	n.a.	CAP: from 1996; adapted conditions from 2023
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 2.02.540 (measure 540)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 707 Aid for agricultural investment – Agricultural/viticultural and horticultural machinery and equipment	
Description:	The aid shall be limited to innovative machinery and equipment, machinery which has a positive impact on water protection, which is energy efficient or which contributes to environmental protection. An example of innovative machinery is the special environmentally-friendly manure spreading equipment, which helps to reduce ammonia but also to make better use of organic fertilisers.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1986	n.a.	aid regularly adapted since 1986; CAP: adapted conditions from 2021
Responsible entity/entities	MA, ASTA	
Reference (s)	NSP – Intervention code: 2.04.712	
Info complementary	A premium of 10 percentage points shall be paid for the purchase of an electric traction vehicle;	

Title of the measure	No 708 Agricultural investment aid – Fixed buildings and installations	
Description:	The objective of the measure is to promote multifunctional, sustainable and competitive agriculture, taking into account animal welfare, environmental protection and climate protection. Future livestock buildings must be at the forefront of animal welfare and environmental technology. More environmentally-friendly stables help reduce emissions of greenhouse gases and air pollutants. For investments in real estate, a holistic analysis of the investment project is necessary (technical, agricultural, environmental, authorisation, financing).	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1986	n.a.	aid regularly adapted since 1986; CAP: adapted conditions from 2023
Responsible entity/entities	MA, ASTA	
Reference (s)	NSP – Intervention code: 2.04.712	
Info complementary		

Title of the measure	No 709 Legal framework for the use of nitrogen fertilisers in agriculture	
Description:	This measure prescribes the reduction of fertiliser use on arable land, grassland and pastures, as well as the application and storage techniques to be respected. Although the legislation aims to reduce water pollution, a reduction in air emissions is also a consequence of this regulation. More stringent measures are in place in the drinking water protection zones delimited in accordance with Article 44 of the amended Water Act, covering approximately 17 % of the national territory. Some provisions of the Nitrates Regulation are being strengthened, in particular with a view to transposing the NEC Directive (reduction of national emissions of certain atmospheric pollutants).	
Type of Instrument	Regulatory	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	Implementation of the Nitrate Directive since 2000; strengthening of certain provisions of the Nitrates Regulation planned for 2023
Responsible entity/entities	MECDD, AGE, AEV, ASTA	
Reference (s)	Amended Grand-Ducal Regulation of 24 November 2000 on the use of nitrogen fertilisers in agriculture Amended Grand-Ducal Regulation of 9 July 2013 (a) on administrative measures in all protection zones for me	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2000/11/24/n5/jo	

Title of the measure	No 710 Agricultural Council	
Description:	The aim of this measure is to help farmers seek support from advisory bodies that help them find the best possible solutions for their farm with their expertise. The range of advice proposed is very broad, ranging from drawing up manure plans, using arable crops/permanent grassland, feeding and keeping animals; and many more. Less nitrogen inputs; suitable feeding, resp. reduced nitrogen feed, improved herd management are examples that help reduce greenhouse gas emissions.	
Type of Instrument	Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2016	n.a.	Adapted conditions from 2020
Responsible entity/entities	MY	
Reference (s)	Ministerial Regulation of 28 February 2020 laying down the content of advisory modules in the field of agriculture, the rate of aid and the maximum amount of aid and the minimum qualifications of providers	
Info complementary	https://legilux.public.lu/eli/etat/leg/rmin/2020/02/28/a109/jo	

Title of the measure	No 711 Legal framework for capping the number of livestock per holding	
Description:	This measure creates a legal framework for capping the number of livestock per holding based on AWU (‘work units’). As livestock has been identified as the main source of ammonia emissions from the agricultural sector, the Ministry intends to avoid a massive increase in livestock. Thus, in addition to the aid made available for the voluntary commitment of the agricultural sector to reduce emissions from the agricultural sector (ammonia, greenhouse gases, etc.), the legislature supplemented this approach with a livestock control system which provides for: — subject to prior authorisation by the Minister any increase in livestock which has the effect of increasing livestock production on the holding to more than two annual work units; — the authorisation is subject to compliance with reference values for specific indicators related to nitrogen management on the farm -; and — to refuse authorisation for an increase in livestock which has the effect of increasing livestock production on the holding to more than five annual work units. In the short term, this measure means that the number of livestock will no longer be able to increase indefinitely and, in the medium and long term, will lead to a reduction in national livestock numbers, and will therefore substantially contribute to a reduction in greenhouse gases and atmospheric emissions, including ammonia.	
Type of Instrument	Regulatory	
State of progress	Planned	
Start of implementing	End of implementation	Comments
		Implementation end of 2023
Responsible entity/entities	MY	
Reference (s)	Draft law 8060 on supporting the sustainable development of rural areas	
Info complementary	https://www.chd.lu/fr/dossier/8060	

3.1.1.7 LULUCF

Title of the measure	No 801 Forestry – forest management	
Description:	This group covers all measures implemented or planned to optimise forest management. (see details in individual cases).	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, ANF	
Reference (s)	Law of 18 July 2018 on the protection of nature and natural resources; 2th (2017-2021) and 3th (2022-2026) National Nature Protection Plan; Forestry code	
Info complementary		

Title of the measure	No 802 Protection of total forest area	
Description:	Article 13 of the Law of 18 July 2018 on the protection of nature and natural resources aims to protect existing carbon stocks in forests. It prohibits clearing without prior authorisation and without compensation by afforestation of new forest areas. No change in the use of forest land shall be permitted, unless authorised by the Minister, in the public interest or for the improvement of agricultural structure. Deforestation is offset by afforestation (3 times the area) and not by other biotopes.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2018	n.a.	
Responsible entity/entities	MECDD, ANF	
Reference (s)	Law of 18 July 2018 on the protection of nature and natural resources.	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2018/07/18/a771/jo	

Title of the measure	No 803 Establishment of Free Developing Forests without timber harvesting	
Description:	The Forest Code (PL7255) Art.33 (2) calls for the strict protection (no timber harvesting) of 5 % of public forests over 100 ha. This will lead to additional strict protection of 2 000 ha of forest (currently 1 250 ha). In the short term, this will lead to an increase in deadwood and thus an increase in carbon stock in the forestry sector. On the other hand, this measure reduces the total wood harvesting potential and the substitution effect for building materials or energy sources. Increase in inhumane forest reserves (RFI).	
Type of Instrument	Regulatory	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2022	2026	
Responsible entity/entities	MECDD, ANF	
Reference (s)	Forestry Code (draft law 7255)	
Info complementary	Draft Forest Code: https://environnement.public.lu/fr/natur/forets/nouveau_code_forestier.html	

Title of the measure	No 804 Establishment of strictly protected areas in public forests with limited timber harvesting	
Description:	The PNPN3 aims to protect a minimum of 30 % of all forests and 10 % of strictly protected forests. The aim is to increase undisturbed forest areas, with little or no use. The PNPN3 aims to designate an additional 7.500 ha of Forest Reserves (10.000 ha by 2030). In the short term, this will lead to an increase in deadwood and thus an increase in carbon stock in the forestry sector. On the other hand, this measure reduces the total wood harvesting potential and the substitution effect for building materials or energy sources. Increase of Protected Areas of National Interest (NIPAs).	
Type of Instrument	Voluntary agreement	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MECDD, ANF	
Reference (s)	3th national Nature Protection Plan (2022-2026)	
Info complementary	https://environnement.public.lu/content/dam/environnement/actualites/2022/10/pnpn3/20220909-pnpn3-strategie.pdf	

Title of the measure	No 805 Conservation of highly biodiverse trees and deadwood in productive forests	
Description:	For private forest owners, conservation of highly biodiverse trees and deadwood is subsidised through RGD 03/03/2022 in Article 19 (preservation of dead trees on the ground) and Article 17 (preservation of biotope trees and standing trees). For public forests PL7255 in Article 33, the principles of close-to-nature forestry shall be applied and include the conservation of dead trees, the conservation of trees of biological interest and the conservation of ageing islands. Increased conservation of highly biodiverse trees and deadwood.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MECDD, ANF	
Reference (s)	Grand Ducal Regulation of 3 March 2022 establishing a set of aid schemes for the improvement of the protection and sustainable management of forest ecosystems	
Info complementary	RGD 03/03/2022: https://legilux.public.lu/eli/etat/leg/rgd/2022/03/03/a111/jo	

Title of the measure	No. 806 Limitation of harvesting levels in vulnerable public natural forest ecosystems	
Description:	The PNPN3 and public forest management rules require limiting harvesting levels to 60 % of the natural increase in biomass in natural forests vulnerable to climate change. This limitation currently applies to all public beech forests, representing 22 % of Luxembourg's total forest area (18.500 ha). This will lead to an increase of 3 m³ of wood per hectare per year in these forests and should at least compensate for natural degradation by the impacts of climate change.	
Type of Instrument	Voluntary agreement	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2022	2026	
Responsible entity/entities	MECDD, ANF	
Reference (s)	3th national Nature Protection Plan (2022-2026)	
Info complementary	https://environnement.public.lu/content/dam/environnement/actualites/2022/10/pnpn3/20220909-pnpn3-strategie.pdf	

Title of the measure	No 807 Increased use of wood from Prugois forests as building material	
Description:	Article 38 of the Forestry Code (PL7255) states that a Grand-Ducal Regulation lays down the rules applicable to the sale of timber from public forests. A platform called e-Holzhaff is set up to facilitate the matching of supply and demand of timber stakeholders in Luxembourg. Only the sale of timber in Luxembourg, which remains in Luxembourg, can be considered. A study by the Wood Cluster estimated that 25 % of the wood sold is used as material. This percentage could reach a maximum of 50 %.	
Type of Instrument	Regulatory	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2022	n.a.	
Responsible entity/entities	MECDD, ANF	
Reference (s)	Preliminary draft Grand-Ducal Regulation on the sale of timber from public forests. Platforma: e-Holzhaff (Luxinnovation)	
Info complementary	https://www.e-holzhaff.lu/de/produits	

Title of the measure	No. 808 Sustainable Forest Management of Public Forests	
Description:	The Forest Code (PL7255), in Article 35, requires public forest management to be based on the principles of sustainable forest management. A Grand-Ducal Regulation will define these principles and replace the Ministerial Circular of 3 June 1999. However, the Nature and Forestry Administration has already applied the principles of close-to-nature forestry for more than 15 years, as described in the Ministerial Circular of 3 June 1999. These principles include preserving mature and dead trees, avoiding monoculture and clear-cutting, etc.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1999	n.a.	
Responsible entity/entities	MECDD, ANF	
Reference (s)	Helsinki Resolution (Guideline H1) 1993 and Ministerial Circular of 3 June 1999 Forest code (PL7255)	
Info complementary	https://www.europarl.europa.eu/workingpapers/agri/eurfo146_fr.htm https://www.foresteurope.org/docs/MC/MC_helsinki_resolutionH1.pdf	

Title of the measure	No 809 Support schemes for the sustainable management of private forests	
Description:	Subsidies are granted to private forest fund owners in the Grand-Ducal Regulation of 16 April 2021 establishing a premium for the provision of ecosystem services in forest environments. That regulation introduces a premium, called 'Klimabonusbësch', for the management of areas with protected forest biotopes or habitats of Community interest. Subsidies are also provided for in the Grand-Ducal Regulation of 3 March 2022 establishing a set of aid schemes to improve the protection and sustainable management of forest ecosystems. Subsidies are granted for natural regeneration, the maintenance of young stands, the first selective thinning, the removal of the forest by horse or cable, the conversion to a freely evolving forest, the preservation of biotope trees and standing trees, the conservation of ageing blocks in forests, the grant for the creation of PGFa restoration of the forest ecosystem by afforestation of agricultural land, the preservation of dead trees on the ground and reforestation through species selection and the mix of species. The share of deadwood will increase by 20 % compared to 2020 in 2040.	
Type of Instrument	ØEconomy	
State of progress	Adopted, Implementation	
Start of implementing	End of implementation	Comments
2023	n.a.	
Responsible entity/entities	MECDD, ANF	
Reference (s)	Grand Ducal Regulation of 3 March 2022 establishing a set of aid schemes for the improvement of the protection and sustainable management of forest ecosystems	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2022/03/03/a111/jo	

Title of the measure	No 810 Aid to promote agroforestry on agricultural land	
Description:	This measure aims to develop agroforestry in all its forms: intra- parcel, bocage, sylvo-pastoralism, etc. It could consist of 3 strands of action: Production of intercultur wood and fruit trees, woody crop with short rotation intercropping, strips of woody structure. The measure will be accompanied by actions, monitoring of advice and research on agroforestry.	
Type of Instrument	Regulatory, economic, information, education, research	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2025		
Responsible entity/entities	MA, MECDD SER, ASTA, ANF, EVA	
Reference (s)	Article 14. GDR of 3 March 2022 establishing a package of aid schemes for the improvement of the protection and sustainable management of forest ecosystems	
Info complementary	https://agriculture.gouv.fr/un-plan-national-de-developpement-pour-agroforestry	

Title of the measure	No 811 Aid for the installation of catch crops and undersowing	
Description:	This measure has positive effects on soil management and an important influence on the evolution of nitrate levels in the soil, as it helps to combat nitrate erosion and leaching, as well as the input of organic matter into the soil contribute to carbon sequestration.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2002	n.a.	Included in the CAP since 2002; CAP adapted conditions (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 1.02.515 (measure 515)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 812 Aid for the transformation of arable land into permanent grassland	
Description:	The primary effect of this intervention is to avoid at least nitrate leaching and soil erosion. A side-effect is carbon sequestration in soil (Conversion arable in grassland for 5 years (retention of arable status)).	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
1997	n.a.	Included in the CAP since 1997; CAP adapted conditions (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	(NSP – Intervention code: 2.02.551) (measure 551)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 813 Aid for crop rotation and diversification on arable land	
Description:	The introduction of support to promote crop rotation on temporary grassland is envisaged.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2015	n.a.	Included in the CAP since 2015; CAP adapted conditions (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	National Strategic Plan (NSP – Intervention Code: 3.02.548 (measure 548) xxx)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 814 Premium for sustainable and environmentally-friendly agriculture (Viticulture)	
Description:	The measure aims to promote integrated vine production, in particular to reduce the impact of vine cultivation on water, the environment and the climate. (in the past: landscape and nature maintenance (Peen) – Viticole sector). Thus, the grass interrow is promoted, which represents a commitment for the entire area of the holding.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1996	n.a.	Included in the CAP since 1996; CAP adapted conditions (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 2.02.542 (measure 542)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 815 Aid for reduced tillage	
Description:	The intervention aims to support direct sowing or reduced tillage in order to positively influence the soil structure, the prevention of erosion and the biological fertility of the soil. As these practices are also more energy efficient than other tillage practices, they also contribute to the reduction of CO_2 emissions.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2002	n.a.	Included in the CAP since 2003
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 2.02.549) (measure 549)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.htm L	

Title of the measure	No 816 Support for the conversion and maintenance of organic farming (MFA)	
Description:	The objective of the intervention is to promote and promote organic agricultural production. This type of agriculture renounces the use of mineral fertilisers. Organic production follows the principle of a circular system. Extended rotations with sowing protein crops or grasslands, as well as the input of organic matter into the soil contribute to carbon sequestration.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
1997	n.a.	CAP: from 1997; adapted conditions from 2021
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 2.02.543 (measure 543)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 817 Aid for the installation of non-productive areas	
Description:	The objective of the measure is to promote sustainable development and efficient management of natural resources such as water, soil and air. This measure has positive effects on soil management and a strong influence on the evolution of nitrates in soils by combating nitrate erosion and leaching, and the input of organic matter into the soil contributes to carbon sequestration.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023	n.a.	CAP (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 1.02.512 (measure 512)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 818 Aid for the installation of non-productive strips	
Description:	The objective of the measure is to encourage the establishment of extensive bands along the structural elements of the landscape, as well as other biotopes, in critical areas of erosion and along rivers. This measure has positive effects on soil management and a strong influence on the evolution of nitrates in soils by combating nitrate erosion and leaching, and the input of organic matter into the soil contributes to carbon sequestration.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
1997	n.a.	CAP: from 1997; CAP adapted conditions (2023-2027)
Responsible entity/entities	MA, SER	
Reference (s)	NSP – Intervention code: 1.02.513 (measure 513)	
Info complementary	https://agriculture.public.lu/de/beihilfen/beihilfen-ab-2023.html	

Title of the measure	No 819 Urban land – Improvement of urban soils, vegetation media, with stable organic carbon to maximise their carbon stocks	
Description:	This measure aims to use the soils of urban green spaces as a reservoir of organic carbon by increasing their organic carbon content, without compromising their quality or creating environmental problems. In order to achieve this objective, it is suggested to achieve a significant modification of stable organic carbon in existing soils or when new green areas are set up. This measure is based on three complementary axes: (I) encourage managers and installers of public and private urban green spaces to amend existing soils or build new soils enriched with stable organic carbon, (II) provide green space managers and creators with a technical framework to maximise soil carbon stocks while maximising environmental co-benefits and (III) provide a framework for the production and marketing of stable forms of organic carbon (e.g. biochar, certain organic waste) compatible with the objectives of the measure: climatic interests, agronomic interests and environmental and health innocent interests. Axis I could take the form of a new measure included in the Climate Pact, in particular in Part 3.3 Sustainable water supply and management of green spaces, Subpart 3.3.2 Green Spatial Management, giving entitlement to a number of points when a certain amount of carbon is stored in green space soils. Axis II could take the form of a technical guide for managers and creators of green spaces setting out the technical provisions to be complied with in order to achieve the objectives of the measure. Axis III could take the form of adapting legislation on waste and/or organic soil improvers to allow and regulate the use of stable organic matter to be used (biochar, stable organic waste).	
Type of Instrument	Voluntary Agreement, Research, Rules	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, VEV, Communes	
Reference (s)		
Info complementary		

Title of the measure	No 820 Urban land – Prohibition of the installation of mineral cutlery for aesthetic purposes (‘gravel gardens’) and encouragement for conversion of existing gravel gardens	
Description:	The objective of the measure is to prevent land take, which is considered unnecessary from the point of view of development, of the land on accompanying parcels of private or public buildings, by maintaining or installing functional soil and permanent green cover. Functional and plant-based soils will then be able to provide much more effectively compared to mineral covered soils, ecosystem services to regulate the overall climate (organic carbon sequestration) and local (control of urban warm islands) and to support biodiversity in and on the soil. The installation of a functional floor may be carried out in accordance with measure 819. The ban on the installation of mineral cutlery would be considered to be complied with where the surface area of the mineral cover of a building accompanying parcel is less than an area or percentage to be defined of the accompanying parcel, outside the area dedicated to vehicle parking. The measure could be integrated into the PAG or PAP or into the building regulations of municipalities and would apply in the case of development or redevelopment requiring a building permit. Encouraging the conversion of mineral cutlery to sustainable vegetation could take the form of a new measure included in the Climate Pact, in particular in Part 3.3 Sustainable water supply and management of green areas, Subpart 3.3.2 Green Spatial Management, or in the Nature Pact, giving entitlement to a number of points. It could also take the form of a subsidy distributed by the municipality. The measure would be considered to be complied with when the area of the perennial vegetation cover exceeds a percentage to be defined of the accompanying parcel, outside the area dedicated to parking vehicles. The measure should favour the establishment of the largest possible plant cover, i.e. at least one herbaceous vegetation cover and maximum one tree cover, with an intermediate level consisting of a shrub cover.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, VEV, Communes	
Reference (s)		

Info complementary	

Title of the measure	No 821 urbanised land – Launch into production of abandoned urban areas with the aim of producing non-food biomass (productive landscape)	
Description:	The objective of the measure is threefold: (a) establish permanent vegetation cover (e.g. miscanthus) or tree cover (hedgerows, very short rotation coppice, poplar) in urban areas (e.g. accompanying parcels of industrial, commercial or transport facilities, brownfield sites and cities, old covered landfills) to green urban and perilousurban areas (measure 2.7 of PNPN3), (b) produce plant biomass through the maintenance and extensive exploitation of these areas on the basis of coherent landscape management, (c) use the plant biomass produced to produce energy (biomass plant) and, where possible,$_{green}$ H2 and biochar via the pyrolysis process. Biochar could then be used to implement measure 819. The implementation of this measure is based on 3 axes: (I) identify abandoned areas with significant potential to implement this measure, (II) remove regulatory and technical constraints to bring abandoned areas into production, and (III) encourage managers of abandoned areas to put them into production. Axis I could take the form of a map identifying the areas left behind and their potential for production. Axis II could take the form of a dedicated Grand-Ducal Regulation or an amendment to the legislation in force for the regulatory part and a technical guide to provide technical solutions. Axis III could take the form of a new measure included in the Climate Pact.	
Type of Instrument	Research, Rules	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MECDD, AEV, ANF, MEA, Communes	
Reference (s)		
Info complementary		

3.1.2 Renewable energies

The Government wishes to strengthen the momentum for the development of renewable energy, with a target increasing from 25 to 37 % by 2030 as a result of initiatives at European level, such as the Green Deal, the Fit for 55, the REPowerEU and the revision of the Renewable Energy Directive, in order to further reduce dependence on fossil fuels.

This heading therefore sets out the policies and measures aimed at achieving this ambitious target, based in particular on

two key technologies, namely wind (measure 224) and photovoltaic (measures 205 to 213), but also by creating a favourable framework for the deployment of renewable energy (measures 201 and 202), whether by facilitating procedures (measures 203 and 204) or by promoting other renewable energy sources such as biogas (measures 214 and 215), hydrogen (measures 216, 217 and 218), and biomass, which over the last few years has contributed to the development of renewable energy in the national territory.

In the area of renewable heating and cooling, a number of measures are planned, such as the facilitation of renewable district heating/cooling (measure 222) and geothermal energy (measure 223) and the promotion of renewable hydrogen (measures 216-218).

In addition to national efforts, mention should also be made of European cooperation in the form of the European renewable energy financing mechanism (measure 220) and statistical transfers (measure 221), which remains an essential pillar in achieving the 2030 target.

Title of the measure	No. 201 Remuneration for electricity from renewable energy sources	
Description:	The main objective of this measure is to create a favourable framework for the continuous deployment of renewable energy in view of the objectives set out in Directive 2018/2001 through various operating aid instruments, in order to increase the share of renewable energy sources in the electricity and heat sector with a view to decarbonising the energy system. The regulatory framework is the amended Grand-Ducal Regulation of 1 August 2014 on the production of electricity based on renewable energy sources, which determines inter alia the connection to the electricity grid and the supply of electricity, the system of guarantees of origin and the guaranteed remuneration in the form of feed-in tariffs or market premiums for electricity produced from wind, solar or hydroelectric power, biogas, sewage treatment plant gas, solid biomass and scrap wood. Remuneration levels vary depending on the renewable energy source and the electrical power of the installation. They shall be guaranteed for a period of 15 years from the date of first injection into the electricity grid. In addition, heat premiums for co-generated marketed heat and a slurry premium, which will be refreshed through the biogas strategy with a focus on livestock manure (measure 215), are foreseen. The regulation also provides for tenders for large-scale photovoltaic installations (measure 205). The last important adaptations to the Regulation were: (a) Enlargement of the circle of beneficiaries of tariffs for photovoltaic power plants of between 30 and 200 kW to all natural and legal persons (before only cooperative and civil societies; EN 2020); (b) Adjustment of tariffs for large biomass and scrap wood plants due to market developments (2022); (c) For 2023: suspension of reduction in remuneration as a result of the surge in prices (2022); (D) Increase in tariffs for biogas plants planned in 2023 to revitalise the sector. The costs related to the development of renewable energy are compensated through the compensation mechanism. In the future, various options should be explored to pass on these costs not only to electricity consumers but also to fossil fuel consumers such as natural gas and fuel oil. As regards this Grand-Ducal Regulation, the Government makes specific and targeted adjustments (e.g. biogas, measure 215), pending the overhaul of the current state aid framework. In this context, a study on the “bi-directional Contract for Difference” has been finalised and a regular exchange with the European Commission is taking place with a view to possible implementation.	
Type of Instrument	ØEconomy	
State of progress	Implemented	
Start of implementing	End of implementation	Comments

2014	n.a.	regular revisions of the Regulation
Responsible entity/entities	MEA	
Reference (s)	Amended Grand-Ducal Regulation of 1 August 2014 on electricity generation based on renewable energy sources	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2014/08/01/n1/jo	

Title of the measure	No 202 Raising awareness, information and advisory services on renewable energy sources	
Description:	The services of Klima-Agence (formerly myenergy) accompany and facilitate the deployment of renewable energy projects, including through instruments such as free energy advice, a platform and website containing all the necessary information on renewable energy, solar cadastre, thermal cadastre, climate pact 2.0 with municipalities, a climate pact for SMEs together with Luxinnovation, and the voluntary agreement with the industrial sector with the participation of around 50 energy-intensive companies from Luxembourg's industrial and tertiary sectors,	
Type of Instrument	Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
		continuous implementation
Responsible entity/entities	MEA, MECDD, Other (s): Klima-Agence, Luxinnovation	
Reference (s)		
Info complementary	https://www.klima-agence.lu/fr/accueil	

Title of the measure	No 203 Revision of legislation with a view to abolishing, reducing or facilitating or speeding up authorisation procedures	
Description:	Some factors limit the acceleration of renewable energy deployment, such as administrative procedures for permit applications. In the event of a lack of time limits in the legislative texts concerned, it is intended to lay down time limits for the authorities responsible for the procedure for examining applications for authorisation and for taking a decision by the competent authority. In addition, the relevant legislative texts will be reviewed in order to identify situations where an individual authorisation is not required or could be replaced by other legislative means. Such as a Grand-Ducal Regulation or in which the procedures for obtaining such authorisation could be simplified, accelerated or even prioritised. The deadlines laid down in Council Regulation (EU) 2022/2577 of 22 December 2022 establishing a framework to accelerate the deployment of renewable energy, which is valid for a period of 18 months, set deadlines for procedures in the field of wind, solar and heat pumps. These deadlines will serve as the minimum basic criteria for the above analysis. The above analyses will be coordinated by the MECDD. If legislative texts are adapted, work on them will be started by the respective competent authorities.	
Type of Instrument	Regulatory	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023		
Responsible entity/entities	MECDD, MINT, MEA, MTEESS,	
Reference (s)		
Info complementary	https://www.consilium.europa.eu/media/60326/st15176-en22.pdf / https://eur-lex.europa.eu/legal-content/EN/TXT/? uri = COM% 3A2022 % 3A230 % 3A to & qid = 1653033742483	

Title of the measure	No 204 Coordination of procedures relating to renewable energy decisions	
Description:	Authorisation procedures may be lengthy due to the complexity of projects, which take some time to prepare, and the high number of applications of all kinds, which are in principle dealt with in accordance with the principle of firm in, firm out, as it is the last of the decisions that determines the timing of orders and construction works, it is desirable that all procedures be completed closely. A coordination group shall be set up, under the guidance of the MECDD, with members of relevant ministries and administrations in order to ensure a parallel and coordinated handling of the relevant requests, for which such consultation is required or requested.	
Type of Instrument	Information	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023		
Responsible entity/entities	MECDD, MEA, MINT	
Reference (s)		
Info complementary		

Title of the measure	No 205 Install photovoltaic system on all residential buildings	
Description:	The State will waive the obligation for the new building so that any new building is equipped with a photovoltaic installation covering a maximum part of the roof. As regards existing buildings and in cases where people do not have the financial resources to invest in a photovoltaic installation, the State will bear the cost of the photovoltaic installation. The benefit of this measure is twofold: people who do not have the financial means can benefit from this measure and their electricity bill will be reduced by self-consumption. On the other hand, buildings which would not be equipped with photovoltaic installations in normal times will be involved in the energy transition. The Ministry of Energy and Spatial Planning will develop ways to implement the measure and cover the investment costs. Before implementation, however, various legal issues still need to be clarified. For the existing building, the government is also analysing the possibility of creating a register where owners (of roofs suitable to accommodate a photovoltaic installation) can register in order to make their roof available. The arrangements, constraints and organisation of this register and the possible appointment of a concessionaire are being examined.	
Type of Instrument	Regulatory, budgetary	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)	PM State of Nation Address 2022; Grand Ducal Regulation of 9 June 2021 on the energy performance of buildings;	
Info complementary	https://gouvernement.lu/fr/actualites/toutes_actualites/discours/2022/10-octobre/12-etat-de-la-nation.html	

Title of the measure	No 206 Calls for tenders for large power photovoltaic power plants	
Description:	Since 2018, five tenders (AO) have been launched for photovoltaic power plants > 500 kW (> 200 kW respectively), subject to the award of a market premium contract. This is in line with the State aid guidelines, which call for competitive tendering as the most appropriate means of promoting renewable energy sources (RES) in terms of cost-effectiveness. For the last four tenders, out of the 155 MW of capacity to be allocated, 74.9 MW could be awarded. A solution to this situation could be the introduction of batches dedicated to self-consumption (see measure 207). In the course of 2023, the two instruments ('regular' invitations to tender and 'self-consumption' invitations to tender) will be evaluated and, depending on the results, the two systems will continue to operate in parallel or a call for tender combining the two approaches, or even exclusively based on self-consumption, will be put in place. Other options/lots could be added such as own consumption with storage, shaving with load terminals. Following the first invitation to tender for self-consumption invitations to tender, it must be noted that the latter was very successful. More details can be found in measure 208. A second call for tenders for self-consumption will also be launched in July 2023.	
Type of Instrument	ØEconomy	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2019		
Responsible entity/entities	MEA, MECO	
Reference (s)	Amended Grand-Ducal Regulation of 1 August 2014 on electricity generation based on renewable energy sources Amended Law of 15 December 2017 on an aid scheme for environmental protection	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2017/04/24/a481/jo	

Title of the measure	No 207 PV ready obligation for industrial and agricultural buildings	
Description:	Residential and functional buildings are moving towards an implicit obligation to install photovoltaic panels in view of the provisions of the amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings (measures 204 and 301). It is therefore important to also provide an instrument for new industrial and agricultural buildings, with significant potential, while focusing on the following two key points, which are the static of the roof and the power of the transformer. It is intended to include this obligation in the recast of the amended Law of 5 August 1993 on the rational use of energy. Thus, from 1 January 2024, any industrial and agricultural building to be authorised must be designed in such a way as to accommodate a photovoltaic installation on its roof. The investment may be made by the owner, the tenant or a third party. This measure concerns functional and agricultural buildings which are not automatically covered by the amended RGD of 9 June 2021 on the energy performance of buildings (measure 301). Moreover, it is still up to the State to take an exemplary role. The State is installing photovoltaic panels on all its new buildings, particularly with a view to self-consumption. By 2 030, the State therefore aims to cover the electricity consumption of its real estate by photovoltaic installations on national territory. This objective includes the project to equip all public car parks with photovoltaic ombridges until 2030 (with the exception of possible cases of technical or regulatory impossibility).	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
2023		implementation planned for 2023/2024
Responsible entity/entities	MEA, MECO, MA	
Reference (s)		
Info complementary		

Title of the measure	No 208 Calls for tenders for photovoltaic power plants in self-consumption mode	
Description:	In response to the situation of multiple crises, an instrument already envisaged but not yet put into practice has been advanced in its implementation: to support and promote self-consumption by businesses and industry. To this end, a call for tenders specifically aimed at self-consumption and awarding State aid in return for investment aid (and not with operational aid such as the 'regular' invitation to tender) was launched in November 2022, in cooperation with the Ministry of the Economy. This instrument was implemented as part of a Autumn 2022 package of measures to address the energy crisis. This instrument should allow companies to secure at least part of their electricity bills. The separate tender for own consumption was allocated a budget of EUR 30 million. This budget is divided into three lots at EUR 10 million each, differentiated according to the power of the power plants (30-200 kW, 200-500 kW, 500 kW – 5 MW) and with different maximum aid intensities (60-55-50 %). Projects are awarded on the basis of the price expressed in EUR/kWc, the amounts of which have also been capped (810-620-EUR 530/kWc). This tender was very successful with some 46 MW that could be awarded, requiring some EUR 16 million in state aid. In view of this success, a second call with a budget of EUR 20 million will be launched in July 2023. Compared to regular calls for tenders, it can be seen that the investment support instrument appears to be more attractive, respectively, that awareness among businesses was increased in this year of the energy crisis 2022. In the course of 2023, the evaluation of the two instruments ('regular' and 'own consumption') will therefore continue.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2022	n.a.	
Responsible entity/entities	MEA, MECO	
Reference (s)	Amended Law of 15 December 2017 on an aid scheme for environmental protection	
Info complementary	https://guichet.public.lu/fr/entreprises/financement-aides/aides- environment/call-project-photovoltaic/call-photovoltaic- aids.html	

Title of the measure	N° 209 Draft call for tender for ground-based photovoltaic installations (agri- PV)	
Description:	On 22 October 2022, the Ministry of Energy launched a pilot invitation to tender for the construction and operation of new agrivoltaic power plants for the production of photovoltaic power. The aim is that these plants (agri-PV) have three advantages, namely the production of renewable electricity, the maintenance of agricultural production, which remains the main objective and the increase in biodiversity aimed at nature protection. As far as electricity generation is concerned, the aim is to mobilise waves of land where larger installed powers than on roofs (and other sealed surfaces) are possible. The award is made on the basis of operating aid, a market premium contract for the injection of the electricity produced.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2022		
Responsible entity/entities	MEA, MECDD, MAVDR	
Reference (s)		
Info complementary	https://guichet.public.lu/dam-assets/catalogue-pdf/appel-offres- ELECTRIISCED/call-offre-agripv.pdf	

Title of the measure	No 210 Framework for promoting self-consumption, communities and energy cooperatives	
Description:	The government has gradually put in place a legislative framework to accompany the different facets of self-consumption and communities (amended Law of 1 August 2007 on the organisation of the electricity market). This law is being amended again to take account of feedback on the aspects mentioned and to adapt these concepts even better to practice. As regards the promotion of these concepts, the preparation of enabling elements (model statutes, standard agreements, explanation of the steps taken to set up a sharing group, etc.) is under way in close cooperation between Klima-Agency, ministries, the regulator and the network operators, all led by Klima-Agency. When these instruments are ready, promotion will be intensified by targeted campaigns. In addition, Klima-Agence generally encourages and assists Luxembourg society stakeholders through awareness-raising campaigns and its basic energy and mobility advisory service (see also measure 313).	
Type of Instrument	Regulatory, Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, Other (s): Klima-Agency, ILR, Network Operators	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market	
Info complementary	https://legilux.public.lu/eli/etat/leg/loi/2007/08/01/n14/jo	

Title of the measure	No 211 Solar Cadastre on the Luxembourgish Geoportal	
Description:	The solar cadastre, provided for in the Government's coalition agreement 2018-2023, was set up in 2020 and serves as a tool for the 'Klima-Agency' for citizens' demarches. The cadastre is an interactive device for identifying and calculating the maximum roofing capacity. This cadastre, which is accessible to all, enables private persons, market participants, network operators, administrations, etc. to plan projects more efficiently or integration into the network. It takes into account information such as the type of roof (flat roof, etc.) and the height of the buildings so that the user only has to select his roof to obtain an initial assessment of the feasibility and the power that can be installed. It also serves as a planning and management tool for administrations in relation to large land (along traffic lanes, old industrial areas or landfills, later possibly free agricultural land).	
Type of Instrument	Information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)		
Info complementary	https://map.geoportail.lu/theme/energie?version=3&zoom=17&X=682156&Y = 6379591 & Lang = lb & rotation = 0 & layers = 1813 & opacities = 1 & ampbgLayer = streets _jpeg https://www.klima-agence.lu/fr/les-etapes-de-mon-projet/etapes-cles/produire- electricity-clean	

Title of the measure	No 212 Obligation to declare the income of a PV plant: limit increased from 4 kW to 30 kW	
Description:	Since the sale of electricity is a commercial activity, the income generated by a PV power plant must also be declared by natural persons. For the sake of simplification and administrative tolerance, the threshold for the installed capacity above which the declaration is mandatory has been increased from 4 kW to 10 kW as from the fiscal year 2021. By decision of the Tripartite Committee in March 2023, this threshold was raised from 10 to 30 kW as from the 2023 tax year. The generation of electricity below this threshold is considered an amateur activity and therefore natural persons are exempted from the reporting obligation.	
Type of Instrument	Taxation	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MFIN	
Reference (s)		
Info complementary	https://impotsdirects.public.lu/dam-assets/fr/legislation/legi21/2021-09-22-LIR- 14-2-of-2292021.pdf	

Title of the measure	No 213 VAT rate fund for photovoltaic installations at 3 %	
Description:	Reduction of the VAT rate (initially 17 %) on the supply and installation of photovoltaic panels at a super-reduced rate of 3 % from 1 January 2023. This applies to installations installed on dwellings and buildings used for activities of general interest. Eligible components are modules, inverters, cabling, fixings, etc.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MFIN, MEA	
Reference (s)	https://legilux.public.lu/eli/etat/leg/loi/2022/12/23/a649/jo	
Info complementary	https://pfi.public.lu/fr/publications.html	

Title of the measure	No 214 Fees for biogas injected into the natural gas network	
Description:	The regulatory framework relating to the production, remuneration and marketing of biogas injected into the natural gas network lays down the organisation of the injection of biogas into the natural gas network and its distribution and marketing. The support mechanism ensures that the producer receives a remuneration for the biogas injected for a period of 15 years from the date of the first injection. As part of the national biogas strategy (measure 215), it is planned to revise the remuneration for the injection of biogas into the natural gas network by incentivising the use of manure in existing and new power plants.	
Type of Instrument	ØEconomy	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
2011		
Responsible entity/entities	MEA	
Reference (s)	Amended Grand-Ducal Regulation of 15 December 2011 on the production, compensation and marketing of biogas	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2011/12/15/n5/jo	

Title of the measure	No 215 biogas strategy and new incentives (financial and other) for biogas	
Description:	The national biogas strategy, approved by the Government Council on 15 July 2022, was drawn up by the Ministry of Energy and Spatial Planning in consultation with the Ministry of the Environment, Climate and Sustainable Development and the Ministry of Agriculture, Viticulture and Rural Development. It is based on the results of a 2021 study on the potential and environmental aspects of biogas. The government has set itself the objectives of recovering 50 % of the manure deposit with a maximum of 1 million tonnes per year, mobilising 75 % of the potential of bio-waste and green waste and limiting the area used for the production of dedicated crops to 1.500 ha. These targets allow gross biogas production to be increased to 330 GWh per year. For the implementation of the strategy, the following measures have been identified: (a) Revision of the remuneration for the production of electricity from biogas by encouraging the valorisation of livestock manure in existing and new power stations by amending the amended Grand-Ducal Regulation of 1 August 2014 on electricity production based on renewable energy sources; (b) Revision of the remuneration for the injection of biomethane by encouraging the valorisation of livestock manure in existing and new power stations by amending the amended Grand-Ducal Regulation of 15 December 2011 on the production, remuneration and marketing of biogas; (c) Transposition of the sustainability and greenhouse gas saving criteria laid down in Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources into national law; (D) Increase the separate collection rate of bio-waste and anaerobic treatment; (e) Revision of the operating conditions of existing plants in order to reduce air emissions and increase plant safety; (f) exclusion of manure from abroad in the calculation of the share for the slurry premium; (g) Setting up a robust and sustainable chain for the management of digestates in order to optimise their agricultural value and limit their impact on the environment; (h) Promotion of the construction of ‘biogas ready’ livestock buildings; (I) Promotion of innovative projects to further reduce greenhouse gas emissions.	
Type of Instrument	Planning, economics	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023		
Responsible entity/entities	MEA, MECDD, MAVDR, MECO	

Reference (s)	
Info complementary	

Title of the measure	No 216 Hydrogen strategy	
Description:	Description of the context of decarbonisation through hydrogen as part of the ambition to achieve climate neutrality by 2050; State of play and estimation of the potential for decarbonisation through hydrogen employment; seven key measures to promote the production, import and use of renewable hydrogen: 1. Contribute to the definition of the legal, regulatory and regulatory framework at EU level, 2. Cooperating with EU Member States and third countries, 3. Identifying opportunities in Luxembourg – Research and Innovation, 4. Turning to reality – Flagship projects to be studied and implemented, 5. Prioritising actions – Towards decarbonisation targeted by renewable hydrogen, 6. Developing instruments for a renewable hydrogen market, 7. Continuously implement and improve. A steering committee "Taskforce H2 Luxembourg" has been set up to monitor the strategy. Following the preparation of the 2020 NECP and the publication of Luxembourg's hydrogen strategy in September 2021, the implementation of the seven measures listed above is also carried out under the coordination of the Energy Department of the Ministry of Energy and Spatial Planning and in close consultation with the other relevant jurisdictions and stakeholders.	
Type of Instrument	Planning	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
2021	n.a.	
Responsible entity/entities	MEA, Other (s): MECO, MECDD	
Reference (s)	Luxembourg Hydrogen Strategy, MEA 2021	
Info complementary	https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2021/09- septembre/27-turmes-hydrogene.html	

Title of the measure	No 217 Remuneration for the production of renewable hydrogen	
Description:	One of the priorities of the hydrogen strategy is to develop a concept of financial support to facilitate pilot projects for the production of renewable hydrogen in Luxembourg. In the short term (before 2030) the domestic production of a certain quantity of hydrogen is significant, and it has become apparent that significant demand will emerge before a European hydrogen transport infrastructure meeting this demand is put in place. The financing of the renewable hydrogen support measure must be organised and the possibility of setting up a compensation mechanism for the gas sector will be analysed.	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023		
Responsible entity/entities	MEA, other MECO	
Reference (s)	Luxembourg Hydrogen Strategy, MEA 2021	
Info complementary	https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2021/09- septembre/27-turmes-hydrogene.html	

Title of the measure	No 218 Connection to a European hydrogen transport infrastructure	
Description:	Given the limited potential for hydrogen production on Luxembourg territory, the interesting potential for hydrogen transit through Luxembourg, and due to the demand likely to evolve faster than expected in the industrial sector, it is important to position Luxembourg from the perspective of security of supply essential for the decarbonisation of non-electrifiable processes in industry and modes of transport that are difficult to electrify (in the short and medium term). The Government of Luxembourg, in consultation with the authorities of neighbouring countries, is working to implement a first interconnected hydrogen pipeline supplying renewable hydrogen in sufficient volumes and at competitive prices. A legal basis will have to be created to define an authorisation procedure so that a hydrogen network operator can be mandated to set up such a network in Luxembourg.	
Type of Instrument	Planning	
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)	Luxembourg Hydrogen Strategy, MEA 2021	
Info complementary	https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2021/09-septembre/27-turmes-hydrogene.html	

Title of the measure	N° 219 Facilitating the use of long-term renewable electricity supply contracts through a risk reduction instrument	
Description:	Facilitating the use of long-term renewable electricity supply contracts, the long-term renewable power purchase agreements (RES PPA), including cross-border, through de-risking instruments, in order to promote electrification based on renewable energy sources for large consumers in Luxembourg (large companies and industry); such contracts are a means of securing stable and planned renewable electricity prices in the medium and long term. The above instruments will aim at reducing risk on the supply side (i.e. production and supply of renewable energy) and the other instrument would be dedicated to demand (i.e. large companies and industry).	
Type of Instrument	ØEconomy	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2023		
Responsible entity/entities	MEA, other MECO	
Reference (s)		
Info complementary		

Title of the measure	No 220 Cross-border cooperation: European Renewable Energy Financing Facility	
Description:	Financial participation in renewable energy production projects in other Member States of the European Union or even third countries aims to increase the share of renewable energy in the European mix and generate renewable energy statistics for Luxembourg's balance sheet. The European Union Renewable Energy Financing Facility (REFM), where two calls for applications have already been organised by the European Commission and in which Luxembourg has participated as a contributing Member State in each case. After a first unsuccessful call for applications (expression of interest), due to the lack of successful projects, a Member State applied as host to the second call. Luxembourg will participate and will be able to benefit from the renewable energy statistics generated by these projects for the next 15 years. Luxembourg will be the first country to participate in this innovative mechanism, taking further the idea of European cooperation in the field of renewable energy and strengthening an instrument that can increase Europe's energy independence in the medium and long term.	
Type of Instrument	Regulatory, budgetary	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 221 Cooperation measures with EU Member States on renewable energy: Statistical Transfers	
Description:	Directive 2018/2001 allows Member States to make use of different cooperation mechanisms in order to contribute in the most effective way to the Union's common binding renewable energy target by 2030 and also to contribute to their national targets. Due to the Fit for 55 package and the RepowerEU plan, the EU and national targets will be increased. As the potential for renewable energy is limited in Luxembourg, it will be increasingly important to turn to these European cooperation mechanisms. Various instruments are currently possible and are already being pursued and implemented by Luxembourg, such as transfers of renewable energy statistics: instrument used in the past with Estonia and Lithuania for the period 2018-2020 A new agreement was concluded on 3 October 2022 with Denmark to cover the period 2021-2025.	
Type of Instrument	Regulatory	
State of progress	Implementation, Planified	
Start of implementing	End of implementation	Comments
Responsible entity/entities		
Reference (s)		
Info complementary		

Title of the measure	No 222 Promotion of efficient district heating and cooling	
Description:	The Ministry of Energy and Spatial Planning aims to provide citizens and businesses with a wide range of solutions that are easy to implement and coordinated at national, regional and local level as alternatives to fossil fuel heating systems and aims in particular at the massive development of decarbonised heat networks, in cooperation with municipalities. A recast of the Law of 5 August 1993 on the rational use of energy is currently being analysed to set the legal framework for district heating and the following issues will be addressed in this context: - Establishment of a legal framework for district heating and cooling aimed at the construction of such networks and laying down the conditions and modalities for operators; - Definition of the tasks of the energy network operator and designation of a supervisory authority (cf. area of electricity and gas); - Connection obligation for all buildings located in the supply zone of the district heating network; - Analysis for the introduction of specific investment aid for the construction of very low temperature district heating networks.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, MECDD, MECO, Communes, Klima-Agency (Climate Pact)	
Reference (s)		
Info complementary		

Title of the measure	No 223 Promotion of medium and deep geothermal energy	
Description:	Geothermal energy is a technology to provide renewable heat and is used to decarbonise the heating sector. The potential of geothermal energy can be exploited through installations close to the surface (< 15 m), shallow probes (15-400 m) and medium-deep geothermal energy (> 400 m). Shallow geothermal energy is mainly used to provide heat to single-family houses and residences, while medium-deep geothermal energy can contribute to the supply of heat to buildings or districts requiring high heat. In order to explore the potential of medium and deep geothermal energy in Luxembourg, several studies have been launched. These studies show a high potential in the south of the country, especially in regions with high energy needs. While there are subsidy instruments in place to promote the exploitation of near-surface and shallow geothermal energy, the government aims to develop economic aid instruments to support the deployment of medium-deep geothermal energy. Various pilot projects have been launched, in particular to carry out initial experiments in order to exploit this potential and at the same time to identify obstacles in Luxembourg. Finally, a three-dimensional model of geology in Luxembourg has been developed by the State Geological Service to prepare and speed up decision-making on authorisation procedures and to provide planners with the geological parameters used to calculate the predimensioning of geothermal drilling. This predimensioning is also used to determine the economic aspects of the project in question.	
Type of Instrument	ØEconomy	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, MECO, Geological Service	
Reference (s)		
Info complementary		

Title of the measure	No 224 Facilitation of authorisations of new sites for the installation of wind turbines	
Description:	Due to the limited national area and ambitious targets for renewable energy, it is essential to facilitate the authorisation of different (new) sites for the installation of wind turbines through different measures and technologies. It is envisaged, for example, to reduce the scope of implementation between wind turbines and motorway roads, based for example on the criteria laid down in Belgium and the Netherlands, and to make it possible to install wind turbines in industrial areas. The feasibility of these measures is currently being studied and discussed with the competent authorities. Moreover, technological progress and the increasing installed capacity of wind turbines make it possible to increase annual production hours. Innovative technologies allow automatic detection of surrounding fauna (birds, bats), so that rapid and targeted deactivation of the wind turbine is initiated.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, MECDD, ITM	
Reference (s)		
Additional info		

3.1.3 Other elements of the dimension

Luxembourg introduced some emergency aid under the 'Solidaritéitspak' tripartite agreements (March 2022, September 2022 and March 2023) in response to the energy crisis, aimed at alleviating household energy costs in the short term and limiting inflation, such as limiting the increase in gas prices, subsidy for customers connected to a district heating network, stabilising the price of electricity, a subsidy on publicly available charging stations, a subsidy on the price of gas oil used as fuel and a subsidy for liquefied petroleum gas (propane in bulk household) and some of these aids also targeted fossil fuels. All this aid was temporary and would expire by the end of 2024 at the latest.

3.2 energy efficiency dimension

The ‘energy efficiency first’ principle enshrined in EU legislation is indispensable for the achievement of the country’s energy and climate objectives, given its demographic change and its dynamic economy, which is characterised by significant growth. In the area of new buildings, Luxembourg already has a leading position in the implementation of energy efficiency requirements for residential and functional nearly zero-energy buildings. Any new construction (residential and functional buildings) must comply with the requirements of the amended Grand-Ducal Regulation of 9 June 2021 on the energy performance of buildings, which defines the ‘nZEB’ (nearly-zero energy building) level.

Thanks to the continuous evolution of regulatory ambitions since the entry into force of the first regulation on the energy performance of residential buildings in 2007 and of functional buildings in 2010, and above all also to the parallel evolution of the skills of the construction sector in Luxembourg, the Luxembourg nZEB is now one of the most ambitious in Europe and ensures that any new construction for which this regulation applies is automatically highly energy efficient and is automatically decarbonised in terms of energy consumption during the use of the building, due to the fact that heat pump is the reference technology for the installation of heat and domestic hot water.

In line with the European energy efficiency first principle, Luxembourg has paid particular attention to improving energy efficiency in buildings and intends to continue on this path.

Improving energy efficiency and decarbonising the stock of existing buildings is the biggest challenge in the coming years. By increasing the rate of energy renovation of buildings and using all available smart technologies, this sector can make a significant contribution to a competitive economy with a climate-neutral impact. As industry accounts for 50 % of electricity consumption, this will also be at the heart of energy efficiency policy. Mobility efficiency (transition from internal combustion engines to much more energy efficient electric engines) also needs to be improved. In general, the social impact of these energy efficiency measures is taken into account and social integration of the new rules is ensured.

3.2.1. National energy efficiency obligation scheme and alternative policy measures in accordance with Articles 7a and 7b and Article 20(6) of Directive 2012/27/EU

Luxembourg transposed Article 7 of Directive 2012/27/EU into national law by introducing in 2015 an EEOS energy saving obligation scheme. Since its creation, the instrument has been reformed and optimised several times, on the one hand to transpose amendments to the Energy Efficiency Directive and on the other to make improvements and to make the mechanism more efficient and better adapted to the needs of the sector.

The current revision of the EED Energy Efficiency Directive foresees in its Article 8 (former Article 7) a level of energy savings obligation to be achieved until 2030 even more ambitious than the one foreseen by the revision of the 2018 Directive. In order to achieve this increased level of obligation, Luxembourg intends to maintain the EEOS bond scheme with the same level of cumulative energy savings as foreseen by the reform of the mechanism in 2021. This EEOS contribution corresponds to a new energy saving to be achieved by all obligated parties of 250.000 MWh per year. In terms of cumulative energy savings over the period 2021-2030, the EEOS is planned to reach 13.750 GWh, which corresponds to 32 % of Luxembourg’s overall cumulative target (42.538 GWh) for energy savings obligations (Article 8 of the proposed revision of the EED Directive).

The following measures (with their reference number) give more details on the EEOS policy instrument:

Measure 120: Energy efficiency obligation scheme (EEOS), description of the scheme in place since 2015, for the first period (2015 to 2020).

Measure 121: Energy efficiency obligation scheme (EEOS), 2021 revision for the second period (2021 to 2030).

The EEOS energy efficiency obligation scheme is complemented by alternative policy measures. According to the modelling calculations, the remaining part of the overall cumulative target or 28.788 GWh (68 % of the overall target) can be almost entirely provided by the following alternative measure:

Measure # 105: CO_2 tax on liquid fuels

This measure has the greatest impact on reducing energy consumption by 2030, even before the impact of the energy

efficiency obligation scheme (EEOS) and will provide reductions in fuel consumption, representing a cumulative saving of final energy between 2021 and 2030 of 27.970 GWh (66 % of the overall target).

A few other energy efficiency measures meeting the eligibility criteria for the energy savings obligation (formerly Article 7 EED) to be qualified as alternative policy measures also contribute to improving energy efficiency; these measures may, where appropriate, be taken into account for the achievement of the overall cumulative target. These measures are set out in Table 28 in Chapter 2.2. The potential to contribute to the achievement of the overall target for these measures is estimated within a range of values, after correction of the overlap effects with EEOS measure 121 or alternative measure No 105 Taxony CO_2 on liquid fuels.

List of alternative measures with their reference number:

Measure 307: Aid scheme Klimabonus Wunnen (residential buildings)

Measure 311: Individual housing aid scheme

Measure 313: Tax incentives for energy renovation of housing

Measure 314: Aid scheme for municipalities

Measure 405: Promoting public transport

Measure 406: Promotion of innovative mobility services

Measure 410: Promotion of electrification of Luxembourg registered car fleet

Measure 420: Revised road vehicle registration tax

Measure 423: Aid scheme for zero-emission CO_2vehicles

Measure 503: Voluntary agreement on improving energy efficiency in industry (up to and including 2023).

Measure 504: Voluntary agreement on decarbonising and improving energy efficiency in industry (from 2024).

Title of the measure	No. 120 Energy Efficiency Obligation Scheme (EEOS)	
Description:	A legislative framework was put in place in 2015 to create an obligation mechanism for electricity and natural gas suppliers (obligated parties) to encourage them to generate energy savings among consumers in Luxembourg. This scheme, based on Article 7 of the EU Energy Efficiency Directive 2012/27/EU, obliges certain actors to make use of energy efficiency and ultimately of consumers, their market knowledge and expertise in the field of energy. The first period of the obligation mechanism shall cover the years 2015 to 2020, for a cumulative overall target expressed in terms of final energy consumption of 5.993 GWh equivalent to a new average annual saving of 285 GWh. The purpose of this scheme is to initiate and promote energy-saving projects by obligated parties, in particular through financial or non-financial incentives for investments in energy efficiency in the industrial, buildings and transport sectors. To this end, all consumers – businesses, municipalities and individuals – are targeted. The scheme is updated regularly, in particular on the basis of the revisions of the EU Energy Efficiency Directive.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2015	n.a.	last renewal and reinforcement in 2021
Responsible entity/entities	MEA	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market; Amended Law of 1 August 2007 on the organisation of the natural gas market; Amended Grand-Ducal Regulation of 7 August 2015 on the operation of the energy efficiency obligation scheme	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2021/06/03/a419/jo	

Title of the measure	No 121 Energy Efficiency Obligation Scheme (EEOS): revision 2021	
Description:	The energy efficiency obligation scheme, set up in 2015 for a first period covering the years 2015 to 2020, shall be revised in 2021 for the second period covering the years 2021 to 2030. Electricity and natural gas suppliers are always the obligated parties in this mechanism. In order to facilitate compliance with the obligations for "small" suppliers, the revision introduces a buy-out option allowing obligated parties to pay (up to a maximum of 1.500 MWh per year) their annual energy savings obligations by paying an amount equivalent to the investments required to meet those obligations. The 2021 revision also reinforces the obligation by introducing a much more dissuasive penalty than the mandatory fine provided for in the mechanism for the first period. Obligated parties who have not achieved their annual energy savings will be forced to pay a penalty (discharge of liabilities) imposed by the regulator. The level of ambition (new energy savings to be achieved annually by obligated parties) was maintained at the (average) level in the first period. The cumulative overall target expressed in terms of final energy consumption for the period from 2021 to 2030 is 13.750 GWh equivalent to a new average annual saving of 250 GWh.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2015	n.a.	last renewal and reinforcement in 2021
Responsible entity/entities	MEA	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market; Amended Law of 1 August 2007 on the organisation of the natural gas market; Amended Grand-Ducal Regulation of 7 August 2015 on the operation of the energy efficiency obligation scheme	
Info complementary	https://legilux.public.lu/eli/etat/leg/rgd/2021/06/03/a419/jo	

3.2. II. Long-term strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private (1), including policies, measures and actions to stimulate cost-effective deep renovation, as well as policies and actions to target the worst performing segments of the national building stock, in accordance with Article 2a of Directive 2010/31/EU

Significantly increasing the annual renovation rate with a focus on deep renovation, which translates into a significant amount of energy actually saved compared to the situation before renovation, is the shared ambition of all current strategies, policies, measures and flagship actions under development or to be developed.

The following measures with their reference numbers give more details on the various instruments supporting the renovation ambitions:

Cross-cutting measures related to renovation

Measure 106:	Climate Pact 2.0 with municipalities
Measure 113:	Vocational training at secondary school level in the context of the energy transition
Measure 114:	Awareness raising, information and advice to citizens promoting behavioural change and enabling framework for citizen engagement
Measure 301:	Regulations on the energy performance of buildings
Measure 302:	Fossil heating phase out
Measure 306:	PRIMe House aid scheme 2017
Measure 307:	Aid scheme Klimabonus Wunnen
Measure 308:	Digitalisation of the Klimabonus aid scheme
Measure 309:	Pre-financing under the Klimabonus Wunnen scheme
Measure 310:	"Climate Loans" aid scheme
Measure 311:	Individual housing aid scheme
Measure 312:	Stone aid scheme
Measure 313:	Tax incentives for energy renovation of housing
Measure 314:	Aid scheme for municipalities
Measure 315:	Promotion of sustainable construction
Measure 316:	Long-term building renovation strategy
Measure 317:	Building awareness, information, guides and consultancy services
Measure 318:	Training of a skilled and sufficient workforce in the buildings sector
Measure 319:	Pioneering role of municipalities in buildings
Measure 322:	Reduction of the environmental impacts of construction
Measure 323:	Decarbonisation of construction sites
Measure 326:	Harmonisation of urban planning rules

Specific measures for residential buildings

Improving the thermal envelope of a building is the most important measure to reduce the energy need for a building ^ Energy renovation works (thermal insulation).

Luxembourg does not provide for a renovation obligation for residential buildings, but relies on a strong incentive for renovation through financial and other incentives for co-properties and owners of rented dwellings. In order to specifically target the worst-performing residential buildings and further intensify their energy renovation, these buildings will soon be able to receive tailor-made support from a national support body.

Decarbonisation through the electrification of buildings through a heat pump also means a significant reduction in final energy consumption (excluding ambient heat) ^ transition to heat pumps, ideally combined with photovoltaic (and self-consumption) electricity generation.

The European EPBD, which is currently being revised, provides for the following for residential buildings: "... MEPs for residential multi-apartment buildings (> 10 building units) to be set based on a national linear trajectory for the gradual

renewal, in line with national roadmap for 2030, 2040 and 2050 targets (zero-emission building stock by 2050)...". Luxembourg will be obliged to achieve the results on the basis of the EPBD requirements, but this obligation does not automatically mean a renovation obligation for citizens or businesses. An obligation to renovate residential buildings is not envisaged in Luxembourg, but the focus is on raising awareness, encouraging and supporting energy renovation through policies and incentives.

Measures No 120, 121:	Energy efficiency obligation scheme (EEOS)
Measure 302:	Fossil heating phase out
Measures No 306:	Aid schemes "PRIMe House" (2017) and "Klimabonus" (2022)
Measure 310:	"Climate Loans" aid scheme
Measure 313:	Tax incentives for energy renovation of housing
Measure 324:	Minimum energy performance requirements for rented dwellings (owner incentives)
Measure 325:	Facilitation of energy works in co-owned buildings
Measure 327:	National accompanying entity 'energy renovation' and 'photovoltaic installations' for residential buildings
Measure 328:	Pilot project "Rehabilitation of neighbourhoods – Differdange"

Measures specific to functional buildings

The energy renovation of functional buildings is more governed by national intentions and European obligations. Several types of obligations will be introduced, notably at public and private level, on the basis of the requirements of the European EED (European Energy Efficiency Directive) and EPBD (European Energy Performance of Buildings Directive) directives which are currently being revised (expected in 2023).

Measure 303:	Energy renovation obligation for public buildings (owned by a public body)
Measure 304:	Energy renovation obligation for functional buildings
Measure 319:	Pioneering role of the State in relation to buildings
Measure 320:	Pioneering role of the public sector in energy efficiency
Measure 507:	Energy audit and monitoring/optimisation obligation for functional buildings with a surface area greater than 1.000 m^2
Measure 508:	'Accelerated' fossil phase-out obligation for functional buildings (surface area above 1.000 m^2) that are adapted for replacing fossil heating with a heat pump (heating system with a starting temperature below or equal to 55 °C (separate ECS))

3.3 Dimension energy security

The policies and measures put in place by the Ministry focus on improving security of supply in the electricity, gas, oil and future hydrogen sectors. This includes ensuring that the framework is developed appropriately and to achieve the ambitious climate objectives described in Chapter 2, maintaining a very high level of security of energy supply in Luxembourg.

Title of the measure	No 901 Report on security of supply in the electricity sector in Luxembourg	
Description:	The Ministry of Energy and Spatial Planning (MEA) of the Grand Duchy of Luxembourg Article 11 (3) of the Law on the organisation of the electricity market, which entered into force in August 2007, entrusts the task of drawing up a report every two years on the security and quality of electricity supply.	
Type of Instrument	Information	
State of progress	Planned	
Start of implementing	End of implementation	Comments
		Updated every 2 years
Responsible entity/entities	MEA	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market	
Info complementary		

Title of the measure	No 902 Report on security of supply in the gas sector in Luxembourg	
Description:	The Ministry of Energy and Spatial Planning (MEA) of the Grand Duchy of Luxembourg is entrusted by Article 16 of the Law on the organisation of the gas market, which entered into force in August 2007, with the task of submitting every two years a report on the security and quality of natural gas supply.	
Type of Instrument	Information	
State of progress	Planned	
Start of implementing	End of implementation	Comments
		Updated every 2 years
Responsible entity/entities	MEA	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the natural gas market	
Info complementary		

Title of the measure	No 903 Luxembourg Risk Preparedness Plan for the electricity sector	
Description:	European Union Regulation (EU) 2019/941 on risk-preparedness in the electricity sector lays down the rules governing cooperation between Member States to prevent and manage electricity crises. Under Article 10 of that regulation, the Minister for Energy, as the Luxembourg competent authority, and in collaboration with various national services and neighbouring States, is to draw up a risk-preparedness plan in the electricity sector for the Grand Duchy of Luxembourg.	
Type of Instrument	Planning	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
		Updated every 4 years
Responsible entity/entities	MEA	
Reference (s)	EU Reg. 2019/941	
Info complementary		

Title of the measure	N° 904 Contingency plan for the security of gas supply in Luxembourg	
Description:	Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard security of gas supply ('Regulation (EU) 2017/1938') requires each EU Member State, through its Article 8, to draw up an emergency plan containing the measures to be taken to eliminate or mitigate the impact of gas supply disruptions and to ensure the gas supply to 'protected' customers.	
Type of Instrument	Planning	
State of progress	Adopted	
Start of implementing	End of implementation	Comments
		Updated every 4 years
Responsible entity/entities	MEA	
Reference (s)	EU Reg. 2017/1938	
Info complementary		

Title of the measure	No 905 Preventive Action Plan	
Description:	Article 8 of Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard security of gas supply (hereinafter 'the Regulation') requires each EU Member State to draw up a Preventif Action Plan (PAP) containing the necessary measures to eliminate or mitigate the risks identified in the common and national risk assessments, including the effects of energy efficiency measures and demand-side measures.	
Type of Instrument	Planning	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
		Updated every 4 years
Responsible entity/entities	MEA	
Reference (s)	EU Reg. 2017/1938	
Info complementary		

Title of the measure	No. 906 Oil reserve	
Description:	This measure concerns the monitoring of oil reserves. As a member of the European Union and of the International Energy Agency (IEA), Luxembourg is required to have an oil reserve corresponding to an average of 90 days of imports from the previous year. Importers of petroleum products are also subject to the national legal obligation to store eight days on national territory, 37 days in the regional territory outside Luxembourg and the remaining quantities in the rest of the EU.	
Type of Instrument	Regulatory	
State of progress	Under analysis	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)	Amended Law of 10 February 2015 on the organisation of the market in petroleum products	
Info complementary		

Title of the measure	No 907 PLEF Support Group “Security of Supply”	
Description:	The Pentalateral Energy Forum is a regional energy cooperation framework that has initiated several actions for further integration of the electricity market and greater security of supply in Europe. The Luxembourg presidency in 2022 was marked by the war in Ukraine and the energy crisis. The existing trust network between the authorities and ministers of the different countries has proven to be very useful to strengthen coordination on gas storage, to exchange on energy saving campaigns and to compare and improve the respective assessments of security of supply at both gas and electricity level.	
Type of Instrument	Voluntary agreement	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)	https://benelux.int/files/7216/3845/2580/PENTA_MoU_def.pdf	
Info complementary		

Title of the measure	No 908 BeLux Crisis Group for natural gas	
Description:	Given the Belgo-Luxembourg common market area, collaboration between Belgium and Luxembourg is a key element for crisis management. For example, close collaboration took place in the preparation of contingency plans in order to align parts such as the definition of protected customers and the structure and logic of the measures. In the event of a national or European crisis, the competent authorities of Luxembourg and Belgium, together with the TSOs of both countries, shall consult each other on a regular basis in order to take stock of the common state of gas supply in the Belgo-Luxembourg common market area and to decide, if necessary, on the measures to be taken. There is a political agreement to deepen cooperation through the signature of an agreement duly detailed solidarity as soon as possible.	
Type of Instrument	Voluntary agreement	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 909 EU Electricity Coordination Group	
Description:	The Group offers a platform for strategic exchanges between Member States, national regulators, ACER, ENTSOE and the Commission on electricity policy. The group can be convened flexibly when there is a need for strategic discussions and will complement the technical exchange between Member States' experts in the cross-border committee.	
Type of Instrument	Other	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 910 EU Gas Coordination Group	
Description:	The Gas Coordination Group should have the role of advising the Commission in order to facilitate the coordination of security of supply measures in the event of an emergency at Union or regional level. It is also the main body consulted by the Commission in the context of the establishment of preventive action plans and emergency plans. The Gas Coordination Group should monitor the adequacy and appropriateness of the measures to be taken under Regulation (EU) No 994/2010 and exchange all information relevant to the security of gas supply at national, regional and Union level. The group was set up by Regulation 994/2010 of the European Parliament and of the Council, which is now replaced by Regulation 2017/1938. Its composition and operating rules are laid down in Commission Decision 2006/791/EC.	
Type of Instrument	Other	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 911 Security of supply in the hydrogen sector in Luxembourg	
Description:	Analysis of the security of supply of the future hydrogen sector to enable a safe and secure development of the hydrogen market in Luxembourg.	
Type of Instrument	Information	
State of progress	Planned	
Start of implementing	End of implementation	Comments
2028		
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

Title of the measure	No 912 Network development plans	
Description:	Set up network development plans for distribution networks to support the integration of generating facilities using renewable energy sources, to facilitate the establishment of energy storage facilities and the electrification of the transport sector, and to provide network users with appropriate information on planned grid extensions or improvements.	
Type of Instrument	Regulatory	
State of progress	Planned	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA	
Reference (s)		
Info complementary		

3.4 Dimension internal energy market

The implementation of the Clean Energy Package as a whole contributes significantly to the overall strengthening of the European internal market. It updates, inter alia, the rules governing the functioning of the internal market in electricity and transmission and distribution systems.

3.4.1 Electricity infrastructure

In order to continue to have sufficient interconnection capacity to cope with the energy transition, both in terms of consumption and decentralised production of electricity based on renewable energy, different projects will be implemented. Apart from efforts to upgrade transmission capacity to transport renewable electricity production from the north of the country to the central and southern consumption centres of the country by upgrading existing lines, project 380 will provide the necessary interconnections for access to the common market area with Germany.

Title of the measure	No 1001 Project 380

Description:	In cooperation with the German transmission system operator Amprion, Creos plans to build a 380 kV extra high voltage line from Bertrange to Aach (Germany) via Bofferdange and a transformation station 380/220/110-65-kV around Bofferdange/Altlinster. In the long run, the existing infrastructure, dating back to the 60s, will no longer be able to safely cover the ever-increasing electricity needs due to the country's strong economic and demographic development. This new construction project will modernise the network, ensure national security of supply and improve the quality of life of the whole population.	
Type of Instrument	other	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
	2028	
Responsible entity/entities	Other Creos	
Reference (s)	https://www.creos-net.lu/creos-luxembourg/projets/380/projet-380.html	
Info complementary		

Title of the measure	No 1002 Strengthening the national high voltage network	
Description:	In order to facilitate the integration of more renewable electricity generation especially in the north of the country, Creos plans to strengthen its high voltage grid and eventually replace 65 kV lines with 110 kV lines.	
Type of Instrument	Other	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	Other (s)	
Reference (s)		
Info complementary		

3.4.2 Energy transmission infrastructure

The dismantling of the old steam turbine (TGV) Twinerg significantly reduced demand for gas at peak times. The existing gas infrastructure therefore remains capable of covering current and foreseeable supply needs. Therefore, no further gas infrastructure expansion measures are foreseen. Import capacity will be improved through other measures, such as transnational cooperation.

Although no further development measures are foreseen in conventional natural gas infrastructure, close cooperation is ongoing with neighbouring countries to make optimal use of the existing gas infrastructure, in particular in the event of a crisis. This coordination continues to take place both bilaterally, regionally (especially within the Pentalateral Energy Forum Gas Platform) and European (ENTSO-G).

The gas infrastructure is financed through the corresponding network charges approved by the Institut Luxembourgeois de Régulation (ILR). The use of EU funds is not currently foreseen.

The proposal for a Directive on common rules for the internal markets in renewable and natural gases and in hydrogen, presented in December 2021, lays down rules for the transmission, supply and storage of natural gas and for the transition from the natural gas system to a system based on renewable gases. It lays down common rules for the transport, supply and storage of hydrogen through the hydrogen system. It lays down the rules relating to the organisation and functioning of this sector, access to the market, the criteria and procedures applicable to the granting of authorisations for networks, supply and storage of hydrogen and the operation of systems. It lays down rules for the progressive establishment of an interconnected Union-wide hydrogen system that contributes to the reduction of net greenhouse gas emissions from hard-to-decarbonise sectors, thereby supporting the decarbonisation of the Union energy system.

This proposal for a Directive, which is still following the European legislative procedure, will provide the basis for modelling the hydrogen market in which Luxembourg will actively position itself. A first step in this direction will therefore be the study on future hydrogen infrastructure needs in the Benelux region and interconnections with neighbouring regions, which will be finalised shortly.

3.4.3 Market integration

The introduction of the ‘BeLux’ common gas market with Belgium in 2015 is one of the key measures to improve the integration of the Luxembourg gas market. This common gas market makes it easier for Luxembourg suppliers to access Zeebrugge’s liquefied natural gas terminals trading platform and, beyond that, gas storage infrastructure. This fosters competition throughout the common market and ensures a more secure supply at lower cost to gas consumers.

Within the Pentalateral Energy Forum, the Market Integration Support Group will further develop the further integration of electricity markets in the region. Indeed, the Forum is a European pioneer exploiting the full potential of transmission capacity by basing its capacity allocation methods on load flows. This will further improve market liquidity and ensure efficient congestion management and, more generally, ensure an efficient market at regional level. Opportunities for cross-border participation in capacity markets in France and Belgium are also being discussed. The Pentalateral Energy Forum is a regional energy cooperation framework that has initiated several actions for further integration of the electricity market

In the context of the common market area with Germany, Luxembourg actively supports the merger of the electricity markets. The further development of the capacity calculation methodology and congestion management within the Core region is a top priority for the day-ahead market. For the intraday market, both active participation in the integrated XBID platform and harmonisation of conditions for Luxembourg network users against German framework conditions (in particular Gate Closure Times) should be noted. Access to the German and European balancing markets for users of the Luxembourg network has been partially opened up and needs to be improved. A particular challenge is that although the Creos transport network is a separate Scheduling Area, Load-frequency control for the whole common area is supported by the German company Amprion. Access for Luxembourg network users to the German and European balancing market will boost decentralised electricity production in Luxembourg and create new marketing opportunities for households, businesses and the industry in the field of DSR. Therefore, Luxembourg is also actively participating in the relevant European Energy Exchange Platforms (MARI, PICASSO).

In this context, it is also worth mentioning the Vianden pumping hydropower plant, which is directly connected to the German transmission network and contributes significantly to system stability and security of supply in the Greater Region.

In order to allow for an active participation of electricity consumers in the market, Luxembourg had legally obliged system operators to replace at least 95 % of all electricity meters with smart meters by the end of 2020. The obligation has been met and today more than 98 % of meters have been replaced by smart meters. The technical bases are therefore laid, for example, for the introduction of variable tariffs over time.

Title of the measure	No 1003 Smart Meter rollout	
Description:	The installation of smart meters throughout the territory will contribute to the efficiency of the energy system and security of supply. National legislation provides for the deployment of smart meters of the order of 95 % in the electricity sector and 90 % in the gas sector by the end of 2020.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
	2020	
Responsible entity/entities	Other (s)	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market	
Info complementary		

Moreover, smart meters provide a technical basis that improves transparency, quality of service and efficiency and offers opportunities for innovative energy services. This includes, for example, transparent access to own consumption data, improved commercial communication processes, boosting consumer flexibility and more efficient network operation. However, in order to take full advantage of these opportunities, it is necessary to further develop the data infrastructure. Thus, the amended version of 1^{August} 2007 on the organisation of the electricity market provided for the development of an energy data platform enabling, inter alia, authorised users (that is to say, the end-user himself) to access relevant data on their electricity consumption, taking into account all aspects of data protection which are an absolute priority. This platform is intended as a central tool for a strategy for the development of flexibility in the electricity sector. Together with smart meters, this platform facilitates the creation of innovative products around flexibility and decentralised production.

Title of the measure	No 1004 Energy Data Platform	
Description:	Implementation of a national IT energy data platform that will improve the transparency and efficiency of the electricity and natural gas market, facilitate new services such as demand response to system balancing, and help the market to benefit from technical and economic efficiency gains, in particular for large energy customers. It will also ensure compliance with data protection as an integral feature of the processing operations carried out on the platform. Thus, the text specifies, inter alia, the purposes of the platform, the implementing rules, the data to be entered, data protection, and the rules on access to the platform and provides, inter alia, that the market communication is managed by that platform.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
	2026	
Responsible entity/entities	Other (s)	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market	
Info complementary		

Title of the measure	No 1005 Regulatory framework for aggregation	
Description:	A regulatory framework for aggregator activity will be introduced following an amendment to the Electricity Market Design Act. This framework, the details of which will be developed by the regulator, will aim at clarifying the role of aggregator, including its rights and responsibilities towards the customer and other market participants, in order to activate this market, which aims to enable customers to valorise their flexibility.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA – ILR	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market	
Info complementary		

Title of the measure	No 1006 New tariff structure for network tariffs	
Description:	ILR plans to review the structure of network tariffs with a view to establishing a fair pricing structure conducive to the development of services that contribute to energy policy objectives, including: • assurance of the reliability and quality of electricity supply,• the proportionate level of costs in relation to performance• the promotion of innovation and economic growth; • the development of clean energy technologies • and, in general, the encouragement of all measures and behaviours contributing to the decarbonisation of our societies.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
	1January 2024	
Responsible entity/entities	ILR	
Reference (s)	Draft amendment to Regulation (EC) No E20/22/ILR of 26 May 2020 laying down the methods for determining tariffs for the use of networks	
Info complementary	https://web.ilr.lu/FR/Professionnels/Electricite/Commun/Consultations	
	/_layouts/15/ILR.Internet/ConsultationsDetails.aspx? cid = 117 & WID = B85F1184 — 06D2-4B8E-9A21-0C545B8D293C Source =https://web.ilr.lu /FR/professionals/Electricite/Commun/Consultations	

Title of the measure	No 1007 Dynamic electricity prices	
Description:	An obligation to offer dynamic prices will be introduced for any supplier serving more than 15 000 customers. Dynamic prices are price formulas that reflect price changes in spot markets, including day-ahead and intraday markets, at intervals at least equivalent to the frequency of market settlement. The possibility for final customers to expose themselves to such prices, giving them the opportunity to capitalise on their flexibility	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
Responsible entity/entities	MEA, Other	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market	
Info complementary		

Existing regulations have been adapted to create the appropriate framework for the active participation of consumers in the market.

The implementation of the Clean Energy Package under the amended Electricity Market Design Act of 1 August 2007 increases the electricity flexibility of consumers. The amendments to this law, most recently in 2022, have made it possible to regulate and promote self-consumption based on renewable energy, whether individual or collective. In addition, the concept of energy communities has been introduced, which allows the latter to produce, consume, store and sell the electricity generated by the generating units owned by it or its members, to organise the sharing, within the energy community, of the electricity produced by the generating units owned by that energy community or its members or shareholders, to access all relevant energy markets directly or through aggregation and to provide energy efficiency services, recharging services for electric vehicles or other energy services to its members or shareholders.

ILR publishes annual reports on the electricity and gas market. In particular, these reports analyse the competitive situation of the markets on the basis of the number of suppliers operating in Luxembourg and the switching rates among customers in different segments. In addition, ILR draws up an annual report on the compliance of electricity and gas supply prices with the public service obligations.

Title of the measure	No. 1008 Facilitation of electricity sharing and energy communities	
Description:	As provided for in the law since February 2021, the energy community and collective self-consumption will be encouraged by the legal framework and accompanying measures. Electricity sharing shall be facilitated by a platform operated by the network operators allowing the allocation of energy quantities according to the needs of a sharing group. The Klima-Agency will advise citizens wishing to create energy communities and make available standard agreements facilitating this creation.	
Type of Instrument	Regulatory, information	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2021		
Responsible entity/entities	MEA, Klima-Agency, Network Managers	
Reference (s)	Amended Law of 1 August 2007 on the organisation of the electricity market	
Additional info		

Title of the measure	No 1009 Support to long-term contracts (power purchase agreements PPP)	
Description:	As set out in Solidaritéits Pak 2.0 of 28 September 2022, this measure will encourage companies to source energy directly from renewable energy suppliers through power purchase agreements (PPPs). PPPs mainly encourage the consumption of energy from renewable resources at stable prices which are currently below market prices. They thus contribute as much to the competitiveness of businesses in the current crisis as to the energy transition through the decarbonisation of production processes. In this context, the Government will develop new derisking instruments for certain sectors at particular risk of a competitive disadvantage due to the energy cost due to the energy crisis. Through these instruments, these companies will be able to benefit from aid to cover the difference between the market price and the energy price paid in the context of a PPP in the event that energy prices on the market fall below PPP prices. The aid may not exceed two thirds of the price difference up to a maximum of EUR 65/MWh. These changes will be made subject to approval by the relevant services of the European Commission.	
Type of Instrument	Regulatory	
State of progress	Implemented	
Start of implementing	End of implementation	Comments
2022	2023	
Responsible entity/entities	MINECO, MEA	
Reference (s)	Solidariteits Pak 2.0	
Additional info		

3.4.4 Energy poverty

Prevention and reduction of energy needs is the key to minimising the risk of people not having sufficient means to heat their homes or of being unable to pay their bills for electricity, gas, water and heating. Specific measures are targeted for households in energy poverty and/or low income.

Measure 317: Building awareness, information, guides and consultancy services

Measure 311: Individual housing aid scheme

Measure 312: Stone aid scheme

Measure 329: Assistance to households in energy poverty

These measures are complementary to cross-cutting measures:

Measure 310: “Climate Loans” aid scheme

Measure 316: Long-term building renovation strategy

Measure 309: Pre-financing under the Klimabonus Wunnen scheme

Measure 324: Minimum energy performance requirements for rented dwellings (owner incentives)

Measure 405: Promoting public transport

In case these measures are not sufficient, the current social assistance legislation stipulates that any person who fulfils the conditions for eligibility for social assistance is entitled to a minimum supply of domestic energy under specified conditions, if they are unable to cover the cost of their domestic energy.

3.5 Dimension Research, innovation and competitiveness

3.5.1 Specific R & D & I measures

The strategies and tools in place as well as the sample of public and private R & D & I activities highlighted in Chapter 2.5 show the broad scope of the themes. It appears that despite existing strategies, R & D & I capacities for energy transition are often too fragmented and insufficiently coordinated, not allowing on the one hand to produce effective responses to interdisciplinary challenges, and on the other hand to activate these responses and implement solutions. The NRF also recognised this lack of coordination and launched at the beginning of 2023 a new ncer project (National Centre of Excellence in Research) on energy transition and climate action (listed as Measure 115 below)44.

Part of the proposed measures directly related to R & D & I actors and included in a transverse way in Chapter 3.1 – "Decarbonisation" dimension therefore aim to strengthen interdisciplinary collaborations across the entire maturity chain (from basic research to technological or regulatory implementation) and thus accelerate the implementation of solutions produced by the public and private R & D & I ecosystem in Luxembourg. They will contribute to increasing the country's attractiveness to innovative talent and actors in all scientific and technological disciplines and to enhancing the competitiveness of actors. Two types of measures are prioritised for these purposes, measures to (1) provide incentives for inter- and transdisciplinary collaborations through federative funding and (2) strengthen the University of Luxembourg's research teaching capacities through teacher chairs, which will also contribute to the development of existing academic ecosystems. R & D & I specific measures:

> Measure 115: National Centre of Excellence in Research (ncer) for energy transition and climate action
> Measure 116: Strategic RDI programme for the governance of the energy transition and climate action
> Measures No 117: Support the establishment of research chairs and public-private or public-public partnerships at the University of Luxembourg and at public research centres

Measure No 117 reflects the importance of the creation, dissemination and dissemination of scientific and technological knowledge and know-how in initial (including academic) and continuing training, and of society as a whole. The systemic changes required to succeed in the energy transition require first and foremost its ownership by all actors in society. It is important to note that the establishment of these chairs will be conditional on long-term third-party funding to ensure the involvement of public and private stakeholders, that the chairs must be integrated into the university's thematic development strategy and that they will ultimately have to be validated by the university's governance bodies.

These measures are in line with the R & D & I measures proposed in the 1st[edition] of the NECP for the period 2021 to 20230 below and contribute to making them more operational, namely:

- Rebuilding a research infrastructure involving all relevant actors in the field of research and innovation
- Continued increase in investment in energy research and development
- Strengthening the efforts and capacities of national research institutions
- Luxembourg as an international hub for climate solutions

3.5.2 Other NECP measures related to R & D & I activities

Beyond the specific R & D & I measures, many other NECP measures can rely on public and private R & D & I skills and vice versa feed into R & D & I activities. Indeed, the implementation of the ambitious objectives of the NECP relies largely on accelerated technological and socio-economic innovation. Brief details of the examples adduced are as follows:

> Measures No 106, 107, 108, 110 or 112, which propose alternative approaches to the development of land and urban planning and support, in particular, the municipalities to put them in place,

44 The Ministry of Higher Education and Research and the National Research Fund launch the National Centres of Excellence in Research programme – gouvernement.lu//Le Government of Luxembourg (https://gouvernement.lu/fr/actualites/toutes_actualites/communiques/2023/01-janvier/24-meisch-pgrogramme-cherche.html)

Measures No 215, 216, 222 or 223, aimed at the development of renewable energy production and storage chains,
Measures 316, 322 or 323 in relation to sustainable construction and renovation and the need to put in place life cycle assessment methodologies to assess the overall climate impacts of buildings,
Measures No 427, 510, 513, 514 or 522 in relation to the decarbonisation of transport, logistics and industrial or artisanal production activities, including carbon capture and use (CCU) and direct air capture (DAC),
Measures 521, 602 and 603 aimed at a more resource-efficient management and reduction of the associated carbon footprint through the principles of the circular economy.

3.5.3 Financing and cooperation

The objectives and means of financing R & D & I activities are described in Chapter 2.5, both at national and European level. Given the size of the country and the very strong organisational links with the Region and Europe, collaborations with RDI actors beyond national borders are crucial for developing common solutions. In particular, these collaborations are successfully supported by Luxinnovation: the MESR activity report 2022 provides information and 150 new Horizon Europe contracts involving Luxembourgish participants were signed in 2022.45 Luxembourg's maintenance of the7th place in the European Innovation Table in 2022, with a top ranking in the ranking of the most attractive research systems46, also reflects the importance attached to international cooperation.

Two NECP measures specifically contribute to enhancing the funding available for R & D & I activities in relation to the energy transition and climate action, namely:

Measure 103: Climate and Energy Fund, established by the Climate Law (Measure 101) Measure 104: Just Transition Fund, a new financial instrument for EU cohesion policy.

A number of NECP financial measures also contribute to ensuring affordable energy prices for businesses, which is an important and equally important factor of competitiveness, helping companies to decarbonise their own activities. This includes a package of financial support measures, described in chapter 3.1.1.4 (decarbonisation dimension industry) and chapter 3.4 (internal energy market dimension). In addition, measures for decarbonised mobility and logistics (Nos 425, 426 and 427). The effects of these measures in terms of nationally competitive energy prices are illustrated in Chapter 4.5.3 – Electricity and gas markets, energy prices.

2022 activity45 report of the Ministry of Higher Education and Research (https://gouvernement.lu/dam-assets/en/publications/reporting activity/minist-enseignement-superieur-recherche/2022-rapport-activite-mesr/mesr-rapport-annuel-2022.pdf

The46 three indicators under the heading "attractiveness of the research system" are international scientific co-publications, quotes from scientific publications and the share of foreign doctoral candidates, see also https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en#european- innovation-scoreboard-2022.

4 current state of play and projections based on existing policies and measures

In order to create a sound analytical basis for Luxembourg's energy and climate policy analysis, modelling was entrusted to a group of national experts. The long-term projections have been prepared by STATEC in collaboration with the Environment Administration (AEV), the Rural Economy Service (SER) and experts from the various ministries concerned. STATEC was responsible for modelling energy consumption and production as well as GHG emissions from combustion, while RES treated the agriculture sector and VEA the waste sector.

As requested by Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, two scenarios have been identified:

- The WEM (With Existing Measures) scenario is based on existing policies and measures, which were adopted until 31 December 2021. It mainly consists of an extension of trends in historical data and is presented in Chapter 4.
- The WAM (With Additional Measures) scenario integrates additional (new and reinforced) policies and measures, as described in Chapter 3. It is presented in Chapter 5.

The projections were made using a number of complementary tools. There are three main STATEC models:

- The Modux econometric model is used to prepare the macroeconomic projections as a basis for the annual update of the Stability and Growth Programme under the "European Semester". The main results are economic and demographic growth, as well as fuel sales by 2027.
- The LuxGEM general equilibrium model is used for macroeconomic and demographic projections for 2050. It replicates Modux's medium-term projections and is coupled with the NEAM energy model. Unlike the latter, LuxGEM makes it possible to assess the impact of tax measures such as the CO_2 tax.
- The NEAM energy model makes it possible to project energy consumption and GHG emissions, including all available information on the flows and stocks of buildings and vehicles. For example, it makes it possible to assess the impact of measures concerning buildings, the impact of electric cars or modal choice.

In general, it should be noted that modelling and projections, which derive from them, serve as a guideline, as they take into account the most up-to-date data and the specificities of Luxembourg, but any long-term projection is always linked to inherent uncertainties. This is particularly true for a small, open economic system such as Luxembourg. Therefore, individual decisions or decisions taken abroad at European level, or even developments at global level, may lead to significant changes compared to the scenarios presented in this plan.

4.1 Projected evolution of key exogenous factors

Both scenarios (WEM and WAM) are based on a set of largely identical assumptions for the main exogenous factors.

4.1.1 Macroeconomic forecasts

According to STATEC projections, Luxembourg's population will increase from around 626 000 in 2020 to around 764 000 in 2030, to around 900 000 in 2040 and 1 019 000 in 2050. This is equivalent to an average growth of 2.00 % per year until 2030, which will then decline to 1.65 % per year between 2030 and 2040 and to 1.25 % per year between 2040 and 2050. Overall, Luxembourg's population will increase by around 22 % by 2030 compared to 2020, by around 44 % by 2040 and by 63 % by 2050.

Table 33: Population growth and gross domestic product (GDP)

	Units	2020	2025	2030	2035	2040	2045	2050
Population	Thousand	626	685	764	833	900	962	1019
GDP	Annual average growth in%	— 0,80	2,96	2,75	2,75	2,75	2,75	2,75

Source: STATEC (2023)

According to Modux's medium-term projections (up to 2027), STATEC modelling assumes an annual growth rate of gross domestic product of 2.96 % in 2025 and then stabilises at 2.75 % from 2028 onwards.

4.1.2 Assumptions on energy prices

As regards the assumptions about price trends in global and European energy markets, the European Commission recommendation47 has been followed.

Table 34: Assumptions on price developments for fossil energy sources

	Unit	2020	2025	2030	2035	2040	2045	2050
Mineral oil	EUR 2020/tep	268	643	643	643	680	738	824
Natural gas (NCV)		130	554	473	473	473	473	494
Coal		67	128	130	131	139	146	153

Source: European Commission (2022)

4.2 Decarbonisation dimension

4.2.1 GHG emissions and removals

4.2.1.1 Trends in annual GHG emissions for the period 2005 to 2021

The evolution of annual GHG emissions from 2005 to 2021 is presented in Table 35. In 2021, a total of 9,39 million t CO_{2eq} was emitted, corresponding to a reduction of 28 % compared to 2005. 86 % of 2021 emissions (8,07 million t CO_{2eq}) are attributed to Luxembourg under the Effort Sharing Regulation48, the scope of which is identical to that of the amended Climate Law of 15 December 2020 for the period 2021-2030 (ESR emissions/Climate Law). 14 % (1,32 million t CO_{2eq}) are accounted for under the Emission Trading System49 (ETS emissions). Finally, in 2021, the balance of GHG emissions and removals from land use, land use change and forestry (Land Use Change and Forestry)50 amounted to -0,61 million t CO_{2eq} (LULUCF).

In terms of ESR emissions/Climate Law, emissions in 2021 were slightly higher than in 2020 (+ 5.5 %), a year marked by the COVID-19 pandemic lockdown, but were 12.7 % below the 2019 level, respectively 20.2 % below the base year 2005 level. They are also 1.3 % lower than the 2021 emission allocation set under the Grand Ducal Regulation of 22 June 2022 determining annual greenhouse gas emission allocations for the period up to 31 December 2030 (see also Figure 1). The national emission reduction target for 2021 has therefore been met.

Table 35: Historical GHG emissions and removals

[Thousand tonnes CO_{2eq} (AR5)]	2005 *		2019	2020	2021
Energy and manufacturing industries, construction	442		545	528	594
Transport	7164		6170	4618	4919
Residential and service sector buildings	1630		1608	1587	1647
Agriculture and forestry	696		714	726	720
Treatment of waste and waste water	184		206	194	192
Emissions ESR/Climate Law	10116		9244	7653	8073
ETS EMISSIONS	2919		1496	1377	1317
Emissions TOTALES – ESR/Climate Law & ETS	13035		10740	9030	9391
LULUCF	— 572		— 367	— 451	— 608

* The 2005 data are the agreed figures for determining the national 2030 climate target as well as the sectoral targets, based on the verified 2021 inventory and taking into account the current scope of the EU Emissions Trading System (EU-ETS).

Source: GHG Emission Inventory (submission of March 2023)

47European Commission (2022), Recommendation for reporting on GHG projections in 2023

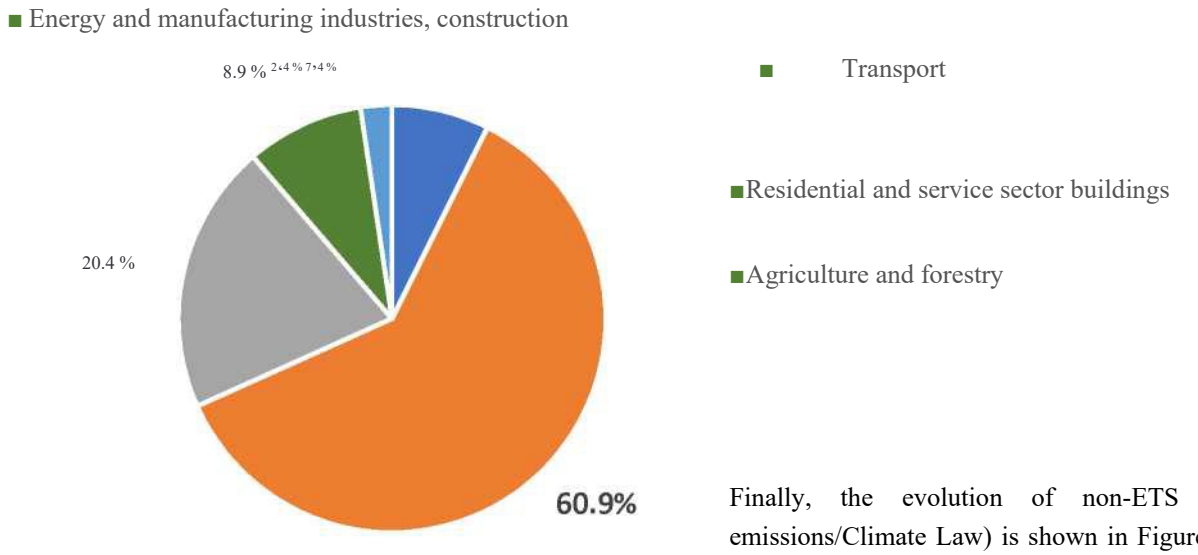
48R (EU) 2018/842 on binding annual GHG emission reductions by Member States from 2021 to 2030. This Regulation took over from Decision 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions (Effort Sharing Decision).

49Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Union

50R (EU) 2018/841 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry

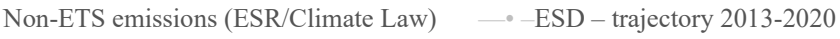
Furthermore, in 2021, ESR emissions/Climate Law were dominated by the transport sector (60.9 %), followed by buildings (20.4 %), agriculture (8.9 %), industry (7.4 %) and waste (2.4 %), as illustrated in Figure 19.

Figure 19: Sectoral distribution of GHG emissions according to the Climate Law in 2021



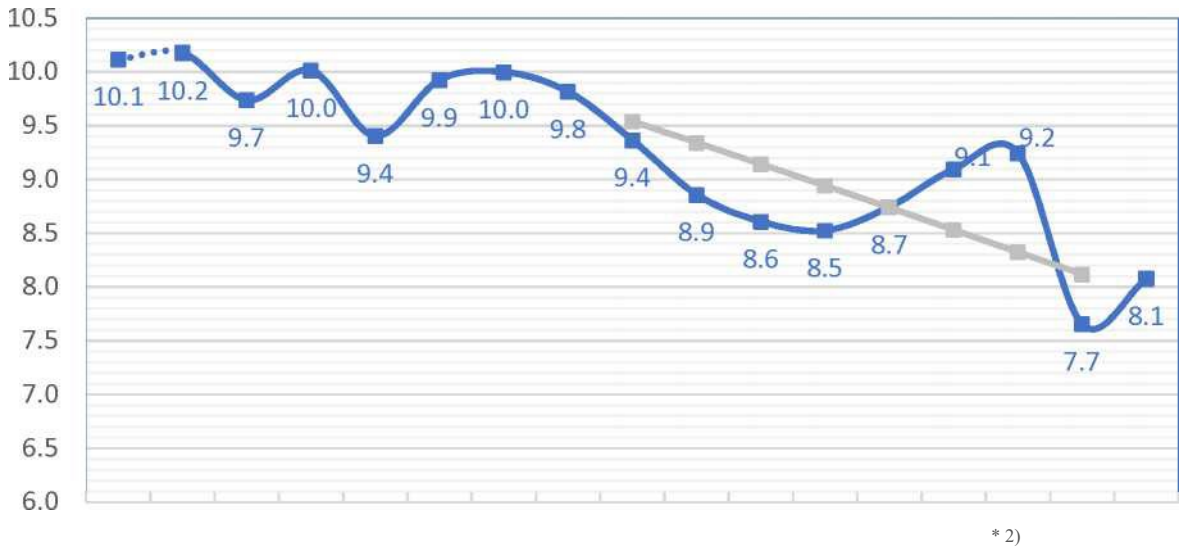
Source: GHG Emission Inventory (submission of March 2023)

Finally, the evolution of non-ETS emissions (ESR emissions/Climate Law) is shown in Figure 20 for the whole period from 2005 to 2021. It is compared to the trajectory of Decision 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions (ESD) from 2013 to 2020.



Source: GHG Emission Inventory (submission of March 2023)

Figure 20: Evolution of non-ETS emissions (ESR emissions/Climate Law) for the period 2005-2021



4.2.1.2 Projections based on existing policies and measures (WEM scenario)

The WEM (With Existing Measures) scenario is based on existing policies and measures, which were adopted until 31 December 2021. The following tables show the results of the WEM projections for each of the 5 sectors of the Climate Law, for installations falling under the scope of the ETS Directive and for the LULUCF sector.

Table 36: Projections of GHG emissions and removals until 2030 based on existing policies and measures (WEM scenario)

[Thousand tonnes CO_{2eq} (AR5)]	2021 *	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy and manufacturing industries, construction	594	569	545	523	502	481	460	439	419	400
Transport	4919	4331	4494	4575	4550	4476	4401	4237	4072	3914
Residential and service sector buildings	1647	1670	1634	1594	1557	1522	1487	1452	1417	1382
Agriculture and forestry	720	715	713	706	702	700	699	701	702	704
Treatment of waste and waste water	192	187	184	180	177	173	170	167	164	165
Emissions ESR/Climate Law	8073	7472	7570	7578	7487	7352	7217	6996	6774	6565
ETS EMISSIONS	1317	1310	1304	1297	1392	1449	1439	1429	1420	1411
Emissions TOTALES – ESR/Climate Law & ETS	9391	8783	8874	8875	8880	8801	8656	8426	8194	7976
LULUCF	— 608	— 422	— 398	— 360	— 327	— 306	— 278	— 266	— 235	— 201

* Emissions for the year 2021 are observed data in the latest GHG emission inventory (submission of March 2023). Projections start from 2022 onwards.

Source: STATEC, AEV &SER (2023)

Table 37: Projections of GHG emissions and removals until 2050 based on existing policies and measures (WEM scenario)

[Thousand tonnes CO_{2eq} (AR5)]	2025	2030	2035	2040	2045	2050
Energy and manufacturing industries, construction	502	400	328	267	227	197
Transport	4550	3914	3253	2808	2517	2296
Residential and service sector buildings	1557	1382	1210	1040	883	731
Agriculture and forestry	702	704	711	705	698	692
Treatment of waste and waste water	177	165	167	169	171	171
Emissions ESR/Climate Law	7487	6565	5668	4988	4495	4086
ETS EMISSIONS	1392	1411	1368	1330	1308	1293
Emissions TOTALES – ESR/Climate Law & ETS	8880	7976	7036	6318	5803	5379
LULUCF	— 327	— 201	— 53	— 211	— 360	— 508
Total Balance Sheet – ESR/Climate Law & ETS &LULUCF	8552	7775	6983	6107	5443	4871

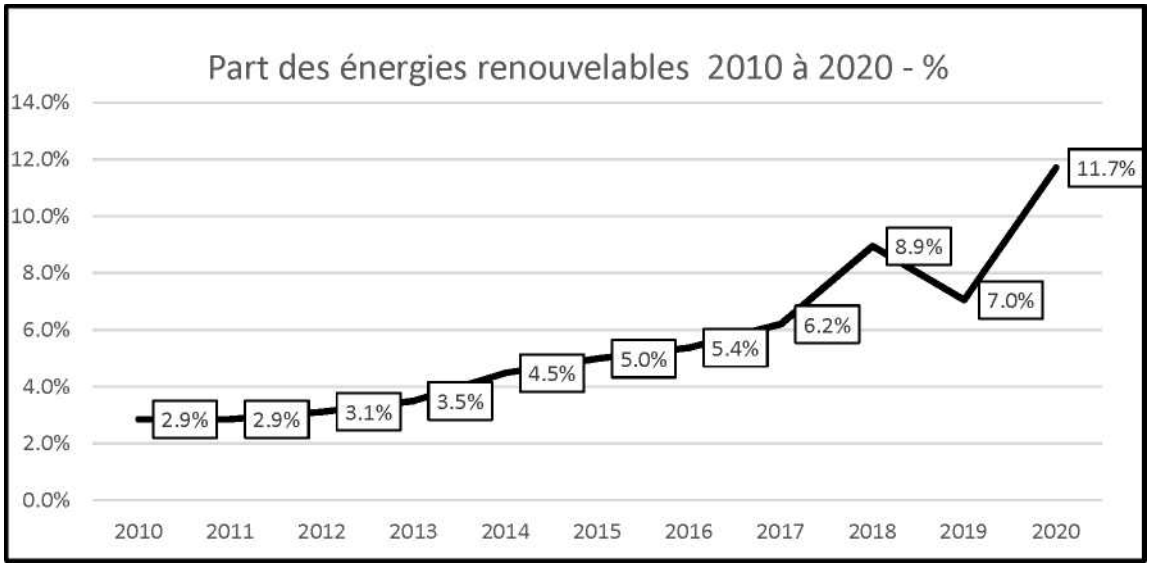
Source: STATEC, AEV &SER (2023)

4.2.2 renewable energy

The Government Council adopted on 20 May 2020 the initial version of the National Climate and Energy Plan (NECP). The plan describes the policies and measures following a baseline and baseline scenario describing the ambitious national targets to be pursued in order to achieve a reduction in greenhouse gas emissions (55 %), a minimum share of renewable energy in Luxembourg's gross final energy consumption (25 %) and energy efficiency measures (reducing energy consumption by 40 to 44 %) by 2030. Details of sectoral objectives and related technologies can be found in Chapter 2.1.2 Renewable Energy. The following chapter describes the scenario with existing measures.

Baseline Situation: historical evolution of energy production from renewable sources across sectors from 2010 to 2020

Figure 21: Share of renewable energy in gross final energy consumption: period 2010 to 2020, including European cooperation



Source: EUROSTAT (SHARES)

Throughout the period 2010-2020 and driven by the Renewable Energy Action Plan, the share of renewables has steadily increased (Figure 21). This graph includes both national production and European statistical transfers. The gap in 2019 is explained by the fact that no indicative trajectory or binding target were set and no statistical transfers took place.

In 2021, according to figures published by EUROSTAT, the overall share of renewable energy in gross final energy consumption was 11.7 %, representing substantial growth over the last decade.

The trend in the shares of renewable energy in the electricity, heat and transport sectors for the years 2017 to 2021 is shown in Table 38. During this period, the share of renewable energy almost doubled from 5.9 % to 9.9 % (without European cooperation). Shares in the electricity and heat sectors increased by around 70 %, while in the transport sector the increase was around 50 %.

Table 38: Share of renewable energy by sector between 2017 and 2021

EUROSTAT-SHARES	2017	2018	2019	2020	2021
RES share, electricity sector%	8.1 %	9.1 %	10.9 %	13.9 %	14.2 %
RES share, heat sector%	7.5 %	8.5 %	8.9 %	12.7 %	12.9 %
RES share, transport sector (without multipliers)%	5.4 %	5.4 %	7.0 %	8.0 %	8.0 %
Total RES share – Production/Consumption%	5.9 %	6.2 %	7.0 %	10.1 %	9.9 %
Total RES share – including RES cooperation%	5.9 %	8.6 %	7.0 %	11.7 %	11.7 %

ENR: renewables

The distribution of renewable energy sources differs depending on the feasibility of potential projects on the national territory. Due to its geography, territorial isolation and topography, Luxembourg focuses primarily on the deployment of wind, photovoltaic and biomass, while ensuring the availability of feedstock at regional level and compliance with sustainability and greenhouse gas emissions saving criteria.

NECP 2020: comparison: baseline (WEM) and Target Scenario (WAM)

Table 39: Share of renewable energy by sector by 2040 – NECP baseline scenario

Referenzszenario

	EE-Energieeizeugung, Energiemengen absolut					EE-Ante	L, gemessen an (sektoraler) Nachfrage				
	Eipheit 2020	2025	2030	2035	2040	Einheit	2020	2025	2030	2035	20 * 0
EE-Strom	752	1.249	1.731	2.071	2.332		11.9 %	19.4 %	26.5 %	31.3 %	34.7 %
EE-Wârm	1.626	2.070	2.462	2.699	2.896		12.1 %	15.4 %	18.6 %	20.4 %	21.9 %
EE-Biokraftstoffe	1.855	1.892	1.993	1.450	1.450		7.7 %	8.0 %	8.0 %	5.6 %	5.5 %
EE-Verkehr, gesamt *	2.784	3.438	4.463	4.355	5.390		11.1 %	13.5 %	16.1 %	15.1 %	17.6 %
EE-Gesamt, national	4.232	5.211	6.187	6.221	6.679		9.2 %	11.2 %	12.9 %	12.8 %	13.5 %
EE-Kooperationsbedarf	1.000	2.917	4.833	4.833	4.833		2.2 %	6.2 %	10.1 %	9.9 %	9.7 %
EE-Gesamt, inkl. Kooperation	5.232	8.128	11.020	11054	11.512		11.3 %	17.4 %	23.0 %	22.7 %	23.2 %
Vergleich: Bruttoend-energiebedarf * *	46.119	46.717	47.913	48.773	49.650						

GWh

54

The 2020 NECP baselinescenario, based on existing measures (WEM), is evolving continuously but scarcely throughout the period 2030 to 2040. Renewable energy production increased from 6.187 GWh in 2030 (without European cooperation) to 6.679 GWh in 2040 – growth of 8 % over a 10-year period (Table 39). This rather low growth in the baseline scenario shows the need for additional measures to accelerate the deployment of renewable energy.

Table 40: Share of renewable energy by sector by 2040 – NECP target scenario 2020

Zielszenario Paris Art. 2.1a

	EE-Energieerzeugung, Energiemengen absolut					EE-Ante	L, gemessen an (sektoraler) Nachfrage				
	Einheit	2020	2025	2030	2035	2040	EI nhei t	2020	2025	2030	2035	2040
EE-Strom	GWh	748	1.563	2.251	2.680	3.150	%	11.9 %	23.5 %	33.6 %	38.8 %	45.4 %
EE-Wârme EE-Biokraftstoffe		1.626	2.030	2.551	2.495	2.609		13.7 %	19.9 %	30.5 %	35.8 %	47.1 %
EE-Verkehr, gesamt *		1.632	1.563	1.485	1.738	1.749		7.5 %	8.8 %	10.0 %	14.4 %	18.7 %
EE-Gesamt, national		2.581	3.755	4.769	7.391	9.587		11.3 %	18.4 %	25.6 %	40.4 %	54.3 %
EE-Kooperationsbedarf		4.006	5.156	6.287	6.914	7.508		9.4 %	13.9 %	19.6 %	24.8 %	31.9 %
EE-Gesamt, inkl. Kooperation		1.000	1.374	1.748	1.748	1.748		2.3 %	3.7 %	5.4 %	6.3 %	7.4 %
Vergleich: Bruttoend-energiebedarf * *		5.006	6.530	8.035	8.662	9.257		11.8 %	17.6 %	25.0 %	31.0 %	39.3 %
		42.587	37.203	32.141	27.926	23.526						

Thecomparison of the two scenarios shows that from the outset there was a clear political will to progress in renewable energy production on the national territory. For 2030, total energy consumption is significantly reduced, in particular on the basis of energy efficiency measures. As a result, the share of renewable energy in gross final energy consumption increases from 12.9 % to 19.6 % for the target scenario. For 2040, national renewable energy production is increasing by 830 GWh. The share of renewable energy increased from 13.5 % to 31.9 % (Table 40).

This large gap between the two scenarios shows that the renewable energy targets are ambitious and have a significant impact on the share of renewables. The relative increases between the different scenarios are shown in Table 41.

Tableau 41: Relative differences between the target scenario and the baseline scenario – NECP 2020

Verânderung Zielszenario zu Referenzszenario

	EE-Energieerzeugung, Energiemengen absolut					EE-Ante	L, gemessen an (sektoraler) Nachfrage				
	Einheit	2020	2025	2030	2035	2040	EI nheit	2020	2025	2030	2035	2040
EE-Strom	%. Verand-erung, brrngrn auf Referenz — Szenario	— 0.5 %	25.2 %	30.0 %	29.4 %	35.0	%t Verand-erung, brouth auf Referenz — szenano	—	21.1 %	26.4 %	24.0 %	31.0 %
EE-Wârm		0.0 %	— 1.9 %	3.6 %	— %			0.1 %	29.2 %	63.8 %	75.6 %	114.6 %
EE-Biokraftstoffe		— 12.0 %	— 17.4 %	— 25.5 %	7.6 %	—		13.4 %	10.1 %	25.6 %	155.2 %	242.3 %
EE-Verkehr, gesamt *		—	9.2	6.9 %	19.8 %	9.9 %		-2.5 %	36.2 %	59.3 %	168.1 %	208.9 %
EE-Gesamt, national		— 5.3 %	— 1.1 %	1.6 %	11.1 %	12.4 %		2.5 %	24.2 %	51.5 %	94.1 %	137.2 %
EE-Kooperationsbedarf		0.0 %	— 52.9 %	— 63.8 %	— 63.8 %	— 63.8 %		8.3 %	— 40.8 %	— 46.1 %	— 36.8 %	— 23.7 %
EE-Gesamt, inkl. Kooperation		— 4.3 %	— 19.7 %	— 27.1 %	— 21.6 %	— 19.6 %		3.6 %	0.9 %	8.7 %	36.9 %	69.7 %

• Inkl. Multîplikationsfakloren gemàB Berechnungslogik hinsichtlich des EE-Anteil s im Verkehrssektor

♦• Untcr Ber-ckckskhtigung der Deckelung des Energiebedarfs fla. Flugverkehr; Due EU Regulatlvschreibteinc Deckelung bel der Berucksichtlgung des Energi EBC da RFS des Flugverkehrs dar, sodass Im Pal le vcTgleichsweise kleiner Milgliedsslaaten yesterday keine Verzerrung bzw. Pônalwirkung cnistehen würde. Der Energiebedarf für Flugverkehr liegt bei beiden Szenarien im Jahr 2030 bei 5.936 GWh aufgrund der Deckelung werden Efür jedoch nur 2.216 GWh fürdie Ermittlung des Bruttoendenergiebedarts berûcksichtigt. Im Faite Luxemburgs bedingtdies folglich eine merkbare Verminderung des als BezugsgrdRe fürden gesamten EE-Anteil relevanten Bruttoendenergiebedarfs - ohne Flugwrkehrsdeckelung kàme d ^ ESER beispielsweise gemàR Zielszenano im Jahr 2030 bel 35 861 GWh zu liegen, mit Berucksichtigung der Deckelung ergeben si ch die angegebenen 32.141 GWh.

Evolution of energy production from renewable sources across sectors by 2040 under the WEM (With Existing measures) scenario

In this chapter, developments in renewable energy production in the different sectors are presented for the WEM scenario. The WEM and WAM (With Additional Measures) scenarios are modelled on the NEAM model developed by STATEC.

WEM scenario – Renewable electricity sector

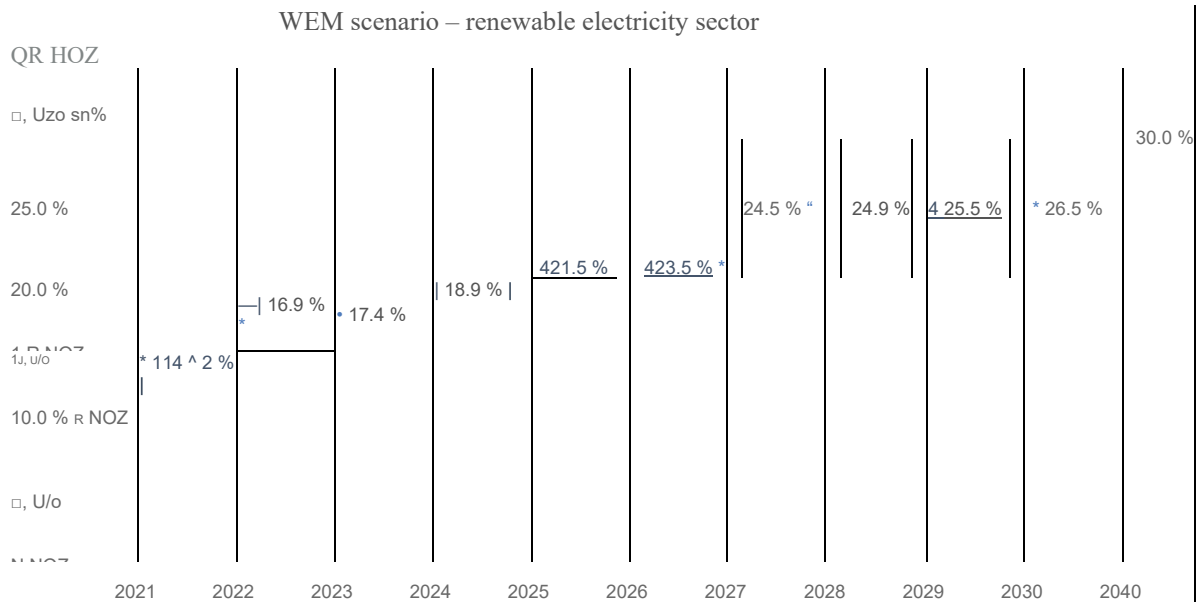
Tableau 42: Projected evolution of renewable sources/technologies in the renewable electricity sector by 2040 – WEM scenario

WEM scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Hydroelectric power	104	104	104	104	104	100	100	100	103	103	102
Eolien	315	328	348	417	540	640	679	692	726	785	1016
Photovoltaic	180	303	322	362	419	475	516	544	569	592	838
Renewable waste	43	43	44	45	46	47	48	49	49	50	60
Biogas *	62	63	63	63	63	63	64	64	64	64	65
Solid biomass * *	285	290	298	306	314	323	331	340	348	356	428
RES production	989	1131	1180	1297	1486	1648	1738	1788	1859	1950	2508
Consumption -El	6954	6687	6775	6846	6924	7014	7101	7189	7278	7369	8358
RES share – Electricity – %	14.2 %	16.9 %	17.4 %	18.9 %	21.5 %	23.5 %	24.5 %	24.9 %	25.5 %	26.5 %	30.0 %

Source: STATEC-MEA modelling 2023

In the WEM scenario, the generation of electricity from renewable sources is mainly driven by wind and photovoltaic. Between 2030 and 2040, PV increased by more than 40 % and wind by 30 %. Solid biomass changes only marginally between 2021 and 2040, with a total growth of 50 % over the two decades. The hydropower, renewable waste and biogas sectors show very low growth in the years 2021 to 2040. With existing measures, the share of renewable energy in the electricity sector increased to 30 % in 2040 (Figure 22).

Figure 22: WEM scenario – Renewable electricity sector developments 2021-2030 and 2040



Source: Scenario WEM STATEC-MEA 2023 modelling, MEA Graphic

WEM scenario – Renewable Heat Sector

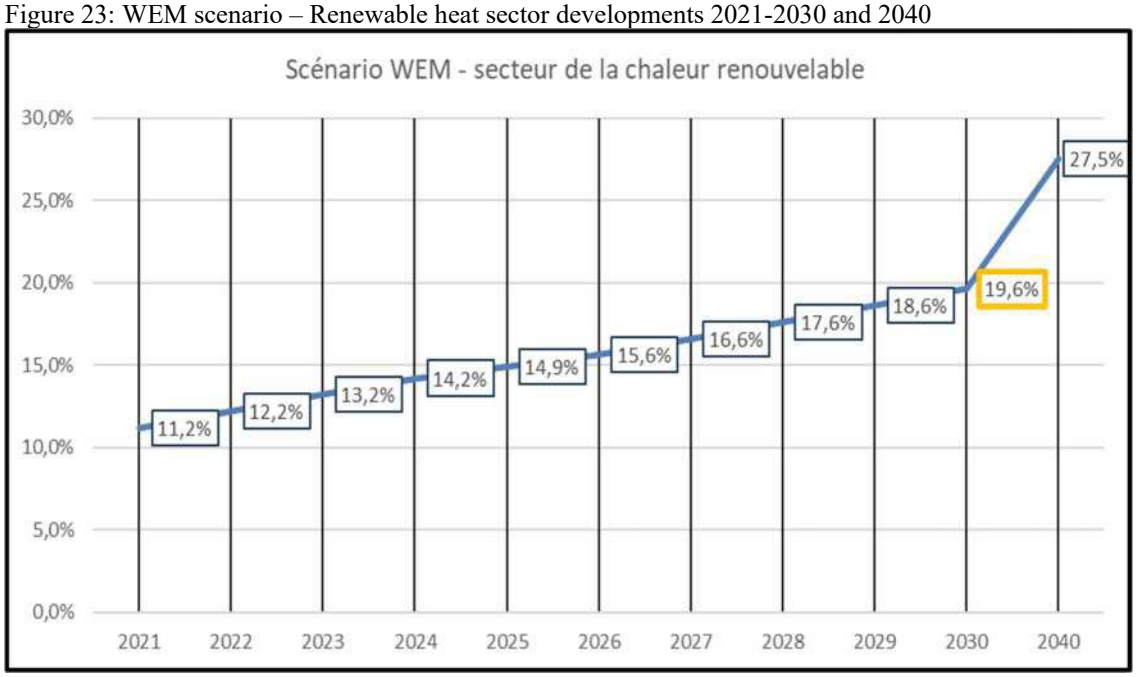
Table 43: Projected evolution of renewable sources/technologies in the renewable heat sector by 2040 – WEM scenario

WEM scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Biogas (centralised) – biomethane	30	30	30	30	30	30	30	31	31	31	32
Solid biomass (centralised)	1203	1226	1262	1296	1330	1367	1401	1436	1471	1505	1810
Solid biomass (decentralised)	132	134	136	138	139	140	141	142	143	144	147
Renewable waste (centralised)	12	12	12	12	13	13	13	13	13	14	16
Thermal solar panels	31	35	35	35	35	35	35	35	35	35	35
Heat pumps (PAC)	54	137	209	274	336	397	457	519	581	643	1242
Renewable hydrogen (Industry)	0	0	0	0	0	0	0	0	0	0	0
RES Consumption	1463	1574	1684	1784	1883	1982	2078	2177	2274	2371	3282
Consumption -CH	13117	12876	12730	12562	12662	12679	12522	12372	12224	12078	11929
RES share – Heat –%	11.2 %	12.2 %	13.2 %	14.2 %	14.9 %	15.6 %	16.6 %	17.6 %	18.6 %	19.6 %	27.5 %

Source: STATEC-MEA modelling 2023

In the WEM scenario of renewable heat production, the importance of heat pumps is becoming increasingly visible, in particular to decarbonise the buildings sector. Among the various renewable heat sources, heat pumps played an almost negligible role in 2021 (3.7 % share of all renewable heat sources), although in 2040 their share increased to 37.8 % (Table 43). The use of solid biomass as a transitional renewable energy source remains important, especially in the industrial sector and district or municipal heating networks. Renewable heat from biomass remains predominant until 2040. Figure 23 shows the evolution of the share of renewable energy in the heat sector from 2021-2030 to 2040.

Figure 23: WEM scenario – Renewable heat sector developments 2021-2030 and 2040



Source: STATEC-MEA modelling 2023, MEA Graphic

WEM scenario – Transport sector

Table 44: Projected evolution of renewable sources/technologies in the transport sector by 2040 – WEM scenario

WEM scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Biofuel incorporation rate%	7.70 %	8.0 %	8.0 %	8.4 %	8.8 %	9.0 %	9.2 %	9.4 %	9.7 %	10.0 %	10.0 %
Fossil fuels	20631	18157	18840	19179	19075	18763	18450	17764	17072	16411	13467
Share of biofuels – road transport	1589	1453	1507	1611	1679	1689	1697	1670	1656	1641	1347
— Simple counting biofuels	1233	1135	1168	1266	1259	1276	1292	1279	1280	1075	882
— Biofuels double counting	351	309	320	326	324	319	314	302	290	279	229
— Advanced biofuels	5	9	19	19	95	94	92	89	85	287	236
Renewable hydrogen + SAF	0	0	0	0	0	0	0	0	0	0	0
— road transport	0	0	0	0	0	0	0	0	0	0	0
— air transport	0	0	0	0	0	0	0	0	0	0	0
Electricity share	173	196	221	251	288	331	378	429	485	545	1224
Renewable share	19	24	29	36	43	52	63	76	90	107	337
— RES transport	4	5	15	18	21	31	38	45	63	75	303
— RES rail	15	19	23	29	34	41	50	60	72	86	269
RES Consumption *	1608	1477	1545	1657	1734	1761	1785	1776	1791	1802	1919
Consumption ENR * *	1983	1818	1940	2070	2236	2288	2329	2333	2393	2635	3428
Consumption Tr.	22768	20148	20972	21465	21557	21330	21094	20451	19860	19485	17782
RES share – Transport * * – %	8.7 %	9.0 %	9.3 %	9.6 %	10.4 %	10.7 %	11.0 %	11.4 %	12.0 %	13.5 %	19.3 %

* without multipliers

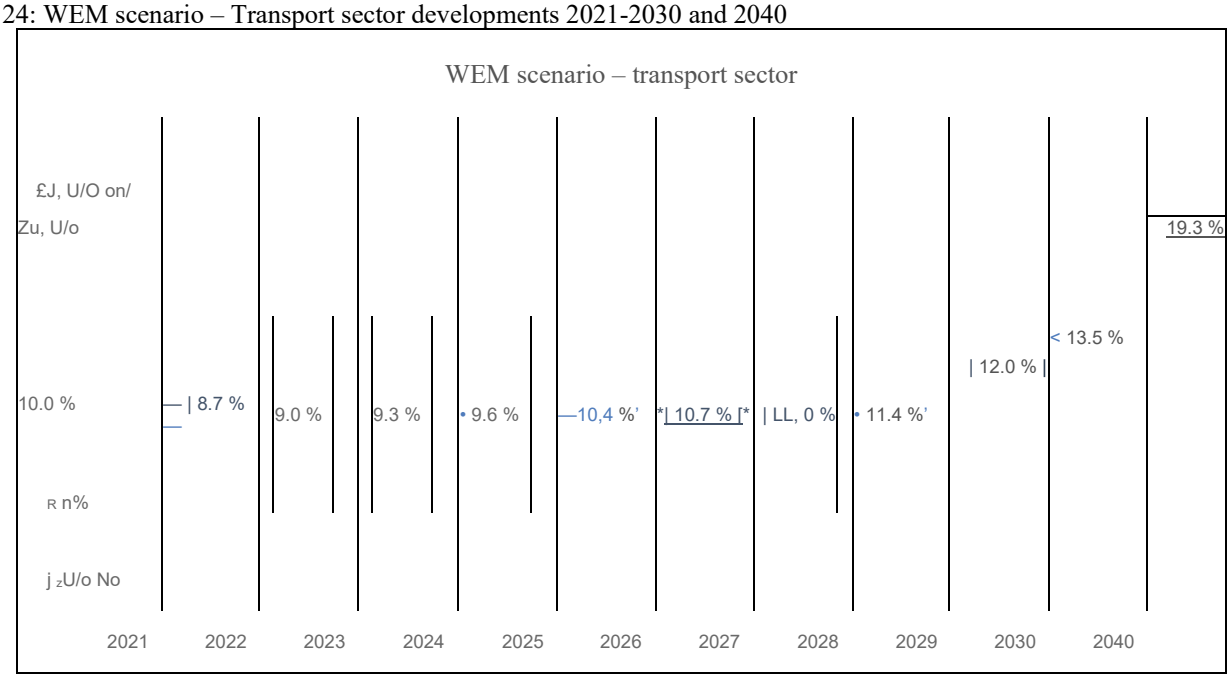
* * with multipliers (Article 27 Directive 2018/2001/EC)

Source: STATEC-MEA modelling 2023

In the WEM transport scenario, the share of fossil fuels remains high by 2040, making the share of electricity difficult to achieve. Fossil energy consumption therefore remains at 13.467 GWh (75.7 % of total consumption in the transport sector), compared with electricity which is 11 times lower than that of fossil fuels (1.224 GWh – 6.9 % of total consumption in the transport sector) (Table 44). First-generation biofuels also retain the advantage over advanced biofuels. The WEM scenario does not model the potential contribution of renewable hydrogen to the decarbonisation of the

transport Sector. Figure 24 shows the evolution of the share of renewable energy in the transport sector from 2021-2030 to 2040.

Figure 24: WEM scenario – Transport sector developments 2021-2030 and 2040



Source: STATEC-MEA modelling 2023, MEA Graphic

WEM scenario – Indicative path and overall objective

Table 45: Overall share of renewable energy and European cooperation by 2040 – WEM scenario

WEM scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Domestic RES production	4059	4182	4409	4739	5104	5391	5600	5740	5925	6123	7709
European cooperation	800	1300	1000	0	2000	1850	2700	2350	2350	3700	4000
— of which statistical transfers	800	1300	1000	0	1850	1500	2050	1400	1000	1950	1000
— of which REFM	0	0	0	0	150	350	650	950	1350	1750	3000
RES production + European cooperation	4859	5482	5409	4739	7104	7241	8300	8090	8275	9823	11709
Final energy consumption	48290	45736	46553	46894	47077	46984	46717	46090	45462	44875	42365
Aviation	7414	7820	7986	8056	8126	8196	8266	8335	8403	8472	9074
— Current Aviation share –%	15.4 %	17.1 %	17.2 %	17.2 %	17.3 %	17.4 %	17.7 %	18.1 %	18.5 %	18.9 %	21.4 %
— Aviation threshold –%	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %
Adjusted gross final energy consumption	43860	40742	41444	41736	41860	41691	41339	40603	39869	39176	35909
Overall RES share	11.1 %	13.5 %	13.1 %	11.4 %	17.0 %	17.4 %	20.1 %	19.9 %	20.8 %	25.1 %	32.6 %
Indicative trajectory and overall target	11.0 %	13.5 %	11.0 %	11.0 %	17.0 %	11.0 %	20.1 %	11.0 %	11.0 %	25.0 %	32.6 %

Source: STATEC-MEA modelling 2023

While the overall share of renewable energy in final energy consumption increases over the period 2021 to 2040, it requires a significant input of statistical transfers (respectively statistics acquired under the REFM), but only to reach the 25 % already foreseen in the 2020 NECP. The quantities required in terms of European cooperation amount to more than 50 % in 2030, as in 2040 (Table 45).

Table 46: Share of sectors and overall share with or without cooperation – WEM scenario

WEM scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
RES share – electricity sector	14.2 %	16.9 %	17.4 %	18.9 %	21.5 %	23.5 %	24.5 %	24.9 %	25.5 %	26.5 %	30.0 %
RES share – heat sector	11.2 %	12.2 %	13.2 %	14.2 %	14.9 %	15.6 %	16.6 %	17.6 %	18.6 %	19.6 %	27.5 %
RES share – Transport *	8.7 %	9.0 %	9.3 %	9.6 %	10.4 %	10.7 %	11.0 %	11.4 %	12.0 %	13.5 %	19.3 %
Overall RES share – without cooperation	9.3 %	10.3 %	10.6 %	11.4 %	12.2 %	12.9 %	13.5 %	14.1 %	14.9 %	15.6 %	21.5 %
Overall RES share – with cooperation	11.1 %	13.5 %	13.1 %	11.4 %	17.0 %	17.4 %	20.1 %	19.9 %	20.8 %	25.1 %	32.6 %
Indicative trajectory and overall target	11.0 %	13.5 %	11.0 %	11.0 %	17.0 %	11.0 %	20.1 %	11.0 %	11.0 %	25.0 %	32.6 %

* with multipliers (Article 27 Directive 2018/2001/EC)

Source: STATEC-MEA modelling 2023

The sectoral shares of renewable electricity and heat increased between 2021 and 2040. In the transport sector, the share of fossil fuels remains high and the share of electricity in the transport sector remains too low to counteract this trend.

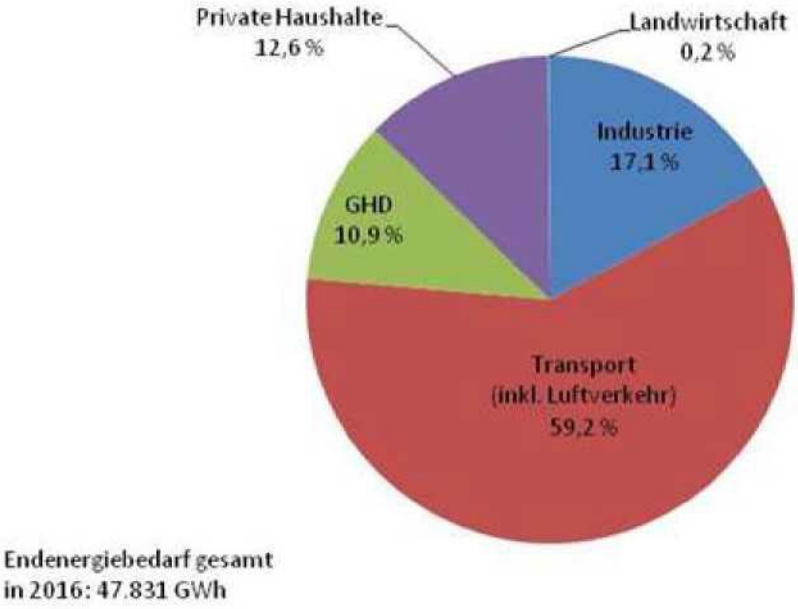
With the contribution of European cooperation, the WEM scenario reaches 32.6 % of renewable energy in gross final energy consumption in 2040, so almost one third of the energy needed will come from renewable sources, with the electricity sector first (Table 46).

4.3 Dimension energy efficiency

Baseline situation of energy consumption in Luxembourg

In 2016, Luxembourg's final energy consumption was around 48 TWh (Statec 2018). The transport sector accounts for the largest share of final energy consumption in Luxembourg, accounting for 59 % (Figure 25:). Foreign road transport accounts for the largest share, around 34 %. In energy statistics, this figure corresponds to the amount of fuel purchased by all non-resident vehicle owners in Luxembourg. It also includes transit traffic for lorries and cars, as well as cross-border commuters whose cars are not registered in Luxembourg. At the same time, air transport accounts for around 12 % of total final energy consumption, reducing the share of domestic road transport to around 13 % of Luxembourg's final energy consumption. While agriculture accounts for the lowest share of final energy consumption, around 0.2 %, industry consumes the largest share of energy in Luxembourg with just over 17 %.

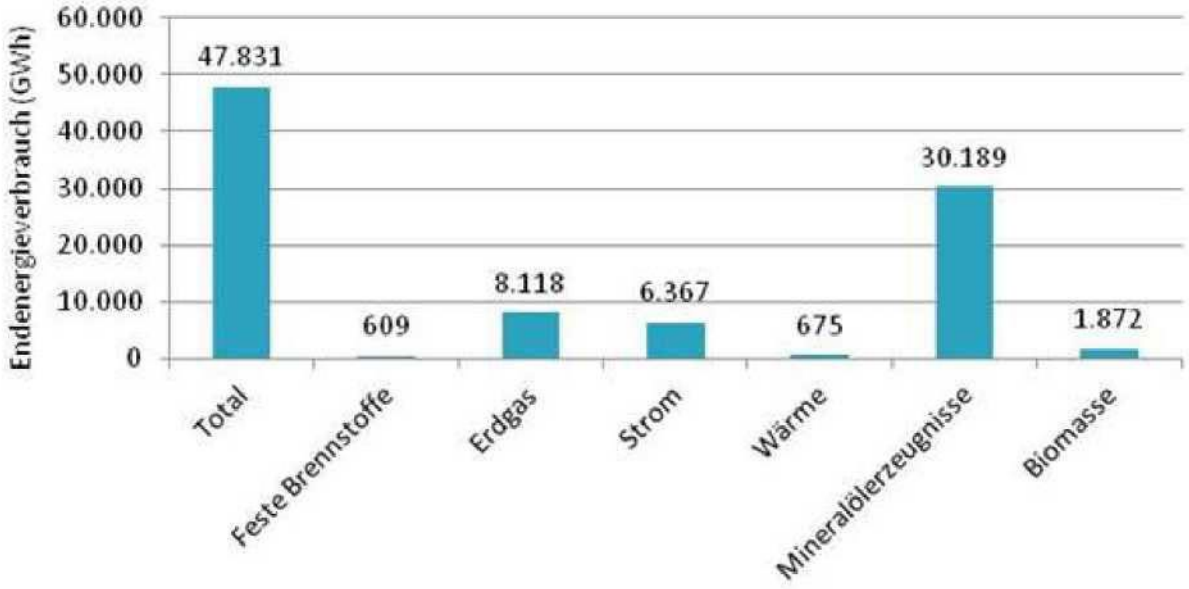
Figure 25: Final energy consumption in Luxembourg in 2016, broken down by sectors Industry, Households, Manufacturing, Trade and Services, Transport and Agriculture



Source: IREES according to Statec 2018

In 2016, Luxembourg's energy consumption was dominated by the need for petroleum products (63 %). Moreover, energy needs were also covered by natural gas (17 %), electricity (13 %) and biomass (4 %) (see Figure 26).

Figure 26: Final energy consumption in Luxembourg in 2016, by type of energy source



Source: IREES according to Statec 2018

(Note: This representation does not take into account any large electricity consumers likely to move to Luxembourg in the near future.

Current potential for the application of high-efficiency cogeneration and efficient district heating and cooling

In 2015, cogeneration generated almost 326 GWh of electricity and 527 GWh of heat in Luxembourg. Cogeneration systems can provide heat up to 500 °C (Klobasa, Steinbach & Pudlik 2016).

The following areas also present potential for the use of high-efficiency cogeneration:

- Decentralised CHP systems in buildings
- Use of cogeneration in industry
- Supply of district heating and combined heat and power plants

The economic potential resulting from the use of CHP plants and the supply to the district heating network depends mainly on the evolution of renovation activities in the buildings sector, and thus on the evolution of the heating needs of buildings in general. In the area of decentralised energy supply to buildings, the use of cogeneration corresponds to an electrical performance below 500 kW. Due to the heating and cooling needs of buildings, the still untapped economic potential for high-efficiency cogeneration and heating supply lies mainly in residential buildings.

Today, around 50 % of economic cogeneration potentials in the buildings sector are developed through existing collective heating concepts. Consequently, in Luxembourg, the building sector alone has a potential for economic cogeneration of around 1 170 GWh of useful energy (Klobasa, Steinbach & Pudlik 2016).

At the same time, industry is expected to have a relatively low economic potential of around 500 GWh of final energy and 425 GWh of useful energy by 2030 (see Table 47). Relevant sectorsinclude the chemical industry, the wood industry and the food industry. However, exploiting this industrial potential requires excellent geographical conditions and long periods of operation (Klobasa, Steinbach & Pudlik 2016).

Table 47: Additional potential for cogeneration heat production in industry by 2030 compared to industry's final energy consumption

Sektor	B r e n n st offbeda rf in GWh		KWK-geeignet (< SOO'C) in GWh		KWK-Bestand in GWh	Ausbau-Potenzial in GWh
	2014	2030	2014	2030	2014	2030
Stahl	1.670	1.422	67	57		
Steine/Erden	1.094	589	164	88		
Railway	319	29S	316	292		210
T extil	226	208	226	208		
Holz	274	253	274	253	65	150
Nahrung	61	57	60	56		25
Bau	77	71	0	0		
Maschinenba	13	12	13	12		
Paper	51	47	50	46		
Sonstige	157	154	145	134	122	115
Summe	3.952	3.107	1.315	1.146	187	500
	KWK-Wàrme *					425
	KWK-Strom * *					255

Which: eigene Abschàtzung,• Umrechnung Endenergie in KWK-Nutzwàrme mit 0,85, *' KWKStrom mit Stromkennzahl 0,6 berechnet

Source: Klobasa, Steinbach & Pudlik 2016

Evolution of energy consumption in Luxembourg by 2040 according to the WEM (With Existing Measures) scenario

Table 48: Final energy consumption of the different sectors in the WEM scenario for the years 2030 and 2040

Sector	Unit	2030	2040
Manufacturing and construction (ETS + Non-ETS)	GWh	7 '274	6 '912
Transport	GWh	25 '428	22 '078
Households (including residential buildings)	GWh	5 '573	4 '857
Trade and services (including tertiary buildings)	GWh	5 '953	5 '977
Agriculture	GWh	64	64
Total final energy consumption *	GWh	44 '293	39 '887

* excluding ambient heat, with international aviation

Source: STATEC 2023 modelling

The energy consumption projections of the Reference Scenario (WEM) and the Target Scenario (WAM) for 2030 and 2040 have been modelled using STATEC NEAM and Lux-GEM models. The NEAM model takes into account current national projections for changes in the economic situation and thus changes in population, employment, number of cross-border workers, residential areas, tertiary and industrial activities and construction, etc., as specified in Chapter 2.2.

The sectors that are taken into account for the monitoring of Luxembourg's final energy consumption (and which are distinguished in the modelling of the different projections) are:

households (including residential buildings), referred to as "private Haushalte" in the 2020 NECP; manufacturing and construction, referred to as "Industry" in the NECP 2020;
trade and services (including tertiary buildings), referred to as 'Gewerbe, Handel, Dienstleistungen' in the 2020 NECP;
transport (including international aviation).

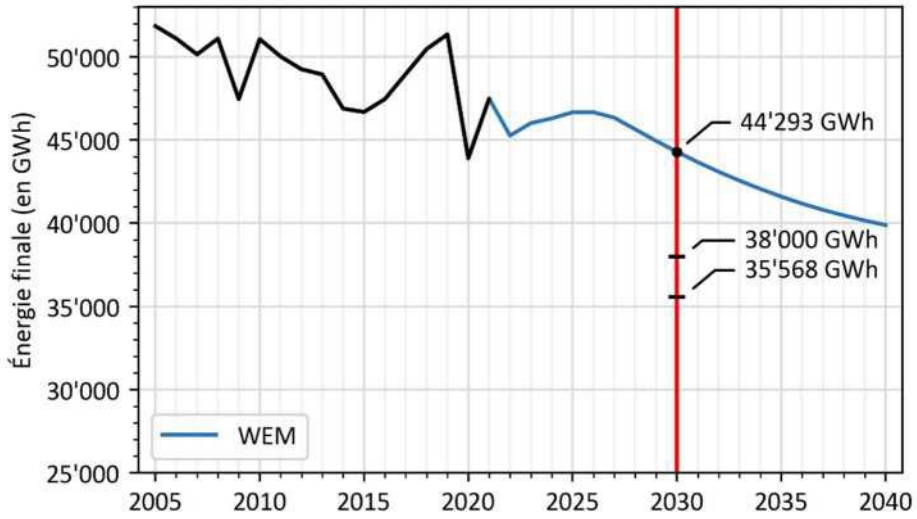
In terms of greenhouse gas emissions, part of the industry and transport sectors fall under the EU Emissions Trading System (ETS). On the other hand, the household sector and the trade and services sector are not covered by this system and are therefore non-ETS sectors.

Table 48 shows the final energy consumption of the WEM scenario for the years 2030 and 2040 broken down by sector. The corresponding trajectories are displayed in Figures 27 to 32. The final energy considered here is the final energy excluding ambient heat, including international aviation.

Total all sectors

Figure 27 shows that, according to the WEM scenario, total final energy consumption will increase to 46 '669 GWh in 2026 before a continuous decrease until 2040. The 44 '293 GWh in 2030 exceed the target range of 35' 568 to 38 '000 GWh corresponding to the energy efficiency improvement range of -40 to -44 % compared to the REF2007 benchmark defined as the national target in the NECP 2020.

Figure 27: WEM scenario – Total final energy consumption



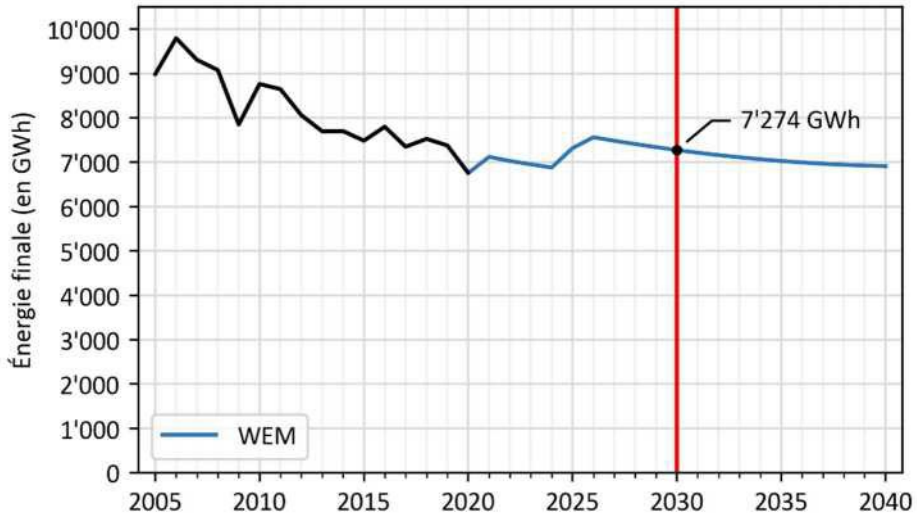
Source: STATEC 2023 modelling, MEA Graphics

Manufacturing and construction

Based on cyclical projections, the continuous increase in manufacturing and construction activities counterbalances almost entirely the improvement in energy efficiency in this sector, which explains the almost constant final energy consumption between 2020 and 2040 (see Figure 28).

According to the model, this increase in activities takes place mainly at the level of non-ETS companies and there is hardly any change at the level of HTA companies.

Figure 28: WEM scenario – Manufacturing and construction

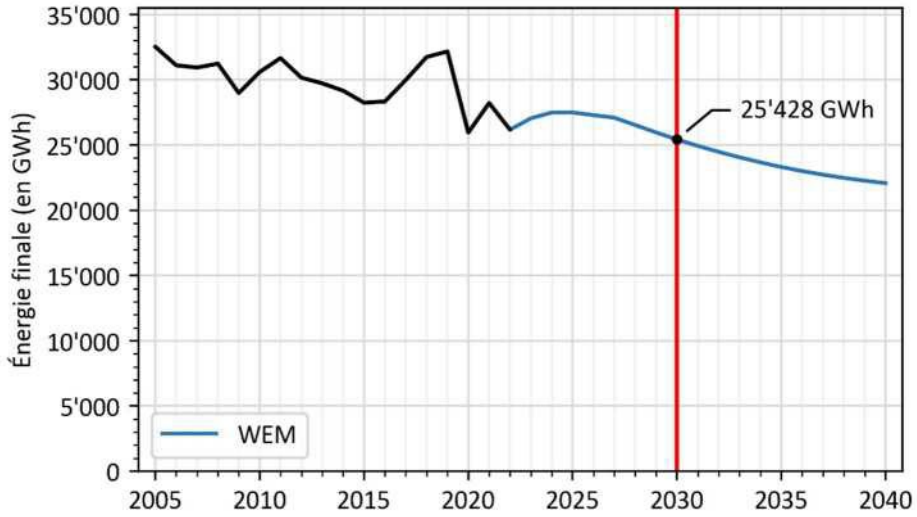


Source: STATEC 2023 modelling, MEA Graphics

Transport

The strong development of the aviation sector (passenger and freight transport) counterbalances some of the improvements in energy efficiency. According to the WEM scenario shown in Figure 29, final energy consumption in transport will increase until 2025 before starting to decrease.

Figure 29: WEM – Transport scenario

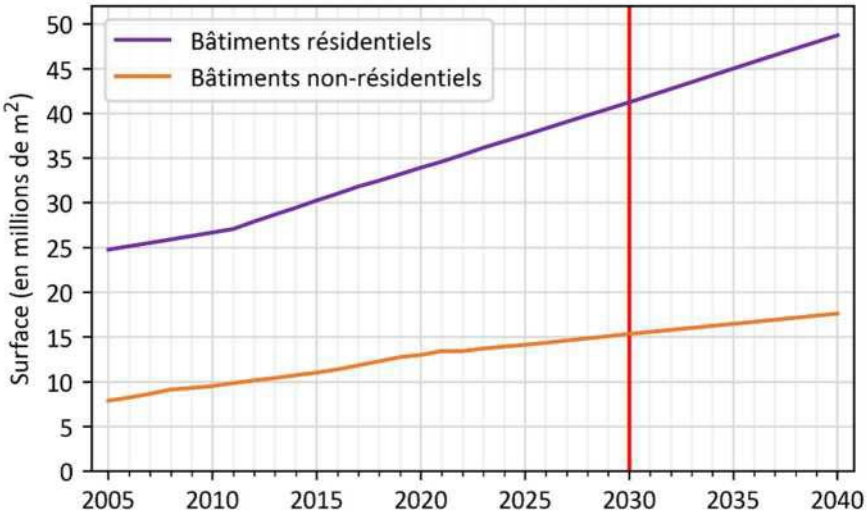


Source: STATEC 2023 modelling, MEA Graphics

Households (including residential buildings)

For the household sector, as well as for the trade and services sector, the significant changes in the surface area of buildings (as shown in Figure 30) must be taken into account when interpreting the evolution of final energy consumption in these two sectors.

Figure 30: Evolution of building surface area – Residential buildings (household sector) and tertiary buildings (Trade and services sector)



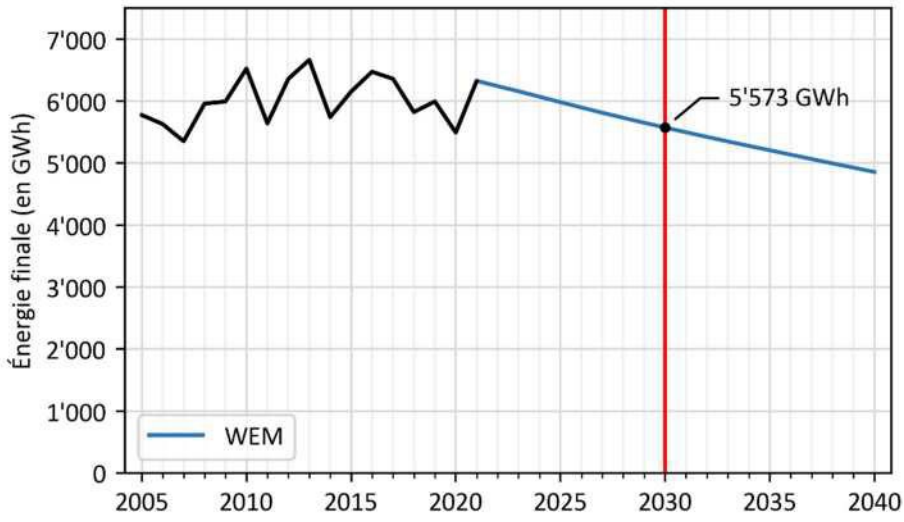
Source: STATEC 2023 modelling, MEA Graphics

The energy consumed by households is largely directly related to use, i.e. heating of residential buildings.

The decarbonisation of buildings through electrification, i.e. the replacement of fossil heating systems with renewable energy

systems, including heat pumps, has a direct effect on GHG emissions and also involves the reduction of the final energy consumed (see Figure 31). Ambient heat operated by a heat pump is not counted as final energy and the replacement of fossil-based heating by a heat pump therefore means a significant reduction in energy consumption.

Figure 31: WEM scenario – Households



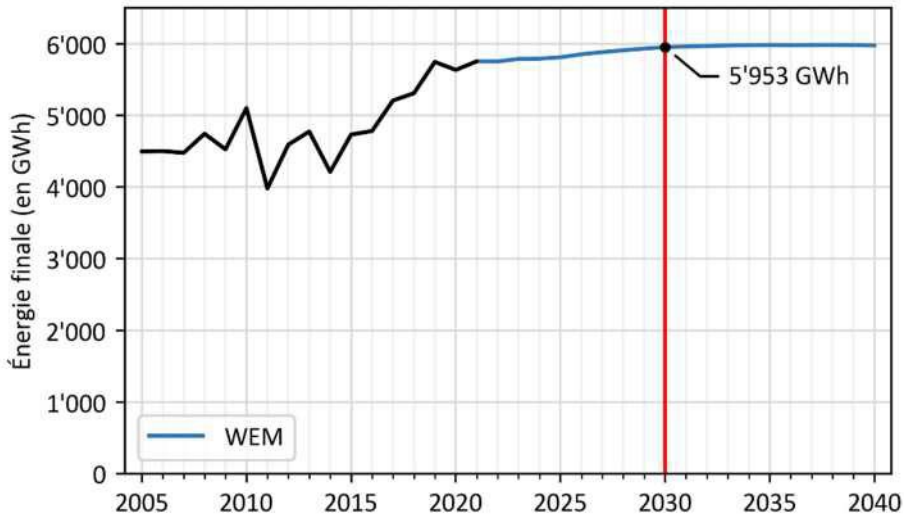
Source: STATEC 2023 modelling, MEA Graphics

Trade and services (including tertiary buildings)

The trade and services sector includes tertiary buildings but also all trade and services activities (which are not specifically allocated to another sector).

Thedecarbonisation of buildings through electrification, i.e. replacing fossil heating systems with renewable energy systems, including heat pumps, has a direct effect on GHG emissions and also involves reducing the final energy need of buildings. However, this effect is affected by other factors such as economic growth, so that in the WEM scenario the sector's final energy consumption does not decrease, as shown in Figure 32.

Figure 32: WEM scenario – Trade and Services

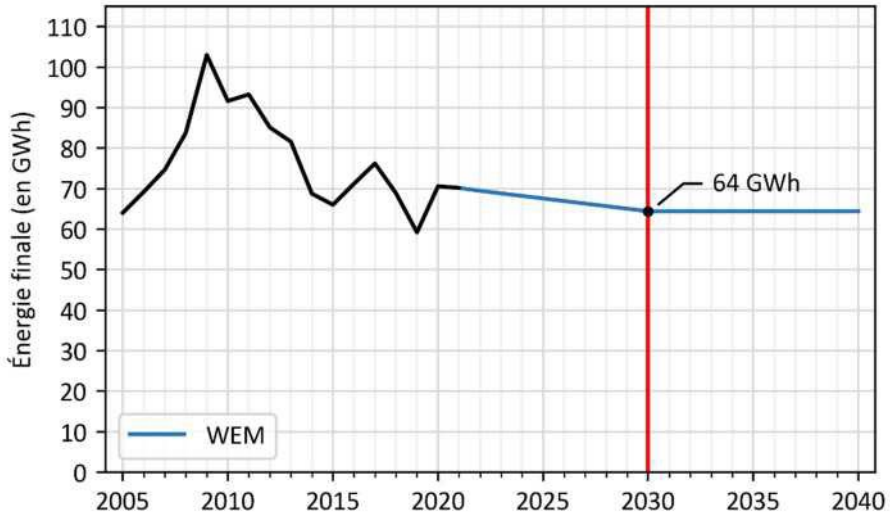


Source: STATEC 2023 modelling, MEA Graphics

Agriculture

The agriculture sector has a negligible final energy consumption compared to the other sectors considered above. Figure 33 shows the evolution of its final energy consumption up to 2040.

Figure 33: WEM scenario – Agriculture



Source: STATEC 2023 modelling, MEA Graphics

4.4 Dimension energy security

Following Russia's invasion of Ukraine in February 2022, Europe faced a significant drop in Russian natural gas supply. The reduction of supply implies a risk to the security of energy supply and a high level of prices and large fluctuations in the energy markets. As natural gas-fired power plants are often needed to meet electricity demand when it peaks during the day or when volumes of electricity from other sources are not sufficient to meet demand, high gas prices translate into high electricity prices across Europe. Other factors, such as the lack of rainfall or the unavailability of nuclear power plants, contributed to a tense situation for winter 2022-2023 with tighter power generation capacity margins across Europe than usual.51

51ENTSO-E seasonal outlook, October 2022

The energy crisis has led to the need to introduce extraordinary measures to ensure security of energy supply. The European Union and its Member States have managed to respond with measures in the area of gas storage, demand reduction and diversification of supply routes to successfully prevent supply disruptions.

For Luxembourg, coordination of measures and sharing of relevant information at European level is essential. In addition, Luxembourg benefits from extensive regional collaboration in the framework of the Pentalateral Energy Forum, as well as from the common markets between Belgium and Luxembourg for natural gas and between Germany and Luxembourg for electricity.

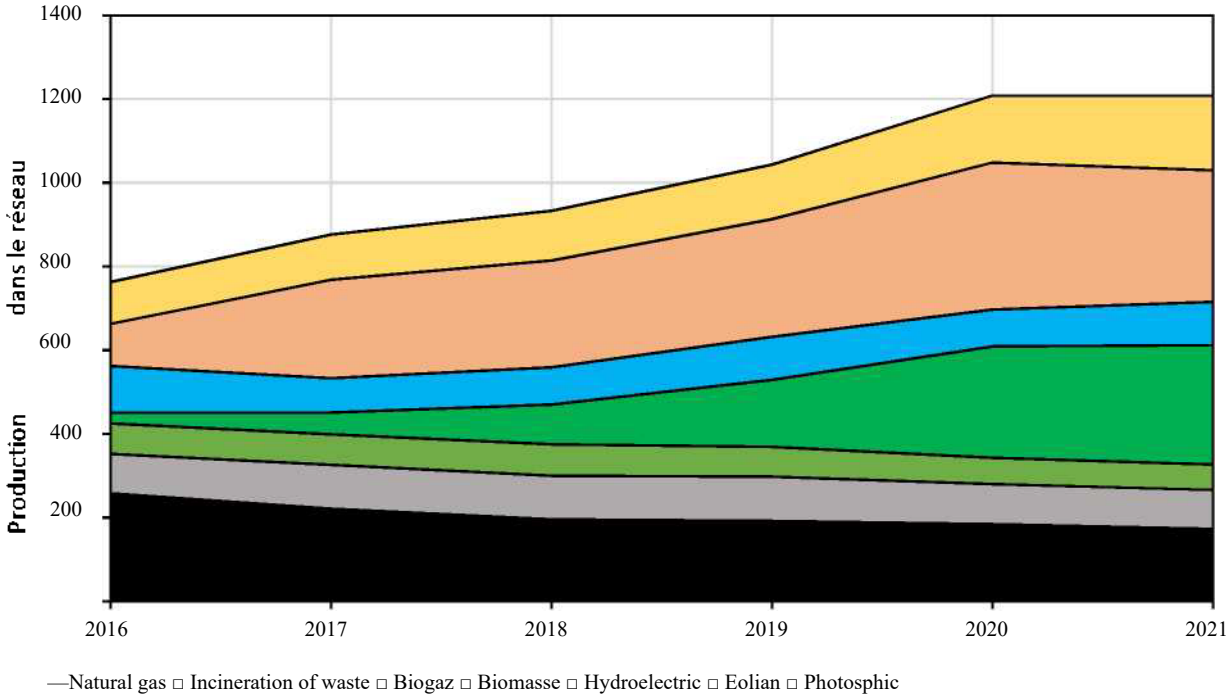
At national level, a significant number of activities and measures have been stepped up by the stakeholders concerned, including the Ministry of Energy and Spatial Planning, the High Commissioner for National Protection, and the network managers, in order to monitor, manage and anticipate the crisis.

As a result, and despite the geopolitical situation and the resulting energy crisis, security of supply in Luxembourg therefore remains at a very high level.

4.4.1 Domestic production and consumption

This section covers the domestic production and consumption of electricity and gas. As regards the electricity sector, over the years, Luxembourg has achieved a significant increase in national electricity production, thanks to continuous development of renewable energy while reducing electricity produced from fossil and non-renewable sources. Figure 34 shows the evolution of domestic electricity production from 2016 to 2021. Overall, production increased by 37 % from 2016 to 2021. The share of renewable energy in Luxembourg's electricity generation mix increased from around 54 % in 2016 to 78 % in 2021. The main increases were achieved thanks to the expansion of wind and biomass, closely followed by solar energy. By contrast, gas-fired electricity generation in cogeneration plants was reduced by 33 % over the same period.

Figure 34: Total electricity generation of the country fed into the grid (source: ILR)



The tables below show the domestic electricity production targets for each energy source and the projected electricity consumption with current policies and measures until 2040. As indicated, a continuous increase in renewable electricity production is expected, in particular for wind and solar power.

Table 49: Projections for domestic production and electricity consumption – WEM scenario (values in GWh).

Power generation by technology	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Hydro	104	104	104	104	100	100	100	103	103	102
Eolian	328	348	417	540	640	679	692	726	785	1016
Photovoltaic	303	322	362	419	475	516	544	569	592	838
Biogas	63	63	63	63	63	64	64	64	64	65
Biomass	290	298	306	314	323	331	340	348	356	428
Natural gas	164	156	147	138	130	121	112	104	95	9
Incineration of waste	72	73	74	76	77	79	80	81	83	97
Total output	1324	1365	1473	1654	1808	1890	1931	1995	2078	2554
Consumption	6480	6598	6706	7072	7362	7491	7625	7764	7910	9528

Tofurther improve security of supply and meet Luxembourg's ambitious climate targets, the new policies and measures aim at a faster development of renewable energy. The tables below present the new national electricity production and electricity consumption targets.

Table 50: Projections for domestic electricity production – WAM scenario (values in GWh).

Power generation by technology	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Hydro	100	95	96	97	100	100	100	100	100	100
Eolian	330	430	511	699	800	867	903	962	1043	1700
Photovoltaic	316	390	480	580	680	780	890	1000	1112	2100
Renewable waste	43	44	45	46	47	48	49	49	50	60
Biogas	67	71	75	79	84	88	92	96	100	100
Biomass	285	290	540	554	568	582	596	610	624	734
Natural gas	157	142	126	110	94	79	63	47	31	0
Waste incineration	72	73	74	76	77	79	80	81	83	97
Total output	1370	1535	1948	2241	2450	2622	2773	2946	3143	4890

Table 51: Forecasts of total electricity consumption – WAM scenario (values in GWh).

Sectors	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Manufacturing and construction industries	3045	3075	3094	3365	3542	3645	3749	3766	3771	4080
Transport	202	238	285	345	416	497	583	671	748	1642
Residential buildings	914	915	931	946	960	977	995	1021	1067	1558
Tertiary buildings	2311	2337	2385	2368	2433	2500	2566	2634	2714	3475
Total electricity consumption	6472	6565	6695	7024	7351	7619	7893	8092	8300	10755

As regards the gas sector, Luxembourg does not extract its own gas. The country covers its gas needs through the transmission networks of upstream system operators in Belgium and Germany, which in turn provide access to production facilities. Deliveries are carried out by network operators and/or through commercial and delivery companies. Luxembourg also does not have gas storage on the national territory. As a result, the amount of gas needed and storage capacities are used in other countries, in particular in the transmission and transit countries from which the gas usually originates.

Asregards the country's gas consumption, the figure below shows consumption between 2016 and 2021 for the different sectors. While 2020 was marked by COVID-19 and particularly low demand, the country's total consumption was around 8 500 GWh in 2021. It shows that the industrial and residential sectors account for about two thirds of total gas consumption.

Figure 35: Total gas consumption of the country by sector (source: STATEC)

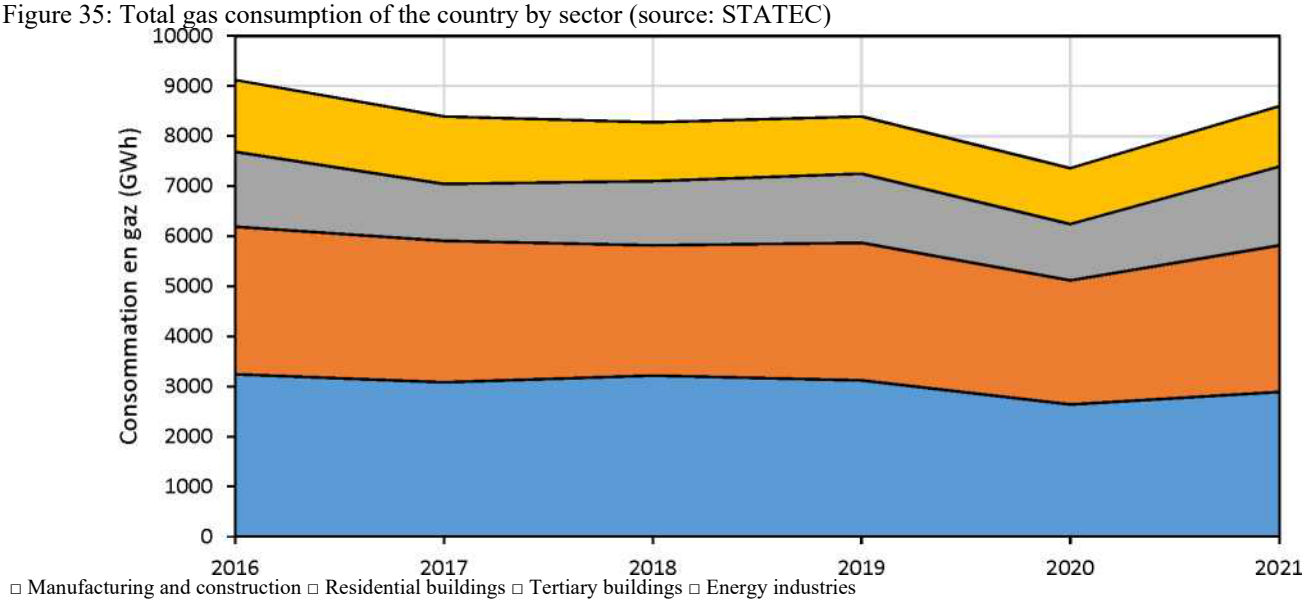


Table 52 shows the country's projected consumption up to 2040 with the current policies and measures in place.

Table 52: Forecast of the country's total gas consumption – WEM scenario (GWh values)

Sectors	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Manufacturing and construction industries	2833	2754	2678	2861	2947	2867	2789	2713	2638	2006
Residential buildings	2897	2866	2831	2797	2763	2730	2697	2665	2633	2326
Tertiary buildings	1543	1541	1530	1523	1522	1517	1511	1505	1497	1375
Energy industries	1148	1088	1027	967	906	846	786	725	665	60
Total electricity consumption	8421	8249	8066	8148	8138	7960	7783	7607	7433	5767

With the new measures, a faster reduction in gas consumption is expected in all sectors due to increased efficiency and the transition from gas to electricity.

Table 53: Forecast of the country's total gas consumption – WAM scenario (values in GWh)

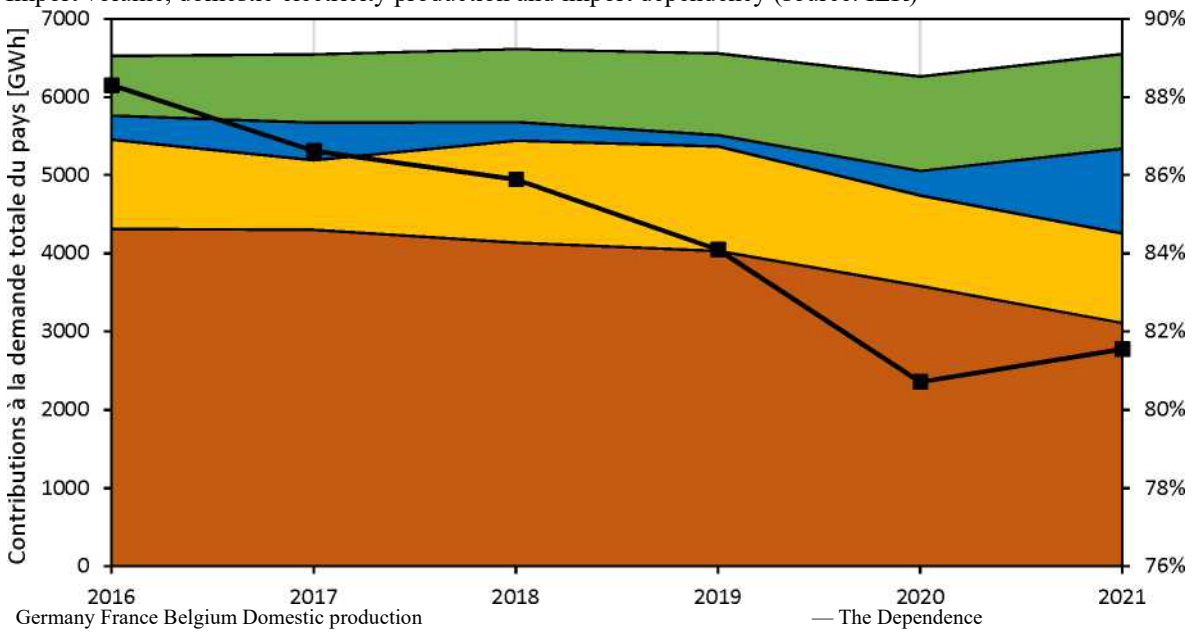
Sectors	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Manufacturing and construction industries	2826	2642	2653	2561	2475	2383	2259	2161	2028	683
Residential buildings	2824	2722	2544	2393	2263	2153	2058	1951	1812	2326
Tertiary buildings	1518	1472	1450	1385	1277	1170	1066	967	871	54
Energy industries	1099	989	862	745	632	524	413	307	203	0

Total Consumption onsumat on tota e electricity	8267	7825	7509	7084	6647	6230	5796	5386	4914	3063

4.4.2 Import dependency

Import dependency in the electricity sector is the result of the country's total electricity consumption less domestic production. Figure 36 shows the evolution of dependency for the years 2016 to 2021. Due to the increase in domestic production, the volume of electricity imported has decreased over the years from around 90 % to around 80 %. Germany remains the main source of imported electricity with around 60 % of net imports.

Figure 36: Import volume, domestic electricity production and import dependency (source: ILR)



With the current measures (WEM scenario) import dependency is expected to continue to decrease to around 73 % in 2040 as shown in the table below.

Table 54: Projections for import dependency – WEM scenario

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Consumption	GWh	6480	6598	6706	7072	7362	7491	7625	7764	7910	9528
Domestic electricity production	GWh	1324	1365	1473	1654	1808	1890	1931	1995	2078	2554
Imported volume net	GWh	5156	5233	5233	5418	5554	5601	5694	5769	5832	6974
Dependency		79.6 %	79.3 %	78.0 %	76.6 %	75.4 %	74.8 %	74.7 %	74.3 %	73.7 %	73.2 %

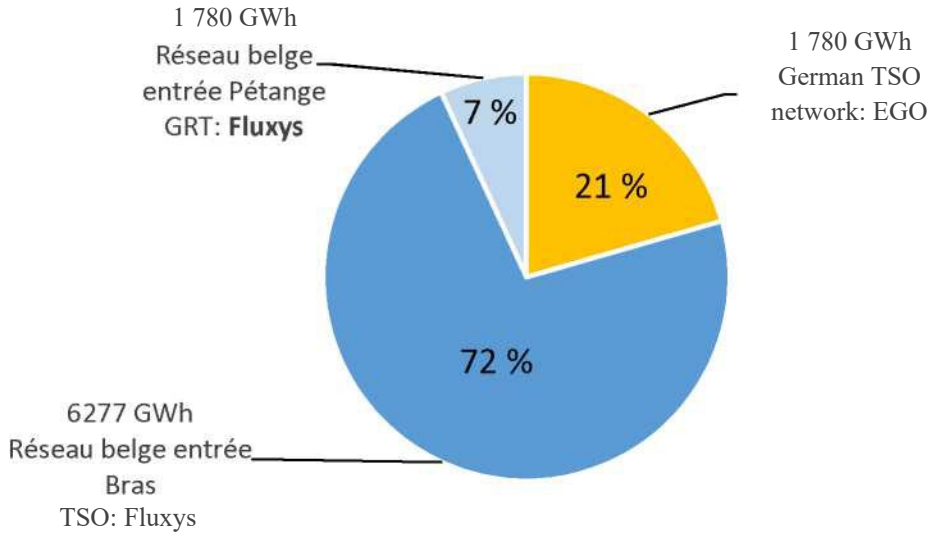
Luxembourg's new targets lead to a stronger and faster development of renewable energy in the country, resulting in an even lower dependence on electricity imports, as shown in Table 55.

Table 55: Projections for import dependency – WAM scenario

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Consumption	GWh	6472	6565	6695	7024	7351	7619	7893	8092	8300	10755
Electricity production domestic servant	GWh	1370	1535	1948	2241	2450	2622	2773	2946	3143	4890
Net imported volume	GWh	5102	5030	4747	4783	4901	4997	5120	5146	5157	5865
Dependency		78.8 %	76.6 %	70.9 %	68.1 %	66.7 %	65.6 %	64.9 %	63.6 %	62.1 %	54.5 %

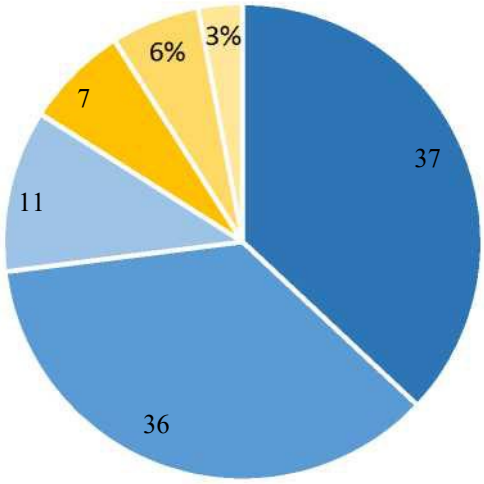
As regards the gas sector, since Luxembourg imports all its gas needs, it is entirely dependent on imports. The volume of imports therefore depends only on gas consumption. The majority of imported gas comes from Belgium, with which Luxembourg shares a common market, the rest of the imported gas comes from Germany. The figure below shows the distribution of flows by entry point in 2021.

Figure 37: Flow distribution by entry point and border TSO in 2021 (source: CREOS)



Inorder to assess Luxembourg's security of supply, it is essential to assess the origin of gas imported into Belgium and Germany. Since most of the gas into Luxembourg is imported from Belgium, the origin of the gas in Belgium is of particular importance. The figure below shows the origin of the gas as imported into Belgium in 2020. As indicated, the dependence on Russian gas was – already in 2020 – very low, with the majority of gas coming from Norway and the Netherlands.

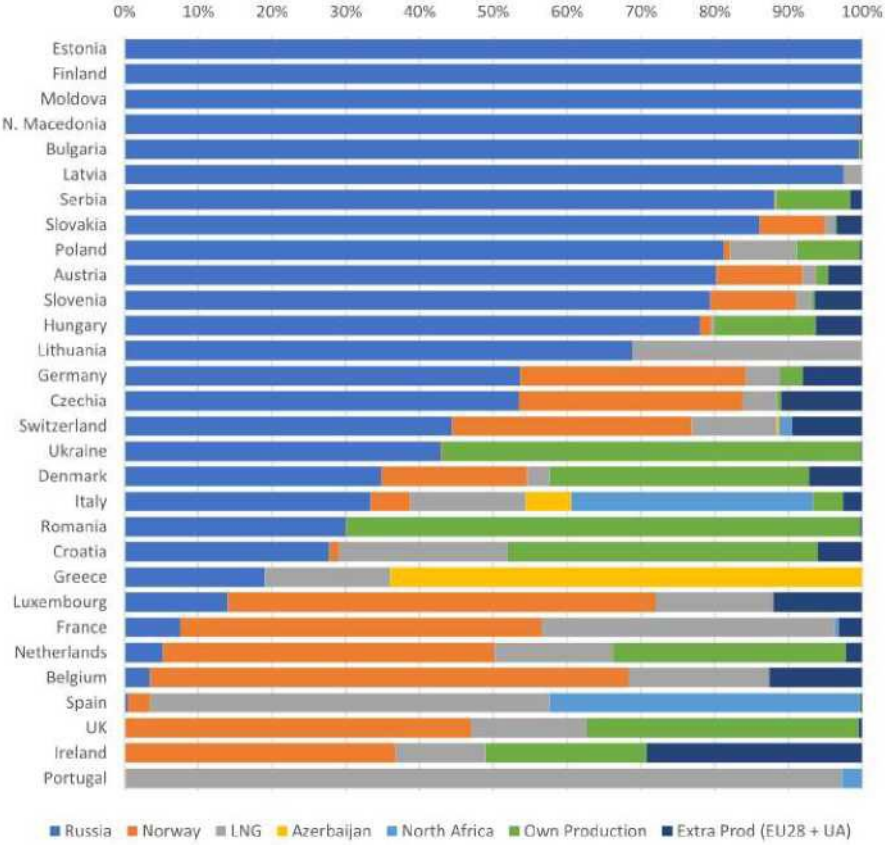
Figure 38: Sources of supply for Belgian gas imports in 2020 (source: European Commission, Directorate-General for Taxation and Customs Union)



Norway, the Netherlands, to the United Kingdom, to Qatar (LNG) Russia (LNG) Other (LNG)

For Luxembourg, direct dependence on Russian gas before the energy crisis was estimated by Bruegel at 13.8 % in 2021. It should be noted that statistics on a country's dependence in Europe must be taken with some caution. Due to the internal gas market, it is not possible to accurately determine the origin of the molecules. It is therefore necessary to build on certain assumptions concerning contractual relations and flows of natural gas in Europe. It should also be noted that Russian gas imports into Europe fell in an extraordinary manner by around 40 % before the crisis, less than 10 % at the beginning of 2023, as the figures in the chart have changed completely since then.

Figure 39: Share of Russian gas imported in 2021 for each Member State (source: Bruegel).



4.4.3 Security of Supply

4.4.3.1 Electricity sector

Legislative framework

At national level, security of supply in the electricity sector is regulated by the Law of 1 August 2007 on the organisation of the electricity market, giving specific roles and responsibilities, in particular, to the system operators, the minister responsible for energy, the government commissioner for energy, and the regulator.

For an overview of the monitoring of security of supply, the Ministry publishes every two years a report on security of supply in the electricity sector52. In this context, and according to the provisions of Article 11 of the Electricity Market Act, security of supply must be understood as an overall term that reflects the overall view of supply to final customers, and includes the entire value chain, i.e. the generation, trading, transmission, sale and distribution of electricity.

At European level, there are also rules governing security of supply, crisis prevention and risk management. Thus, Regulation (EU) 2017/2196 establishes a network code setting out the requirements for maintaining operational security, preventing the spread or degradation of an incident with the aim of avoiding large-scale disruption and blackout state, and enabling rapid restoration of the electricity system from a state of emergency or blackout. Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk prevention in the electricity sector lays down rules for cooperation between Member States in order to prevent, prepare and manage electricity crises in a spirit of solidarity and transparency, taking full account of the requirements of a competitive

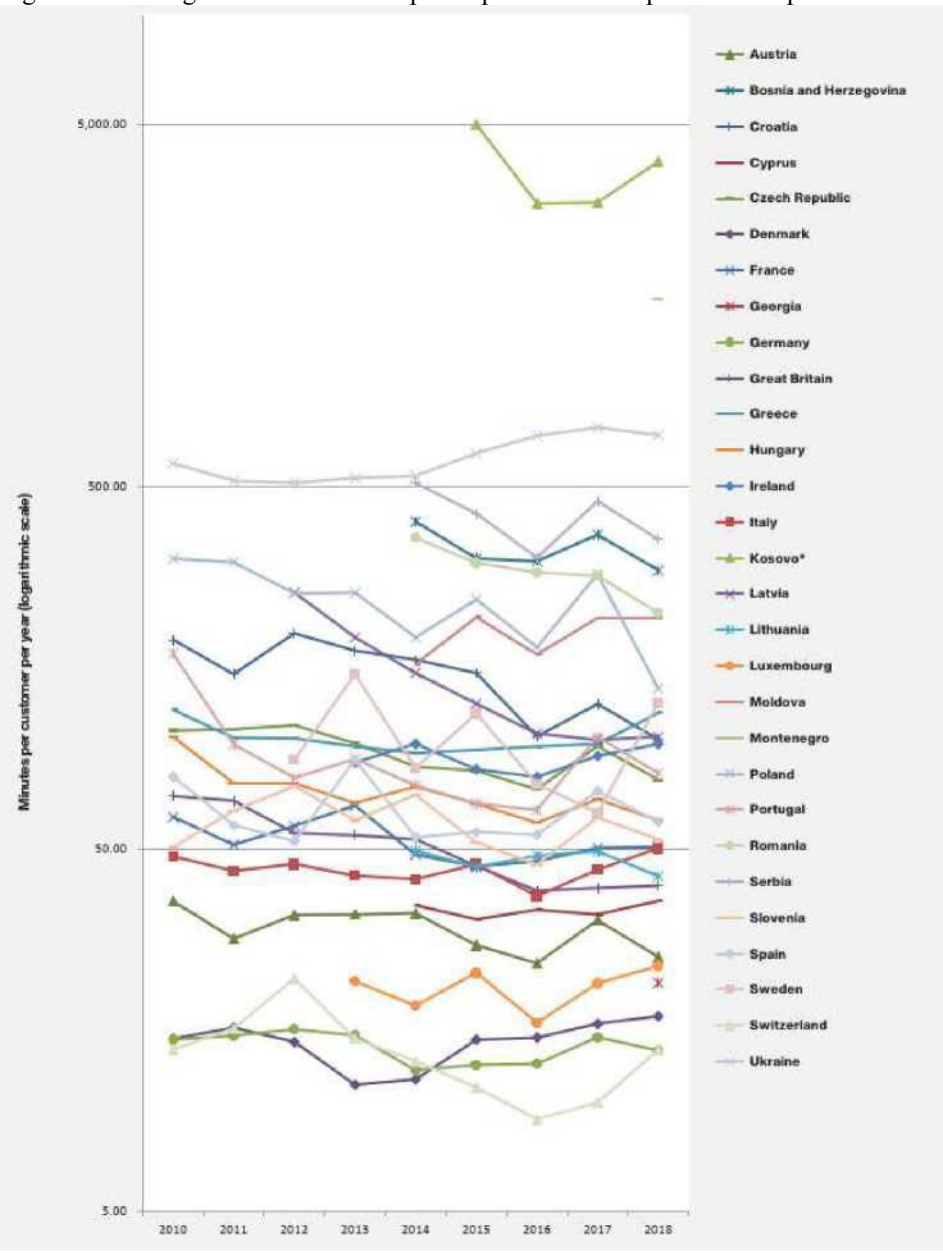
52 Berla über die Versorgungssicherheit im Strombereich in Luxemburg 2022: https://mea.gouvernement.lu/dam-Assets/energie/electricite/ELEC-Bericht-uber-die-Versorgungssicherheit-im-Strombereich-2014-.pdf

internal market in electricity. In this context, Luxembourg has established a national plan for risk preparations described in more detail in this chapter.

Current status

Compared to other countries in Europe and elsewhere, the quality of supply is very high in Luxembourg. In 2021, the average duration of interruptions per connection point was 13,9 minutes per year5354. By way of comparison, the figure below shows the average duration of interruptions per connection point in European countries from 2010 to 2018, it can be seen that Luxembourg has consistently achieved a very high quality of supply.

Figure 40: Average duration of interruptions per connection point in Europe.[50]



Risk preparedness

A risk-preparedness plan in the elector sector was drawn up for the first time in 2021. Different national crisis scenarios have been identified as particularly critical in terms of impact and probability for Luxembourg, which can be grouped into the following categories:

53 ILR, Key electricity market figures: https://assets.ilr.lu/energie/Documents/ILRLU-1685561960-998.pdf
54 7TH CEER-ECRB Benchmarking report on the quality of electricity and gas supply 2022: https://www.ceer.eu/documents/104400/-/-/15277cb7-3ffe-8498-99bb-6f083e3ceecb

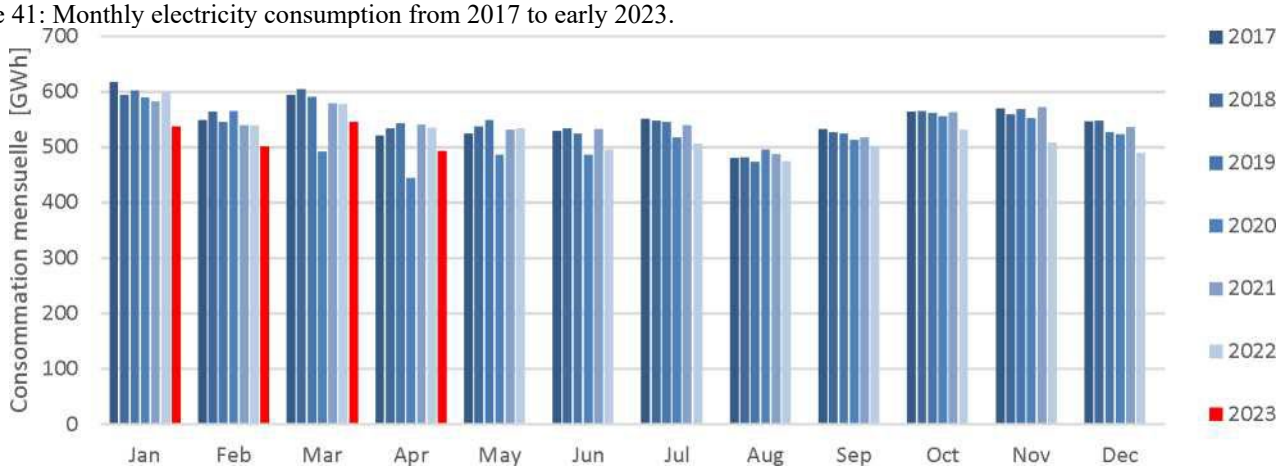
- Cyber-attacks or physical attacks against critical network resources
- Meteorological phenomena
- Serious technical accidents (telecommunications breakdown or nuclear accidents)

Due to the energy crisis, the plan was updated in December 202255 to introduce new measures in case the country faces a supply shortage. One of the tools introduced is the StroumMonitor, an electricity monitor which describes the national level of electricity supply in Luxembourg. Clear signals from the network operator Creos Luxembourg S.A. guide consumers to adopt the right steps and to ensure a secure supply of electricity for all. The StroumMonitor is a means of alerting people to electricity shortages. In addition, it also indicates daily peak times of consumption.

The Risk Preparedness Plan also includes a common regional chapter, which was drawn up in the framework of the Pentalateral Energy Forum. The common chapter identifies common risk scenarios and enhances the cooperation of Member States. In addition, in 2022, a common communication framework and a catalogue of measures were developed and agreed to further improve communication and cooperation between Member States. With the current version of the plan and the government's existing emergency response plans, Luxembourg has reached a mature and high level of risk preparedness in the electricity sector.

The energy crisis has also led to the adoption of Council Regulation (EU) 2022/1854 of 6 October 2022 on emergency response to high energy prices. The Regulation requires, inter alia, a mandatory 5 % reduction in electricity consumption during peak hours from 1 December 2022 until 31 March 2023. The StroumMonitor is one of the tools to address the need to reduce electricity consumption, with the result shown below:

Figure 41: Monthly electricity consumption from 2017 to early 2023.



In addition, that regulation also introduced a measure to introduce a cap on the market revenues that certain generators derive from electricity generation and to redistribute them in a targeted manner to final electricity customers. The respective draft law is currently in the legislative process.

Assessment of future security of supply

In the long term, Luxembourg is less dependent on electricity imports than before, but some dependency remains. Therefore, Luxembourg's security of supply depends on the security of supply of the rest of Europe. The European Resource Adequacy Assessment (ERAA) is the reference analysis for security of supply under European legislation. Given that Luxembourg's security of supply depends in particular on the available production capacity of neighbouring countries, the European analysis is particularly relevant for drawing conclusions in relation to Luxembourg's security of supply. It also takes into account variables such as available renewable power plants, unexpected breakdowns of equipment or lines, or fluctuations in demand depending on temperature.

55 Luxembourg risk preparedness plan for the electricity sector: https://gouvernement.lu/dam-Assets/documents/actualites/2022/12-decembre/09-securite-approvisionnement-electricite/riskpreparednessplan-lu-update20221207.pdf

According to the latest edition of the analysis published at the end of 2022, risks for Luxembourg are not excluded at 100 %, but very low. This is notably linked to the fact that Germany is planning medium and long-term measures to ensure security of supply by developing renewable energy and, where appropriate, reserve capacity.

In addition to this report, the German Federal Network Agency published its report on the development of security of supply in the electricity sector for the common Luxembourg-Germany market until 2031 in early 202356. The report shows that, in the scenarios chosen, security of electricity supply can be ensured between 2025 and 2031. The report analyses different scenarios, including an early phase-out of coal by 2030. In addition, the scenarios took into account, inter alia, the war in Ukraine and the resulting increase in gas prices. In order to ensure security of electricity supply, a series of developments on the generation and grid side need to be carried out and efforts must continue. In particular, an accelerated deployment of renewable energy is needed.

Security of supply for consumers applies to both sufficient generation capacity and sufficient network capacity. The results on the market side show for the Germany-Luxembourg common market up to 2030 or 2031 that demand can be covered at any time during all hours of the year. Network-side analyses show that by respecting the current target dates of network extension and exploiting the potential available for congestion management, it is possible to ensure congestion free operation of the network.

In addition to the current state of security of supply, the above-mentioned report on security of supply in the electricity sector also provides a detailed analysis of the state of the electricity system and the developments needed to ensure security of supply in the coming years. Project 380, which involves the construction of a 380 kV interconnector with Germany to cover the country's future electricity demand, is particularly important. Overall, the report also concludes that security in Luxembourg will remain at a very high level as the necessary measures and plans are implemented. Given Luxembourg's continued dependence on electricity imports, a well-integrated internal market is essential for Luxembourg to support its security of supply and the further development of renewable energies in the Germany-Luxembourg common market is vital for maintaining security of supply.

4.4.3.2 Gas Sector

Legislative framework

As regards security of gas supply, Article 16 of the Law on the organisation of the gas market, which entered into force in August 2007, entrusts the Ministry of Energy and Spatial Planning (MEA) of the Grand Duchy of Luxembourg with the task of drawing up a report every two years on the security and quality of natural gas supply. According to the provisions of Article 16 of the Gas Market Act, security of supply is to be understood as an overall term that reflects the overall view of supply to customers. Security of supply in Luxembourg is addressed by taking into account all stages of the value chain, from production and import to trading, transport and storage, sale and distribution of gas.

At European level, there are also different legal frameworks for security of gas supply. The framework was defined in particular by Regulation (EU) 2017/1938 of the European Parliament and of the Council concerning measures to safeguard security of gas supply and repeal Regulation (EU) No 994/2010, but was significantly extended in the context of the 2022 energy crisis, as further described below.

Current status

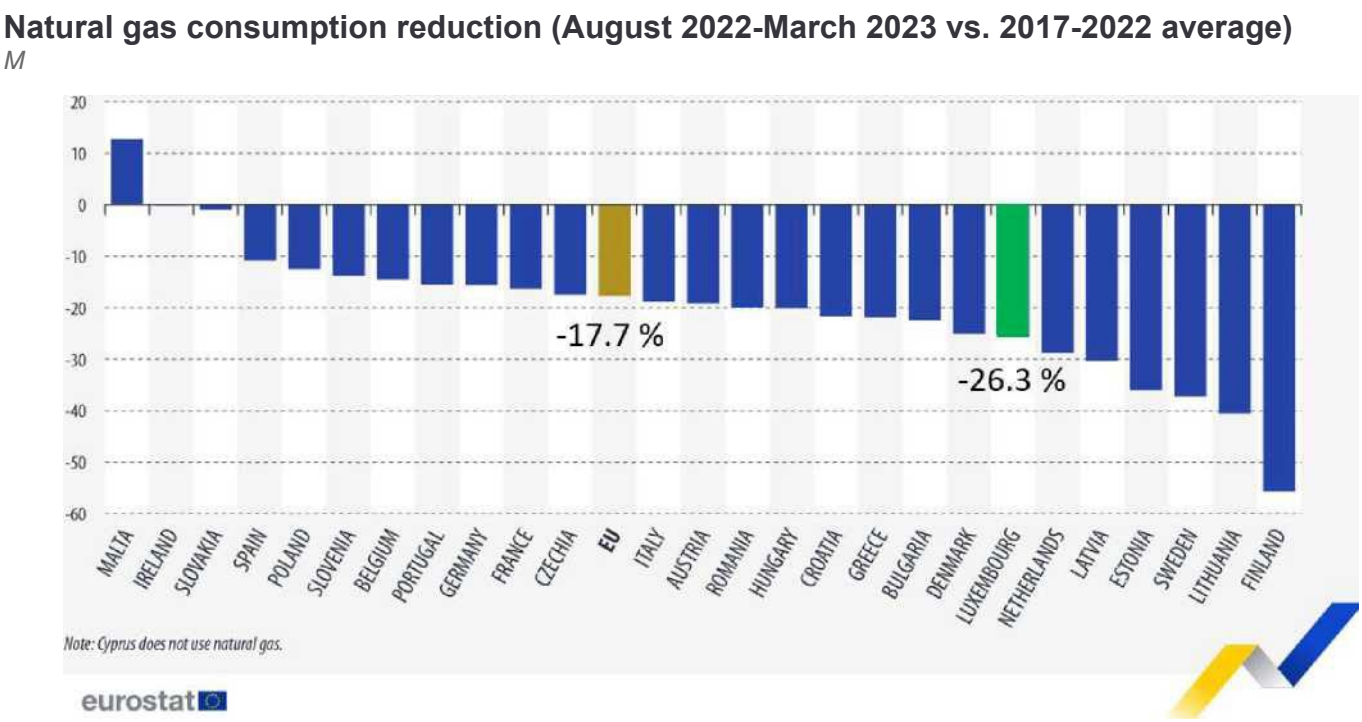
As the energy crisis has led to extremely high prices and fears of gas shortages, a number of EU and national measures to reduce dependence on Russian gas and prevent a possible gas shortage have recently entered into force. To help identify appropriate measures, ENTSO-G carried out simulations on security of supply in Europe. The simulations showed in particular the importance of gas storage in Europe. Gas storage is particularly important during winters to cover increased gas demand. To avoid possible shortages during winter 2022-2023 and subsequent winters, a high level of gas storage was needed before the start of winter. Regulation (EU) 2022/1032 of the European Parliament and of the Council of 29 June 2022 amending Regulations (EU) 2017/1938 and (EC) 715/2009 as regards gas storage established the requirement that European storage levels must be met at a maximum of 80 % by 2022 November

56 BNetzA, Versorgungssicherheit Strom, Stand und Entwicklung der Versorgungssicherheit im Bereich der Versorgung mit Elektrizität (2023): https://www.bmwk.de/Redaktion/DE/Downloads/V/versorgungssicherheitsbericht-strom.pdf?__blob = publicationFile & v = 4

and 90 % by 1. As Luxembourg does not have gas storage, it is obliged to contribute to the obligation to store gas in other Member States. In order to fulfil these obligations under the Regulation, a legal provision has been introduced for suppliers active in Luxembourg to enter into arrangements on 1 November each year providing for the storage of natural gas in Member States of the European Union with underground storage of natural gas for 15 % of their average supplies over the last five years to their customers located in Luxembourg.

Another important result that ENTSO-G simulations have shown was that a reduction in gas demand in Europe is necessary to avoid possible shortages. As a result, the European Council introduced Regulation (EU) 2022/1369 of 5 August 2022 on coordinated gas demand reduction measures, the objective of which is to reduce gas demand for all Member States at national level by -15 % for the period from 1 August 2021 to 31 March 2022 compared to average consumption in the period from 1 August to 31 March of the previous 5 years (2017 to 2022). In order to achieve this objective, the Luxembourg government launched the energy saving campaign57 'Zesumme spueren – Zesummenhalen', which aims to raise awareness and encourage the whole of society to save energy. At the end of 2022, the cumulative reduction in natural gas consumption since 1 August was around -29 % compared to the reference period for the years 2017 to 2022. The figure below shows the demand reductions achieved by the Member States up to January 2023.

Figure 42: Reduction of natural gas consumption in Europe from August 2022 to January 2023 (source: Eurostat)



In order to improve the coordinated purchase of gas, Council Regulation (EU) 2022/2576 of 19 December 2022 enhancing solidarity through better coordination of gas purchases, reliable reference prices and cross-border gas exchanges was adopted. The Regulation improves transparency and the exchange of information on gas purchases by natural gas undertakings or undertakings consuming gas established in the Union or by Member State authorities intending to tender for the purchase of gas or to open negotiations with producers or suppliers of natural gas in third countries for the purchase of gas. In addition, Member States should require that volumes equivalent to at least 15 % of their next year's storage filling target, approximately 13,5 billion cubic metres for the Union as a whole, be included by their companies in the demand aggregation process. Member States without underground storage facilities on their territory, such as Luxembourg, should participate in the demand aggregation process with volumes equivalent to 15 % of their burden sharing obligation under Article 6c of Regulation (EU) 2017/1938 of the European Parliament and of the Council.

Another measure to protect final customers from high prices was introduced by Council Regulation (EU) 2022/2578 of 22 December 2022 establishing a market correction mechanism to protect Union citizens and the economy from excessively high prices. The market

57 Energy saving campaign "Zesumme spueren – Zesummenhalen": https://zesumme-spueren.lu/

correction mechanism will be automatically activated if the following conditions occur. The price of the month ahead on the Title Transfer Facility (TTF) exceeds EUR 180/MWh for three working days and the FTT price for the month ahead is EUR 35 higher than a reference price for LNG on world markets for the same three working days. As from the day following the publication of a market correction notice, market operators shall not accept FTT derivatives that expire during the period from the expiry date of the FTT derivative to the expiry date of the closest FTT derivative (front-year) and whose price is EUR 35 higher than the reference price published by ACER on the previous day ('dynamic offer limit'), and participants in the FTT derivatives market may not submit orders for those FTT derivatives. If the reference price is below EUR 145/MWh, the dynamic offer limit shall remain equal to the sum of EUR 145 and EUR 35.

Thanks to the rapid reaction of the European Union and strong coordination between Member States, security of supply has been maintained throughout 2022, which is also a solid basis for the next winters. However, the situation will need to be monitored very closely, with the possibility of introducing further additional measures.

Risk preparedness

Regulation (EU) 2017/1938 of the European Parliament and of the Council concerning measures to safeguard security of gas supply and repeal Regulation (EU) No 994/2010 requires Member States to carry out a comprehensive assessment of the risks that endanger the security of gas supply in their Member State, in particular taking into account all national and regional circumstances as regards grid configuration, flow load, capacity and different consumption scenarios. The same regulation also provides for Member States to have a 'Preventive Action Plan58' and an 'Emergency Plan' to respond to possible crises in the gas sector.

In particular, the emergency plan59 was updated in 2022 in particular in the context of the war in Ukraine and the resulting change in gas supply in Europe. The update contains a precise definition of the protected customers and the priority levels assigned to 4 categories of customers under the different measures to be adopted depending on the situation. Protected customers are all household customers, essential services (healthcare services; essential social care services; emergency and safety services) and district heating installations, to the extent that they provide heating to protected customers, and only for the volumes necessary for the heating of those protected customers. All measures must be taken to avoid load shedding of protected customers, but they are nevertheless called upon to contribute to the reduction of consumption. Luxembourg's emergency plan for the security of gas supply defines three national levels of crisis and the measures to be taken to eliminate or mitigate the impact of gas supply disruptions.

Assessment of future security of supply

As all gas needs of Luxembourg are imported, the European internal market and geopolitical stability in Europe are of the utmost importance for Luxembourg. As described in the previous sections, most of the gas is imported from Belgium, with which Luxembourg shares a common market. A diversified supply of gas entering the Belgium-Luxembourg common market area is essential to enable a resilient and reliable supply chain. As a significant gas flow from Russia to Europe has been interrupted, much greater dependence on LNG is expected on the gas market in Europe. As Europe will source gas on the global LNG market, it is more exposed to the volatility of global LNG prices. Moreover, as other countries such as China are very active in the LNG market and have already established long-term contracts with many suppliers, the LNG volumes available are relatively low. The resulting LNG available on the market is therefore highly dependent on China's industrial production forecasts.

As described in the previous sections, gas storage will play an important role in maintaining security of supply, especially during winters. Coordinated filling of gas storage in Europe by all Member States will be necessary to ensure that a filling level of 90 % is reached by 1 November before each winter, as required by Regulation (EU) 2022/1032.

An effective method available to Luxembourg to reduce its dependence on gas imports is to increase energy efficiency and encourage the transition from gas to electricity in all sectors of society. In all gas consumption scenarios in Luxembourg, the objective is to

58 Preventive action plan on security of gas supply in Luxembourg (2020): https://mea.gouvernement.lu/dam-assets/energie/gaz/GAZ-Plan-d-action-preventif-gaz-naturel-version-2020.pdf
59 Emergency plan for the security of gas supply in Luxembourg (2022): https://gouvernement.lu/dam-assets/documents/actualites/2022/10-octobre/19-turmes-plan-urgence/lu-plan- durgence-gaz-version-20221019-final.pdf

reduce consumption and thus reduce dependence on gas imports. In particular with new policies and measures, a rapid transition from gas to other energy sources is expected.

4.5 internal energy market dimension

4.5.1 Electricity interconnectivity

Luxembourg is currently connected directly to its three neighbouring countries.

- Creos' transmission network is connected to the neighbouring German transmission network (Bauler and Trèves stations) via two 220 kV double lines with a nominal total transmission capacity of 2 300 MW.
- The Sotel industrial network is connected to Elia's Belgian transmission network via a double 220 kV line and to the French high-voltage electricity grid via a coupling line. The total interconnection capacity of the industrial network is 850 MW.

At the end of 2017, the commissioning of the Schifflange phase converter and the possibility of using a circuit from the 220 kV line to Aubange by Creos enabled Luxembourg to be integrated into the European transmission network, enabling the Creos network to be permanently connected to the Belgian transmission network from a technical point of view. As the network suppliers Elia and Creos control Schifflange's phase-converter, it is possible to coordinate the flow of electricity between Belgium and Germany via the Luxembourg transmission network. This enhanced link with the Belgian transmission network contributes in particular to greater security of supply. Although marketing in the context of European market coupling is not foreseen in the near future, this approach will be reviewed in the context of the further development of crisis management.

In order to strengthen the interconnection with the German transmission network managed by Amprion, Creos plans to build a new 380 kV extra high voltage line from Bertrange to Aach (Germany) via Bofferdange and a transformation station 380/220/110-65-kV around Bofferdange/Altlinster, replacing the existing 220 kV line at this level.

The level of interconnection is calculated using three different methods. To this end, interconnection capacity (n-0) shall be linked to:

- peak load
- total installed production capacity
- total installed generation capacity from RES

Irrespective of the concrete definition of the level of interconnection, Luxembourg goes far beyond the targets for 2020 and 2030.

Table XX: Luxembourg Interconnection Level

	2020	2022	2030	2040
Interconnector capacity in N-0 – Total Luxembourg [MW]	3150	3150	6650	7050
Peak load – Total Luxembourg (MW)	1123	1128	1600	2050
Total electricity generation capacity [MW]	487	677	1866	3226
RES power generation capacity [MW]	402	580	1823	3226
Level of interconnection of charges [%]	280 %	279 %	416 %	344 %
Level of interconnection of total generation [%]	647 %	465 %	356 %	232 %
Level of interconnection of RES generation [%]	784 %	543 %	364 %	232 %

Source: CREOS

4.5.2 Energy transmission infrastructure

Analysis – Gas

Luxemburg currently has network connection points with its three neighbouring countries, as shown in Figure 43. The transmission network covers approximately 280 km of high-pressure pipes and a total of 58 distribution stations (pressure control stations) and 4 border posts to the downstream networks. In recent years, only minor improvements have been made to the transmission network, as the expansion of the main axes has been completed. According to Creos, only isolated compaction will take place at the level of the distribution network in the future. No significant change is therefore foreseen in the aggregated length of pipes in the coming years.

Figure 43: Mapping of the supply situation in Luxembourg

Source: CREOS

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n

Table 56 illustrates developments in technical capacity at existing and planned interconnection points by Creos.

Given a relatively low demand, the border interconnection point at Esch-sur-Alzette was closed in 2013, but could be reactivated if necessary. However, this interconnection point only supplies a small region and is not connected to Creos' transmission network.

The non-interruptible entry capacity at Remich interconnection point is currently limited to 88 000 Nm³/h.

Therefore, the safe and uninterruptible transport capacity (n-1) is currently 268 000 Nm³/h. According to Creos, the current peak load of the group of protected customers is around 140 000 Nm³/h, thus Luxembourg would fulfil its infrastructure obligations under Regulation (EU) 2017/1938. However, due to the small number of interconnection points, this Regulation is not binding on the country. However, it intends to comply with it in order to ensure gas supply to protected customers.

Due to the closure of the Twinerg plant and the resulting sharp decrease in gas consumption, Creos sees no need to increase its capacity.

Mr CREOS was of the opinion that no gas intensive industry would set up in Luxembourg.

Table 56: Existing and future technical capacities of interconnection points

	2021	2030	2040
Esch/Alzette (FR)	20.000	20.000	20.000
Remich (DE)	150.000	150.000	150.000
Arms (BE)	110.000	110.000	110.000
Ptange (BE)	70.000	70.000	70.000
Total	**350.000**	**350.000**	**350.000**

Source: CREOS

4.5.3 Electricity and gas markets, energy prices

The Luxembourg electricity market currently has 19 authorised suppliers, of which 12 were active on the market in 2021. For the gas market, the number of licensed suppliers is 12, of which 7 are active.

The current electricity and gas prices for final customers are shown below.

Table 57 Evolution of electricity and gas prices for final customers.

	2017-S2	2018-S1	2018-S2	2019-S1	2019-S2	2020-S1	2020-S2	2021-S1	2021-S2	2022-S1	2022-S2
Average price of natural gas for household customers [EUR/kWh]	0.0398	0.0411	0.0429	0.0448	0.0414	0.0412	0.0366	0.0438	0.0639	0.0856	0.0891
Average natural gas price for non-household customer [EUR/kWh]	0.0338	0.0345	0.0359	0.0361	0.0307	0.0328	0.0308	0.0347	0.0492	0.0847	0.1225
Average electricity price for household customer [EUR/kWh]	0.1618	0.1671	0.1691	0.1798	0.1799	0.1986	0.1985	0.1988	0.1989	0.2017	0.2017
Average electricity price for non-household customer [EUR/kWh]	0.0873	0.0905	0.0914	0.0975	0.0983	0.1009	0.1020	0.1037	0.1058	0.1404	0.1638

Source: Eurostat

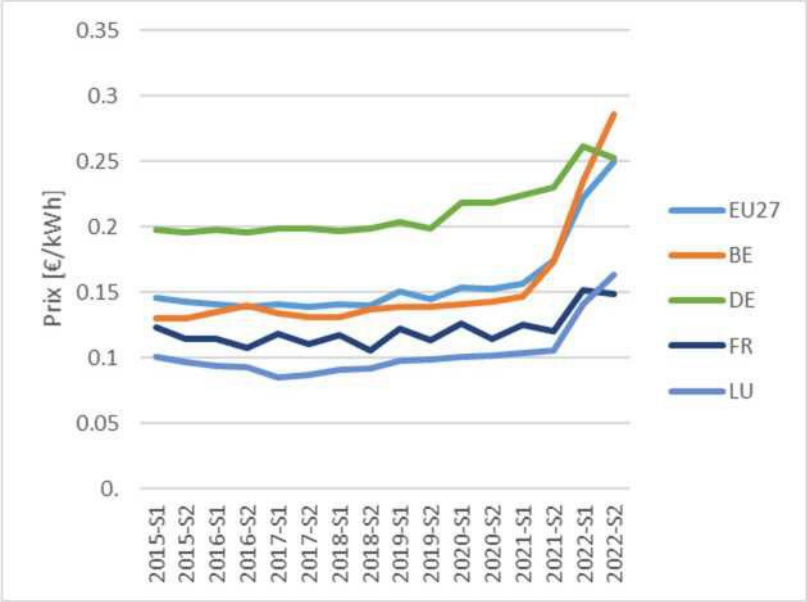
Remarks:

1. Household natural gas customer: Band D2: 20 GJ < annual consumption < 200 GJ

2. Non-household natural gas customer: Band I3: 10 000 GJ < annual consumption < 100 000 GJ
3. Household electricity customer: Band DC: 2 500 kWh < annual consumption < 5 000 kWh
4. Non-household electricity customer: Band IC: 500 MWh < annual consumption < 2 000 MWh

In addition to the table above, the following graph shows the evolution of the electricity price for non-household customers (Band IC: 500 MWh < annual consumption &2000MWh, including all taxes and levies) compared to neighbouring countries from 2015 onwards.

Figure 44 Electricity prices for non-household customers (Band IC: 500 MWh < annual consumption < 2000MWh, including all taxes and levies) compared to neighbouring countries from 2015 onwards



Source: Eurostat

4.6 research, innovation and competitiveness dimension

As argued in Chapters 2.5 and 3.5, R & D & I activities are located at different levels of TRL or upstream or downstream of complex value chains, of which Luxembourg covers only a small part. Although the proposed measures will enhance the RDI ecosystem in Luxembourg, their concrete impacts on the energy transition and climate action are difficult to quantify or even impossible to model. However, the MESR is working on scoreboards and indicators to better identify funding, resources, staff and results in relation to the NECP's flagship themes.

5 impact assessment of planned policies and measures

In order to carry out the impact assessment of policies and measures on a sound analytical basis, modelling was entrusted to a group of national experts composed of STATEC, experts from the various ministries involved, the Environment Administration and the Rural Economy Service. The approach is described in more detail in the introduction to Chapter 4.

5.1 Impacts of planned policies and measures on the energy system and GHG emissions and removals, with a comparison with projections based on existing policies and measures

In addition to the WEM (With Existing Measures) scenario based on existing policies and measures, which was adopted until 31 December 2021 and presented in Chapter 4, the impact assessment identified the WAM (With Additional Measures) scenario integrating the additional (new and reinforced) policies and measures, as described in Chapter 3. This chapter presents the assessment of the impacts of planned policies and measures (WAM scenario) on GHG emissions and removals (chapter 5.1.1), energy consumption (chapter 5.1.2) and renewable energy (chapter 5.1.3). Each time the effects of the WAM scenario are compared to the WEM scenario.

5.1.1 GHG emissions and removals

The results of projected GHG emissions and removals based on planned policies and measures (WAM scenario) are compiled in Table 58 and Table 59 for each of the 5 sectors of the Climate Law (ESR emissions/Climate Law: emissions attributed to Luxembourg under the Effort Sharing Regulation (EU) 2018/842), for installations falling under the scope of the ETS Directive (ETS emissions) and for the LULUCF sector.

Table 58: Projections of GHG emissions and removals until 2030 based on additional (new and reinforced) policies and measures (WAM scenario)

[Thousand tonnes CO_{2eq} (AR5)]	2021 *	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy and manufacturing industries, construction	594	563	534	499	471	440	410	381	356	330
Transport	4919	4331	4461	4384	4128	3781	3336	2955	2631	2326
Residential and service sector buildings	1647	1633	1554	1459	1360	1260	1169	1085	1002	915
Agriculture and forestry	720	715	707	682	658	630	604	583	563	545
Treatment of waste and waste water	192	187	182	178	174	170	166	161	157	157
Emissions ESR/Climate Law	8073	7430	7437	7203	6790	6281	5684	5165	4709	4273
ETS EMISSIONS	1317	1307	1264	1296	1304	1307	1296	1273	1255	1227
Emissions TOTALES – ESR/Climate Law & ETS	9391	8737	8701	8499	8094	7588	6981	6438	5964	5500
LULUCF	— 608	— 387	— 435	— 426	— 431	— 439	— 432	— 442	— 436	— 430

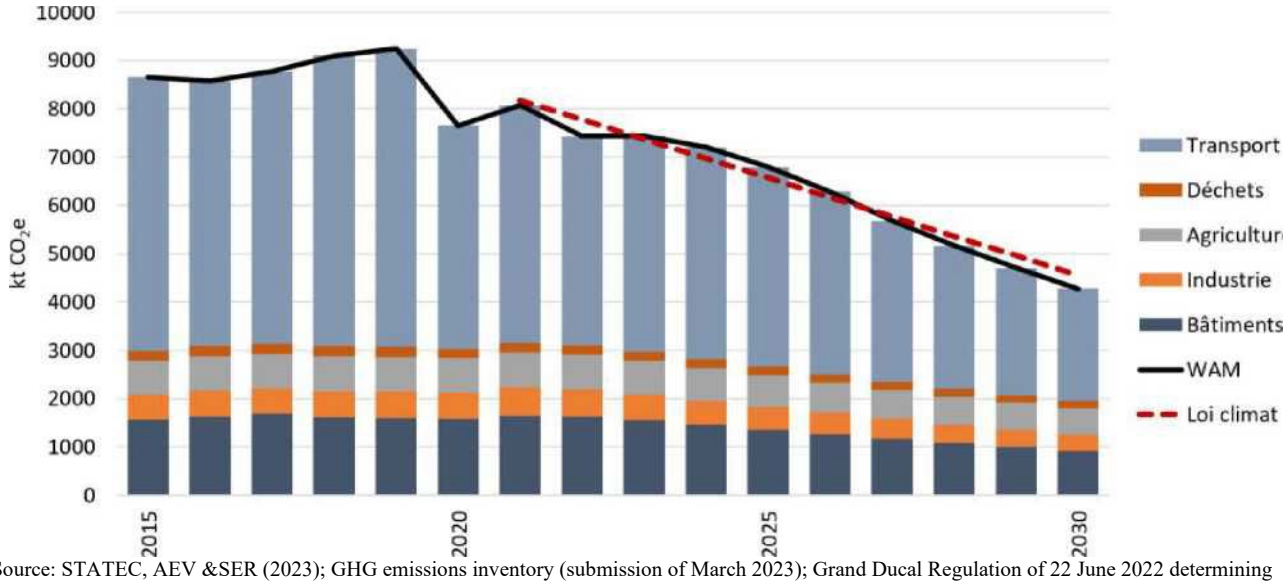
* Emissions for the year 2021 are observed data in the latest greenhouse gas emission inventory. Projections start from 2022 onwards.

Source: STATEC, AEV &SER (2023)

Comparing the projected ESR emissions/climate law of the WAM scenario with the annual emission allocations by 2030 (according to the Grand-Ducal Regulation of 22 June 2022 determining annual greenhouse gas emission allocations for the period up to 31 December 2030), projected emissions in 2030 are about 6 % lower than the emission allocation for that year. Compared to base year 2005, emissions in 2030 would be reduced by almost 58 %, while the national climate target is to

reduce emissions by 55 % by 2030 compared to 2005. The national emission reduction target would therefore be met in 2030, thanks to additional (new and reinforced) policies and measures, while in the WEM scenario emissions would only be reduced by 35 % (see Figure 45 and Figure 46).

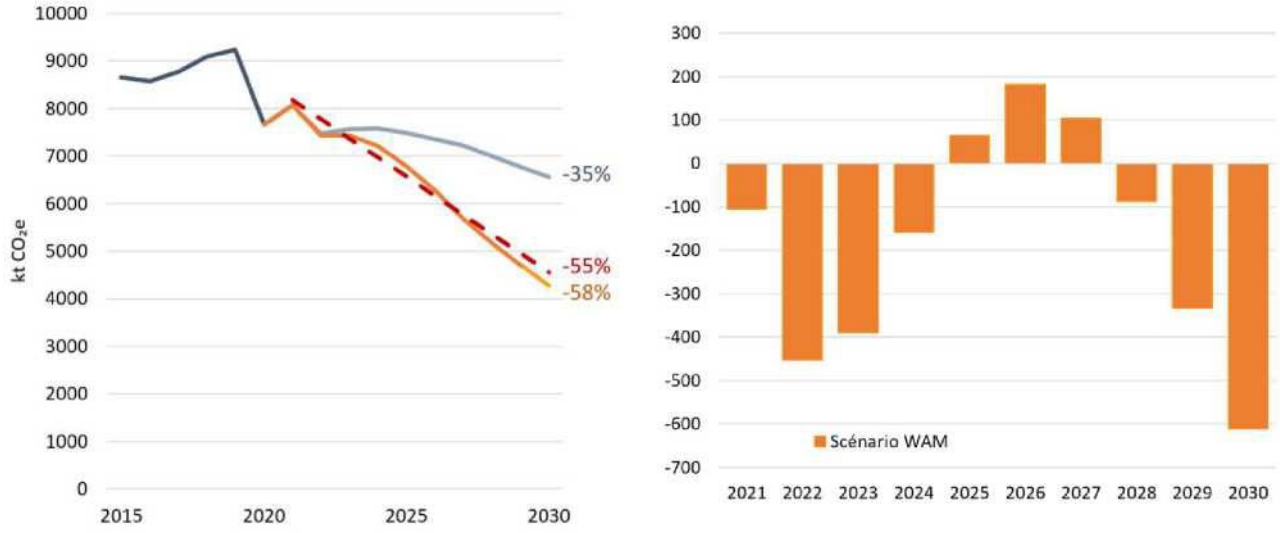
Figure 45: WAM projection of ESR emissions/climate law compared to the trajectory of annual emission allocations by 2030 (climate law) with historical emissions from 2015 to 2021



Source: STATEC, AEV &SER (2023); GHG emissions inventory (submission of March 2023); Grand Ducal Regulation of 22 June 2022 determining annual greenhouse gas emission allocations for the period up to 31 December 2030 (Climate Law)

Although the annual target in 2030 is met (as well as the 2021 target (see 4.2.1.1 and Figure 1)), the projected ESR/Climate Law emissions of the WAM scenario slightly exceed the annual emission allocations from 2023 to 2026. Over the whole period from 2021 to 2030, the WAM scenario combines a bonus of approximately 600 kt CO_{2eq} compared to the trajectory of annual emission allocations (see Figure 46). Thus, the national climate target would be well met over the period from 2021 to 2030.

Figure 46: WAM projection (in orange) and WEM projection (grey) of ESR emissions/climate law compared to the trajectory (red) of annual emission allocations by 2030 (climate law) with historical emissions from 2015 to 2021 & Cumulative emission balance in the WAM scenario compared to annual emission allocations by 2030



Source: STATEC, AEV &SER (2023); GHG emissions inventory (submission of March 2023); Grand Ducal Regulation of 22 June 2022 determining annual greenhouse gas emission allocations for the period up to 31 December 2030 (Climate Law)

Finally, as regards the LULUCF sector, the reinforced target for 2030 is to achieve a total net absorption of -403 kt CO_{2eq} (see 2.1.1). According to the results of the WAM scenario (see Table 58), the LULUCF target would also be achieved in 2030.

In conclusion, the additional (new and reinforced) policies and measures of the NECP update (WAM scenario) would achieve the national 2030 climate targets of the Climate Law.

The results of projections of GHG emissions and removals based on planned policies and measures (WAM scenario) for 2050 are compiled in Table 59 and discussed in Chapter 5.4.

Table 59: Projections of GHG emissions and removals until 2050 based on additional (new and reinforced) policies and measures (WAM scenario)

[Thousand tonnes CO_{2eq} (AR5)]	2025	2030	2035	2040	2045	2050
Energy and manufacturing industries, construction	471	330	256	182	127	109
Transport	4128	2326	1104	566	394	342
Residential and service sector buildings	1360	915	538	236	98	1
Agriculture and forestry	658	545	528	511	496	484
Treatment of waste and waste water	174	157	156	154	155	158
Emissions ESR/Climate Law	6790	4273	2583	1649	1270	1093
ETS EMISSIONS	1304	1227	932	571	562	583
Emissions TOTALES – ESR/Climate Law & ETS	8094	5500	3514	2220	1832	1676
LULUCF	— 431	— 430	— 256	— 428	— 493	— 660
Total Balance Sheet – ESR/Climate Law & ETS &LULUCF	7663	5070	3258	1792	1339	1016

Source: STATEC, AEV &SER (2023)

5.1.2 Evolution of energy consumption in Luxembourg by 2040 according to the WAM (With Additional Measures) scenario

Table 49 shows the final energy consumption of the WAM scenario for the years 2030 and 2040 broken down by sector. The corresponding trajectories are displayed in Figures 47 to 60. These figures make it possible to compare the WAM

scenario with the WEM scenario presented in Chapter 4 and to place it against the objectives of the 2020 NECP. The final energy considered here is the final energy excluding ambient heat, including international aviation.

Table 60: Final energy consumption of the different sectors foreseen in the WAM scenario for the years 2030 and 2040

Sector	Unit	2030	2040
Manufacturing and construction (ETS + Non-ETS)	GWh	6 '985	6 '762
Transport	GWh	19 '066	14 '085
Households (including residential buildings)	GWh	4 '410	3 '322
Trade and services (including tertiary buildings)	GWh	4 '904	4 '332
Agriculture	GWh	64	64
Total final energy consumption *	GWh	35 '430	28 '566

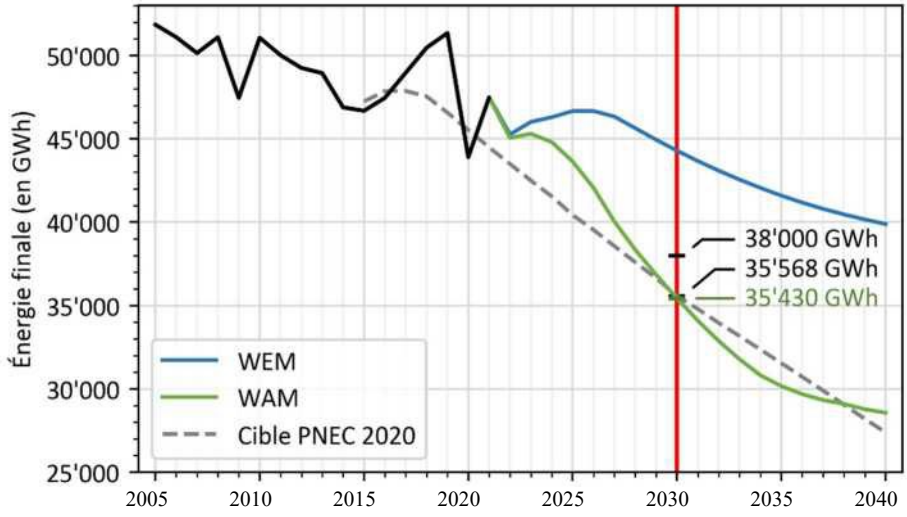
* excluding ambient heat, with international aviation

Source: STATEC 2023 modelling

Total all sectors

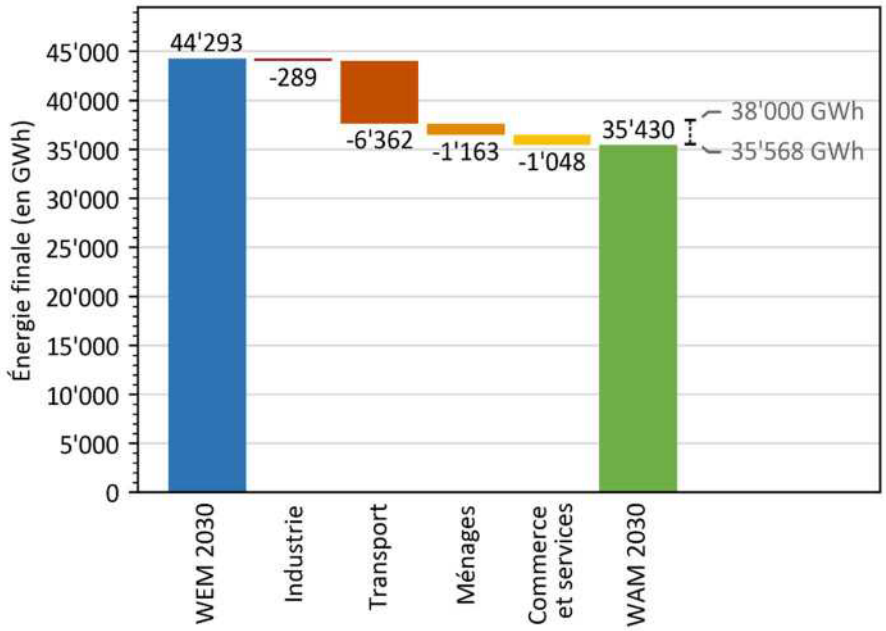
The overall energy efficiency target for all sectors modelled in the WAM scenario is shown in Figure 47. The ambitious target in final energy consumption of 35 '430 GWh in 2030 corresponds to a 44 % reduction compared to the REF2007 scenario and is therefore within the energy efficiency improvement range of -40 to -44 % compared to the REF2007 benchmark defined as the national target in the NEC2020.

Figure 47: Evolution PNEC 2020 vs WEM vs WAM – TOTAL all sectors



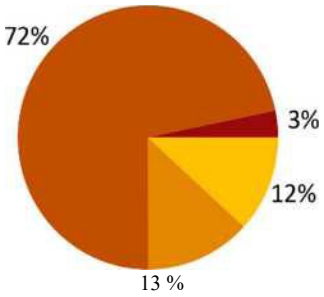
Source: STATEC 2023 modelling, MEA Graphics

Figure 48: Comparison between WEM and WAM – Total final energy consumption in 2030



Source: STATEC 2023 modelling, MEA Graphics

Figure 49: Sectoral contributions to the total final energy difference in 2030 between the WAM and WEM scenarios



Industry Household

Transport Trade and services

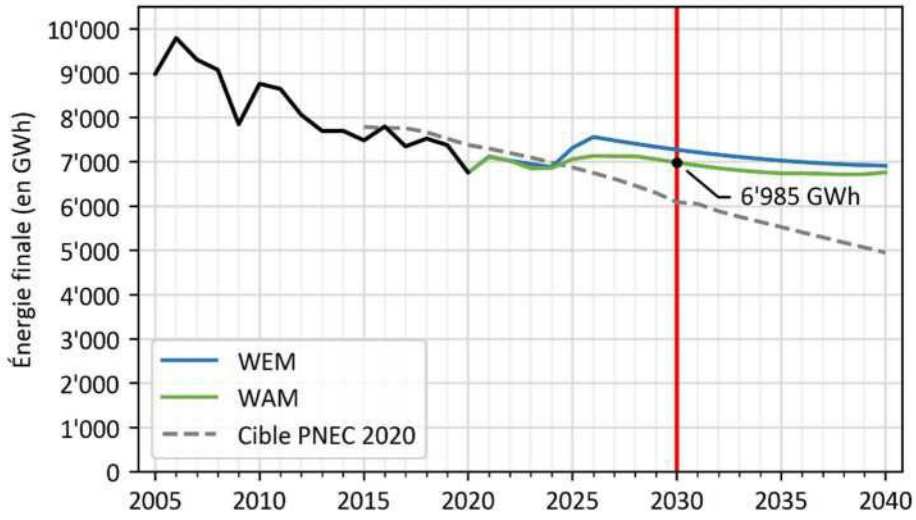
Source: STATEC 2023 modelling, MEA Graphics

Manufacturing and construction

Based on cyclical projections, the continuous increase in manufacturing and construction activities largely counterbalances the improvement in energy efficiency in this sector, which explains the almost constant final energy consumption between 2020 and 2040, with slight fluctuations.

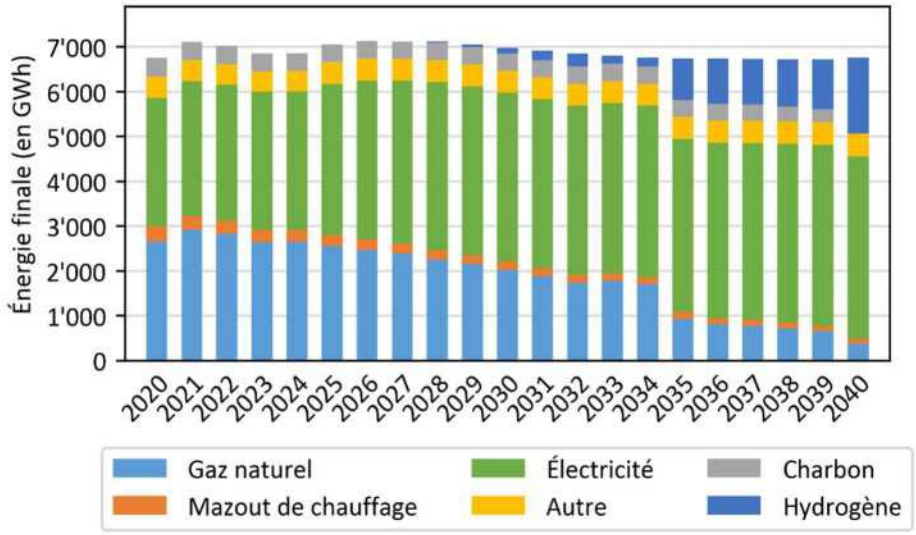
It should be pointed out that the increase in activities is mainly at the level of non-ETS companies and that there is virtually no change at the level of HTA companies.

Figure 50: Evolution PNEC 2020 vs WEM vs WAM – Manufacturing and construction



Source: STATEC 2023 modelling, MEA Graphics

Figure 51: WAM evolution by energy carrier – Manufacturing and construction



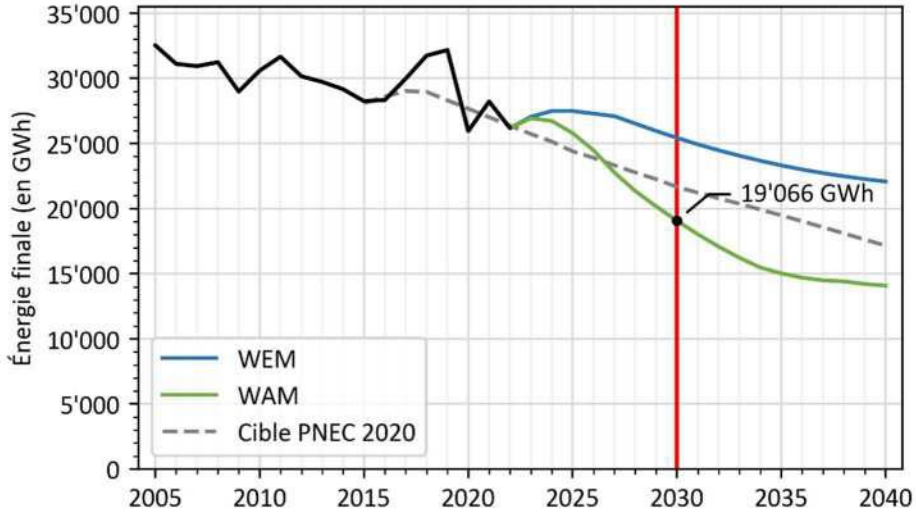
Source: STATEC 2023 modelling, MEA Graphics

Transport

The sharp decline in final energy consumption in the transport sector is primarily influenced by the modulation of the CO_2 tax according to the evolution of the fuel price differential with neighbouring countries (road transport fuels).

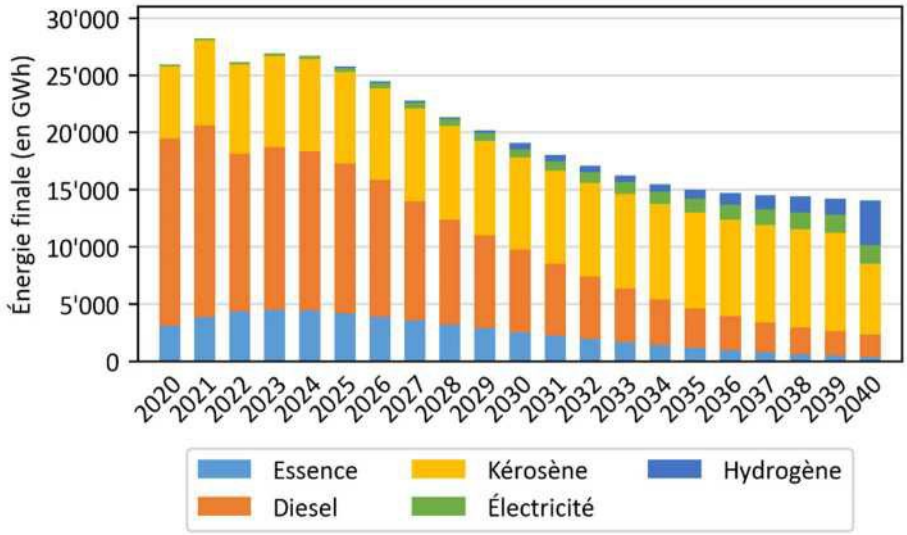
The electrification of the transport sector has an average impact on final energy consumption, but has a significant influence on the reduction of the sector's GHG emissions. The strong development of the aviation sector (passenger and freight transport) counterbalances some of the improvements in energy efficiency.

Figure 52: Evolution PNEC 2020 vs WEM vs WAM – Transport



Source: STATEC 2023 modelling, MEA Graphics

Figure 53: WAM evolution by energy carrier – Transport



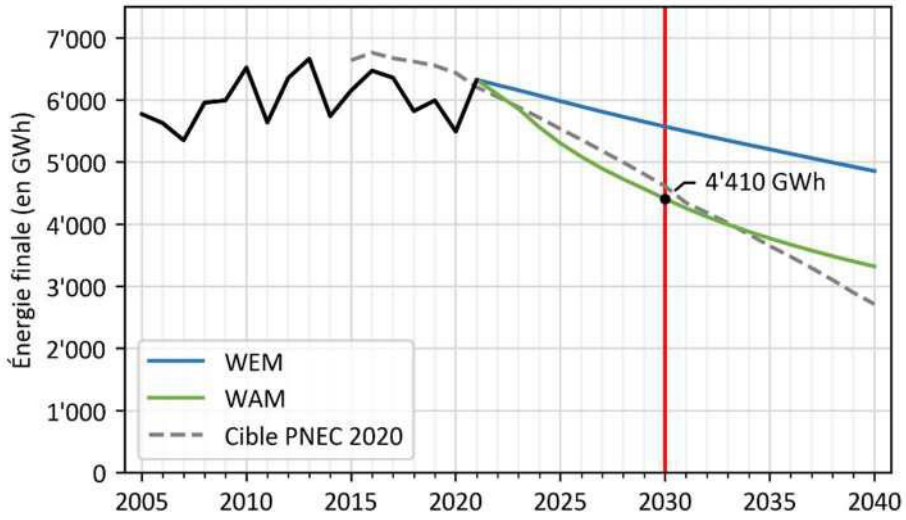
Source: STATEC 2023 modelling, MEA Graphics

Households (including residential buildings)

The energy consumed by households is largely directly related to the use (heating) of residential buildings.

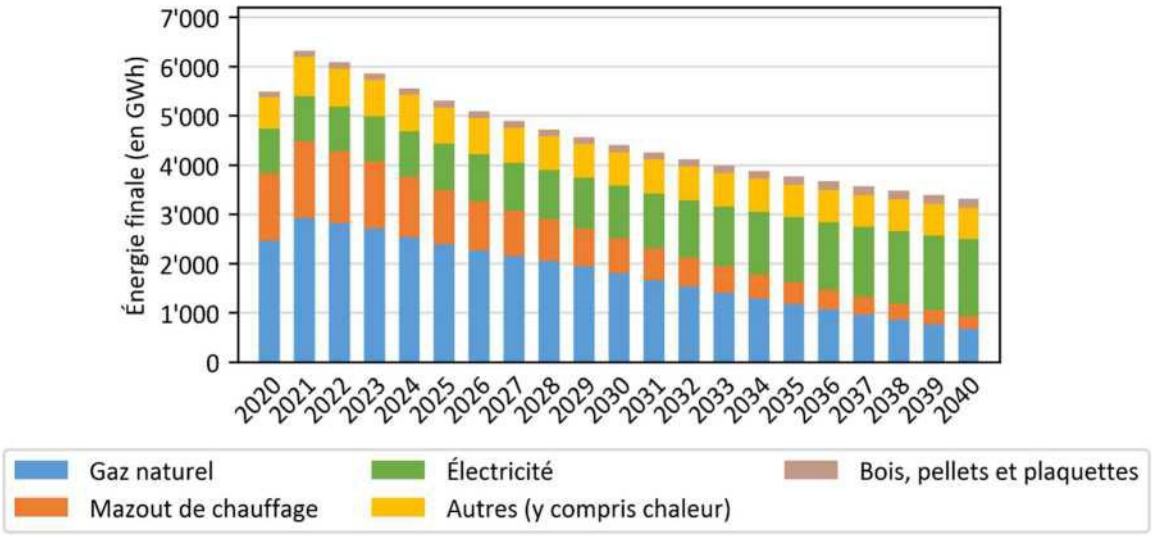
The decarbonisation of buildings through electrification, i.e. the replacement of fossil heating systems by renewable energy systems and in particular by heat pumps has a direct effect on GHG emissions and a significant effect on the reduction of the final energy consumed (as ambient heat operated by a heat pump is not counted as final energy (FEC without ambient heat)).

Figure 54: Evolution PNEC 2020 vs WEM vs WAM – Households



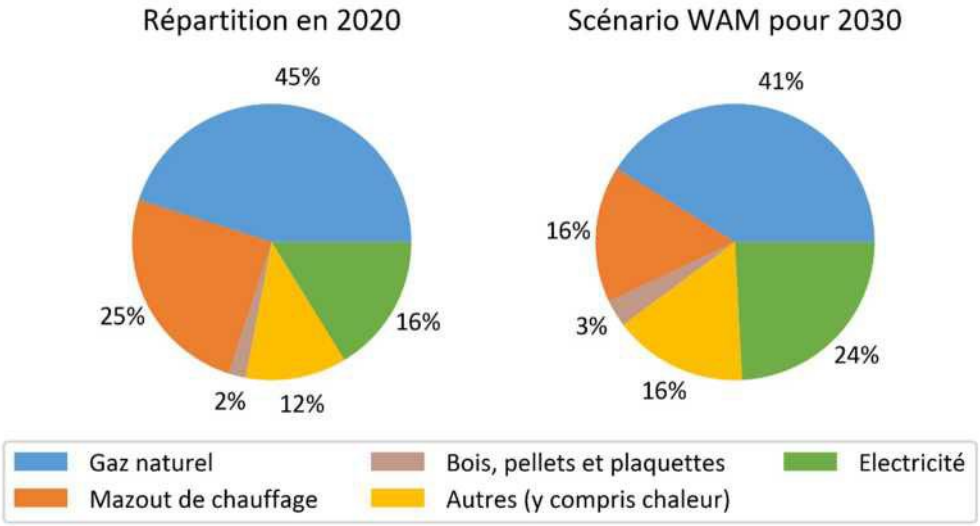
Source: STATEC 2023 modelling, MEA Graphics

Figure 55: WAM evolution by energy carrier – Households



Source: STATEC 2023 modelling, MEA Graphics

Figure 56: Distribution by energy carrier – Households



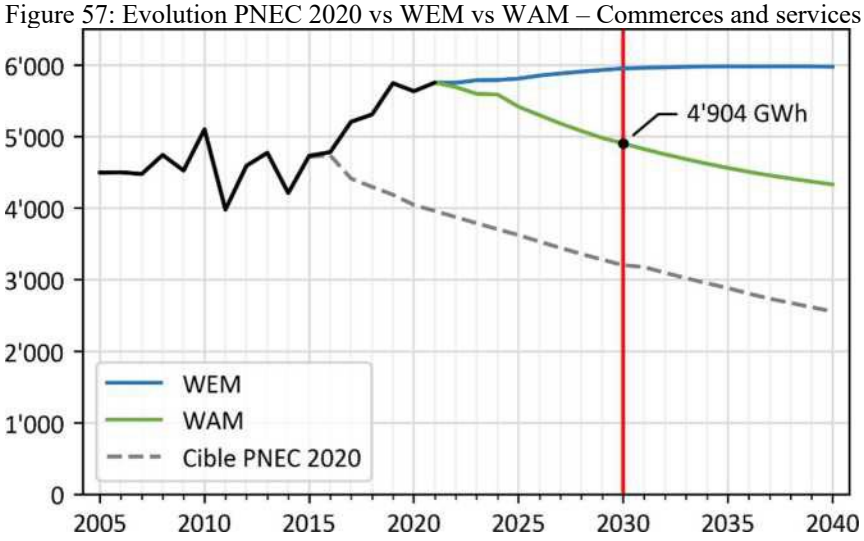
Source: STATEC 2023 modelling, MEA Graphics

Shops and services (including tertiary buildings)

This sector includes tertiary buildings but also all commercial and service activities (which are not specifically allocated to another sector).

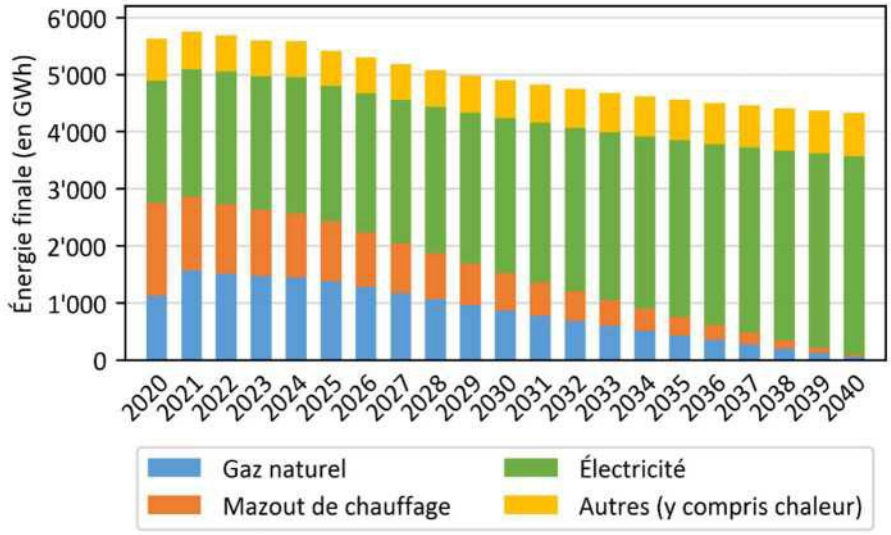
The decarbonisation of buildings through electrification, i.e. the replacement of fossil heating systems by renewable energy systems and in particular by heat pumps has a direct effect on GHG emissions and a significant effect on the reduction of the final energy consumed (as ambient heat operated by a heat pump is not counted as final energy (FEC without ambient heat)).

Figure 57: Evolution PNEC 2020 vs WEM vs WAM – Commerces and services



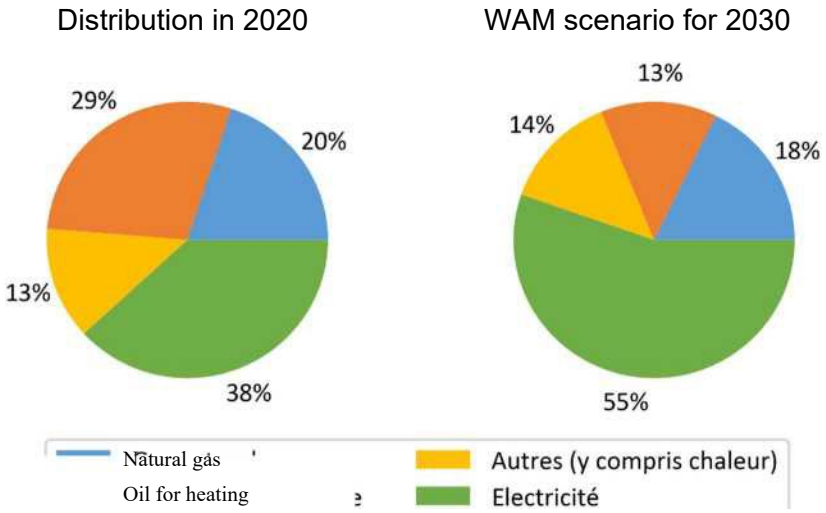
Source: STATEC 2023 modelling, MEA Graphics

Figure 58: WAM evolution by energy carrier – Commerces and services



Source: STATEC 2023 modelling, MEA Graphics

Figure 59: Distribution by energy carrier – Commerces and services

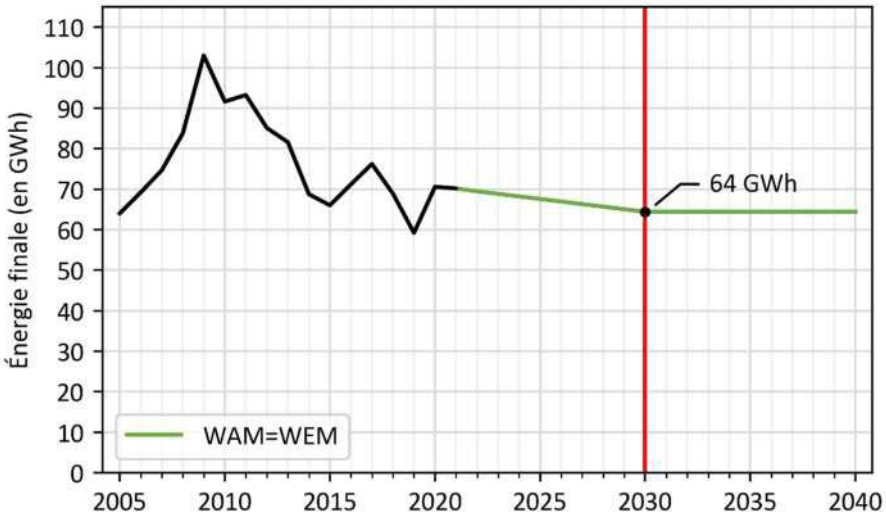


Source: STATEC 2023 modelling, MEA Graphics

Agriculture

The agriculture sector has a significantly lower final energy consumption compared to the other sectors considered above. Figure 60 shows the evolution of its final energy consumption up to 2040.

Figure 60: WAM scenario – Agriculture



Source: STATEC 2023 modelling, MEA Graphics

5.1.3 renewable energy

The 2020 NECP was adopted by the Government in Council at its meeting of 20 May 2020 and forms the basis of Luxembourg's climate and energy policy, a roadmap already implemented by the adoption of laws and regulations, strategies and programmes and projects in the various fields.

During the presentation of the 2020 NECP and the public consultation, the vast majority of stakeholders welcomed the overall level of ambition of the 2020 NECP. In the more detailed comments and proposals, citizens and groups mainly referred to issues of implementation of the 2020 NECP. As far as possible, adjustments were subsequently made and the Government Council chose to take account of comments and proposals when drawing up regulations, programmes and projects in the specific areas of the NECP between 2020 and 2030.

Renewable energy now contributes substantially to the decarbonisation of the energy sector in Luxembourg and is becoming increasingly important in the future to accelerate the energy transition.

The NEC2020 target scenario indicated the trajectory to reach a 25 % share of renewable energy compared to gross final energy consumption by 2030. In addition to near-exponential development of renewable energy, a sharp increase in energy efficiency and consequently a reduction in consumption will therefore be necessary.

This section focuses on the so-called additional measures to further promote the development of renewable energies and increase their contribution. Specifically, the focus is on energy production and the resulting share of renewable energy in the updated NECP target scenario (37 % of renewables in the energy mix for 2030), thus with the additional measures presented in Chapter 3, compared to the baseline scenario, with existing measures.

Development of energy production from renewable sources by sector by 2040 according to the WAM (With Additional Measures) scenario

In the following chapter, developments in renewable energy production in the different sectors according to the WAM scenario for 2040 are presented. The WAM scenario was modelled by STATEC on the basis of the NEAM model and taking into account the measures proposed in Chapter 3. In Chapter 2, some details and expected effects of the implementation of these policies and measures are also described in the chapters on developments in different renewable energy sources.

WAM scenario – Renewable electricity sector

Table 61: Projected evolution of renewable sources/technologies in the renewable electricity sector by 2040 – WAM scenario and comparison with WEM scenario

Wam scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Hydroelectric power	104	100	95	96	97	100	100	100	100	100	102
Eolien	315	330	430	511	699	800	867	903	962	1043	1368
Photovoltaic	180	316	390	480	580	680	780	890	1000	1112	1574
Renewable waste	43	43	44	45	46	47	48	49	49	50	60
Biogas *	62	67	71	75	79	84	88	92	96	100	100
Solid biomass * *	285	285	290	540	554	568	582	596	610	624	734
RES production	989	1141	1321	1747	2055	2278	2465	2630	2817	3029	3937
Consumption -El	6954	6910	6972	7056	7351	7582	7753	7923	8013	8122	9613
RES share – Electricity –%	14.2 %	16.5 %	18.9 %	24.8 %	28.0 %	30.0 %	31.8 %	33.2 %	35.2 %	37.3 %	41.0 %

WEM scenario:

RES share – Electricity –%	14.2 %	16.9 %	17.4 %	18.9 %	21.5 %	23.5 %	24.5 %	24.9 %	25.5 %	26.5 %	30.0 %

Source: STATEC-MEA modelling 2023

The increase in the share of renewable electricity is driven by photovoltaic and wind power throughout the period from 2021 to 2040. The WAM scenario is driven by policies and measures aimed, inter alia, at extending large photovoltaic installations, promoting self-consumption, the PV-ready for new industrial and agricultural buildings, and supporting wind energy by speeding up and facilitating authorisation procedures. A general overview is given in Chapter 2 and all measures can be found under Chapter 3.

In comparison to WEM, hydropower and renewable waste remain unchanged, as the available potential is already exploited and additional installations of these technologies are not foreseen by measures.

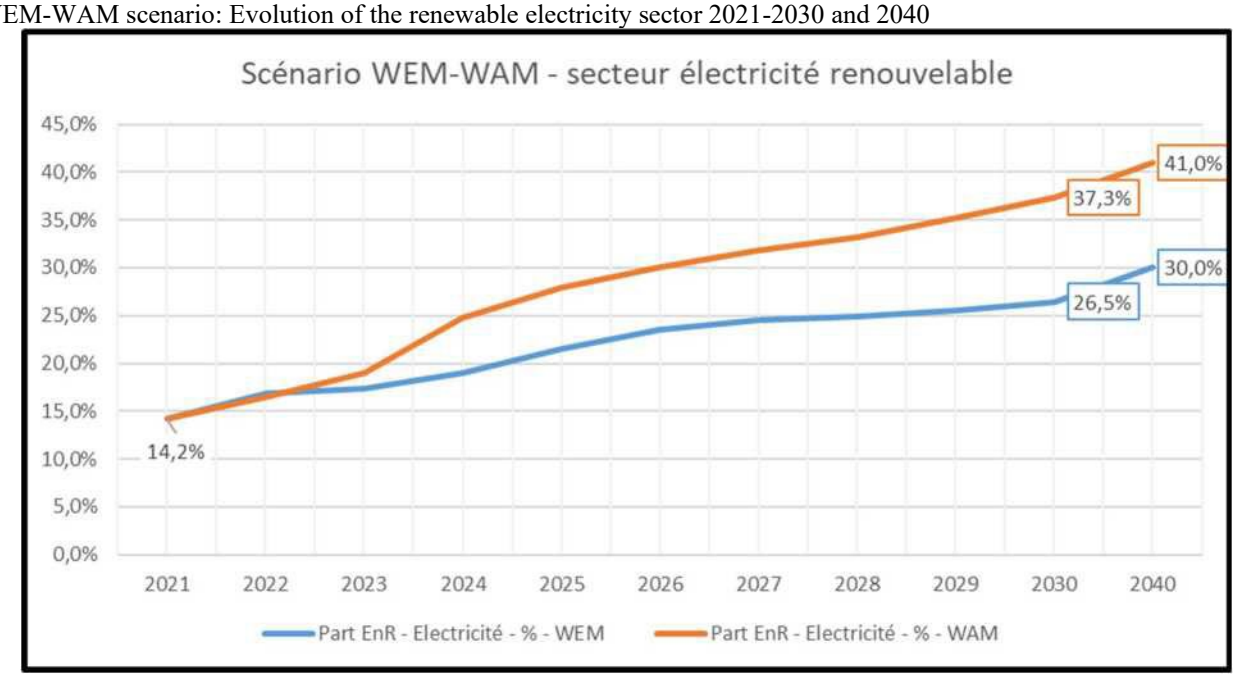
By 2040, wind energy increased from 1.016 GWh to 1.368 GWh, photovoltaic from 838 GWh to 1.574 GWh, biogas from 65 to 100 GWh and solid biomass from 428 to 734 GWh compared to the WEM scenario (Table 61). These differences underline that much of the measures are focused on these technologies and above all on solar energy.

For example, for 2030 the share of renewable energy in the electricity sector increases from 26.5 % (WEM) to 37.3 % (WAM) and for 2040 from 30 % to 41 % according to the modelling (

Figure 61).

A significant factor influencing the share of renewable energy in the electricity sector is electricity consumption, which increases by around 18.4 % between 2030 and 2040.

Figure 61: WEM-WAM scenario: Evolution of the renewable electricity sector 2021-2030 and 2040



Source: STATEC-MEA modelling 2023, MEA Graphic

WAM scenario – Renewable Heat Sector

Table 62: Projected evolution of renewable sources/technologies in the renewable heat sector by 2040 – WAM scenario

Wam scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Biogas (centralised) – biomethane	30	119	125	132	138	145	151	158	164	170	170
Solid biomass (centralised)	1203	1.300	1.310	2.050	2.068	2.103	2.139	2.177	2.217	2.259	1.697
Solid biomass (decentralised)	132	150	170	190	210	230	250	270	290	310	192
Renewable waste (centralised)	12	12	12	12	13	13	13	13	13	14	16
Thermal solar panels	31	35	40	45	50	55	60	65	70	75	100
Heat pumps (PAC)	54	151	237	317	396	485	593	706	840	1.036	3.901
Renewable hydrogen (Industry)	0	0	0	0	0	0	0	35	63	130	1.688
RES Consumption	1463	1767	1894	2747	2875	3030	3206	3424	3658	3994	7764
Consumption – ch	13117	12750	12290	12021	11617	11191	10800	10454	10160	9915	9204
RES share – Heat –%	11.2 %	13.9 %	15.4 %	22.8 %	24.8 %	27.1 %	29.7 %	32.8 %	36.0 %	40.3 %	84.4 %

WEM scenario:

RES share – Heat –%	11.2 %	12.2 %	13.2 %	14.2 %	14.9 %	15.6 %	16.6 %	17.6 %	18.6 %	19.6 %	27.5 %

Source: STATEC-MEA modelling 2023

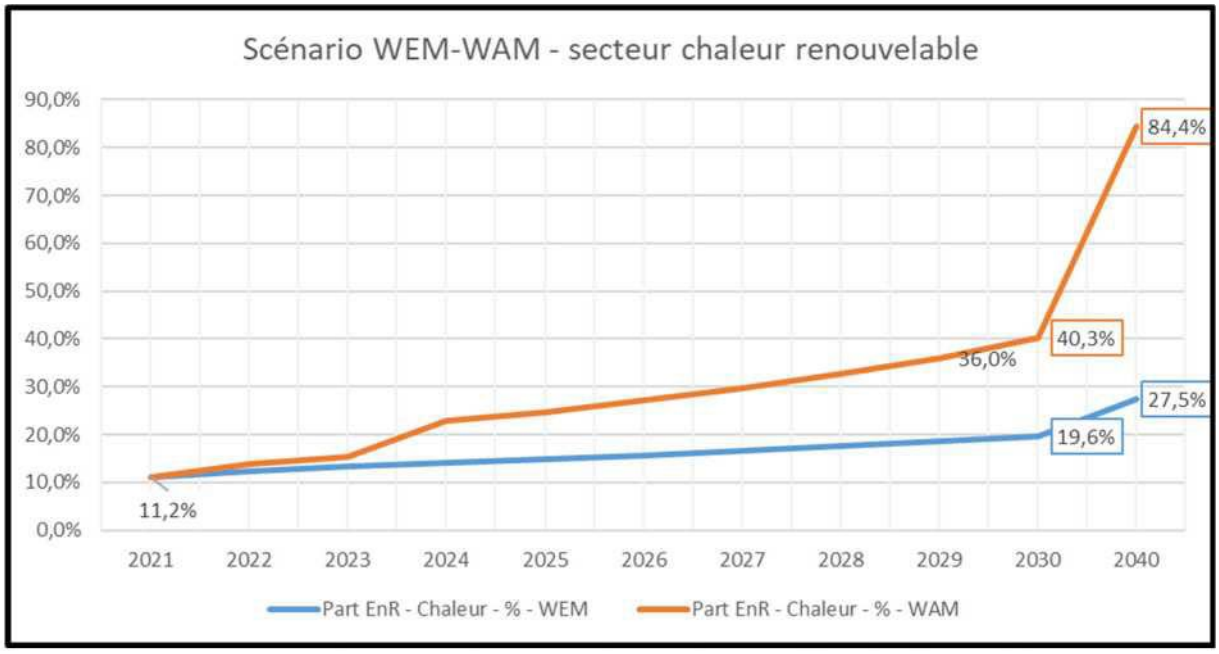
Compared to the WEM scenario, the WAM scenario is distinguished primarily by its heat input from heat pumps, whether used in the residential or tertiary buildings sector, with the objective of decarbonising buildings through electrification, combined with photovoltaic electricity generation (and optimisation of self-consumption of this electricity) (Table 62). For 2030, WEM modelling is 643 GWh significantly lower in terms of heat produced from heat pumps, compared to the WAM scenario (1.036 GWh). Between

2030 and 2040, the deployment of heat pumps will be much more pronounced with the proposed measures, resulting in 3.901 GWh produced (WAM) instead of 1.242 GWh (WEM).

In addition to heat pumps, renewable hydrogen (with priority for industrial processes) plays a role in decarbonising the industrial sector, especially from 2030 onwards. By 2035, and in consultation with the development of a network in the Greater Region, it is planned to put into service a line carrying renewable hydrogen. With 1.688 GWh modelled for 2040, renewable hydrogen contributes substantially to decarbonising the heat sector (industrial processes).

On the otherhand, the centralised production of energy from biogas, respectively the use of biomethane, has seen a sharp increase as a result of the additional measures (WAM: 170 GWh; WEM: 32 GWh). Heat production from solid biomass (centralised and decentralised) as a transitional technology tends to decrease following the accelerated development of heat pumps. Production from thermal solar panels is also subject to slight increases in the WAM scenario compared to the WEM scenario. Figure 62 shows the evolution of the share of renewable energy in the heat sector in both scenarios.

Figure 62: WEM-WAM scenario – Renewable Heat Sector Evolution 2021-2030 and 2040



Source : Modélisation STATEC-MEA 2023, Graphique MEA

WAM scenario – Transport sector

Table 63: Projected evolution of renewable sources/technologies in the transport sector by 2040 – WAM scenario

Wam scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Biofuel incorporation rate%	7.7 %	8.0 %	8.0 %	8.4 %	8.8 %	9.0 %	9.2 %	9.4 %	9.7 %	10.0 %	6.0 %
Fossil fuels	20631	18157	18701	18444	17443	16120	14445	13032	11822	10634	2369
Share of biofuels – road transport	1589	1453	1496	1549	1535	1451	1329	1225	1147	1063	142
— Simple counting biofuels	1233	1126	1159	1217	1151	1096	1011	938	887	697	0
— Biofuels double counting	351	309	318	314	297	274	246	222	201	181	24
— Advanced biofuels	5	18	19	18	87	81	72	65	59	186	118
Renewable hydrogen + SAF	0	0	2	10	177	179	182	205	229	524	4569
— road transport	0	0	2	10	15	20	25	50	75	100	1000
— air transport	0	0	0	0	162	159	157	155	154	424	3569
Electricity Transport	173	186	213	250	299	355	416	482	552	624	1642
— RES transport	4	5	10	18	28	51	74	101	129	158	842
— RES rail	15	20	22	26	28	38	43	47	50	53	94
RES Consumption *	1608	1478	1530	1603	1606	1560	1471	1423	1401	1374	2078
Consumption ENR * *	1983	1831	1907	2000	2120	2118	2063	2067	2104	2326	9075
Consumption Tr.	22768	20386	21099	21235	20275	18900	17019	15481	14165	12904	12150
RES share – Transport * *	8.7 %	9.0 %	9.0 %	9.4 %	10.5 %	11.2 %	12.1 %	13.4 %	14.9 %	18.0 %	74.7 %

* without multipliers

* * with multipliers (Article 27 Directive 2018/2001/EC)

WEM scenario:

RES share – Transport * * –%	8.7 %	9.0 %	9.3 %	9.6 %	10.4 %	10.7 %	11.0 %	11.4 %	12.0 %	13.5 %	19.3 %

Source: STATEC-MEA modelling 2023

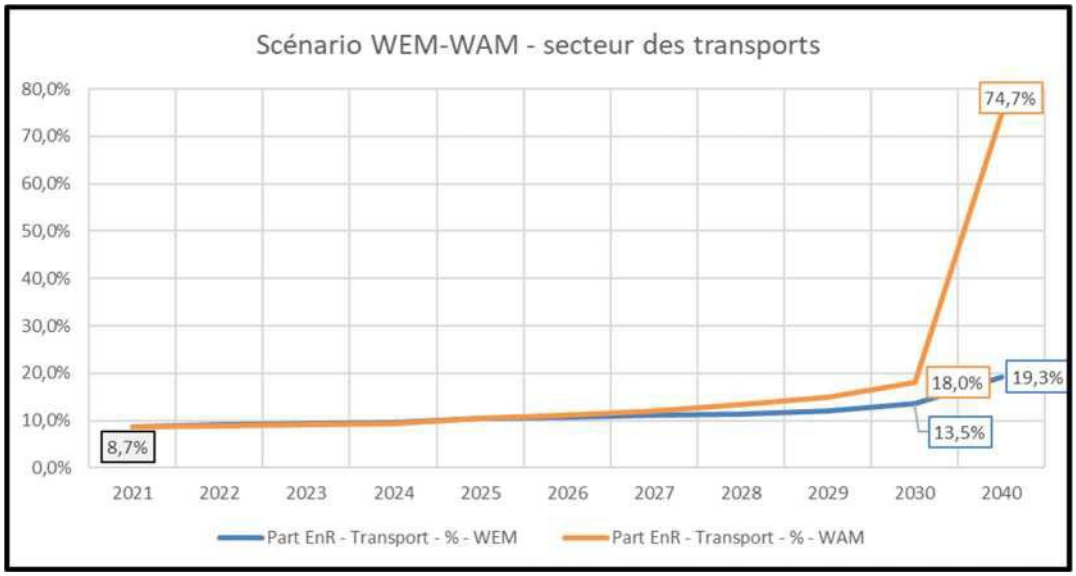
Compared to the WEM scenario, the share of renewable energy is increasing significantly thanks to the additional measures, from 19.3 % to 74.7 % in 2040; this is partly due to a reduction in total consumption modelled for 2040 (WAM: 12.150 GWh; WEM: 17.782 GWh) and above all the significant decrease in fossil fuel consumption (Table 63). In the WAM scenario, fossil fuels will decrease from 10.634 GWh to 2.369 GWh between 2030 and 2040, a reduction of 77.7 % – in contrast to the WEM scenario, the decrease will be only 17.9 %.

The transportsector is experiencing its decarbonisation primarily through electrification of the car fleet. Thus, the share of fossil fuel decreases at the same time. The additional measures lead to an additional consumption of 418 GWh of electricity in 2040.

In addition to electrification, the contribution of renewable hydrogen and its renewable derivatives contributes to the decarbonisation of freight transport, logistics and aviation with a total consumption of 4.569 GWh – a share that is not considered in the WEM scenario.

The increased electrification in this scenario, the deployment of renewable hydrogen and the significant decrease in fossil fuels explain the significant difference in 2040 of the WAM scenario compared to the WEM scenario (Figure 63).

Figure 63: WEM-WAM scenario: Figure 7 – Evolution of the transport sector 2021-2030 and 2040



Source : Modélisation STATEC-MEA 2023, Graphique MEA

WAM Scenario – Indicative Trajectory and Overall Objective

Table 64: Overall share of renewable energy and European cooperation by 2040 – WAM scenario

Wam scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Domestic RES production	4059	4386	4745	6097	6537	6868	7142	7478	7876	8397	13779
European cooperation	800	1200	1000	500	3000	2350	3350	2950	3350	3500	4000
— of which statistical transfers	800	1200	1000	500	2850	2000	2700	2000	2000	1750	1500
— of which REFM	0	0	0	0	150	350	650	950	1350	1750	2500
RES production + European cooperation	4859	5586	5745	6597	9537	9218	10492	10428	11226	11897	17779
Final energy consumption	43388	45823	46163	45837	44851	43464	41705	40275	39025	37866	32757
Aviation	8792	7820	7986	8056	7964	8037	8109	8179	8250	8048	6171
— Current Aviation share –%	20.3 %	17.1 %	17.3 %	17.6 %	17.8 %	18.5 %	19.4 %	20.3 %	21.1 %	21.3 %	18.8 %
— Aviation threshold –%	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %
Adjusted gross final energy consumption	37277	40834	41030	40614	39659	38113	36174	34585	33187	32159	28610
Overall RES share	13.0 %	13.7 %	14.0 %	16.2 %	24.0 %	24.2 %	29.0 %	30.2 %	33.8 %	37.0 %	62.1 %
Indicative trajectory and overall target	11.0 %	13.5 %	11.0 %	11.0 %	21.3 %	11.0 %	26.6 %	11.0 %	11.0 %	35.0 %	62.1 %

Wam scenario – GWh	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Domestic RES production	4059	4386	4745	6097	6537	6868	7142	7478	7876	8397	13779
European cooperation	800	1200	1000	500	3000	2350	3350	2950	3350	3500	4000
— of which statistical transfers	800	1200	1000	500	2850	2000	2700	2000	2000	1750	1500
— of which REFM	0	0	0	0	150	350	650	950	1350	1750	2500
RES production + European cooperation	4859	5586	5745	6597	9537	9218	10492	10428	11226	11897	17779
Final energy consumption	43388	45823	46163	45837	44851	43464	41705	40275	39025	37866	32757
Aviation	8792	7820	7986	8056	7964	8037	8109	8179	8250	8048	6171
— Current Aviation share –%	20.3 %	17.1 %	17.3 %	17.6 %	17.8 %	18.5 %	19.4 %	20.3 %	21.1 %	21.3 %	18.8 %
— Aviation threshold –%	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %	6.18 %
Adjusted gross final energy consumption	37277	40834	41030	40614	39659	38113	36174	34585	33187	32159	28610
Overall RES share	13.0 %	13.7 %	14.0 %	16.2 %	24.0 %	24.2 %	29.0 %	30.2 %	33.8 %	37.0 %	62.1 %
Indicative trajectory and overall target	11.0 %	13.5 %	11.0 %	11.0 %	21.3 %	11.0 %	26.6 %	11.0 %	11.0 %	35.0 %	62.1 %

WEM scenario:

Share EnR WEM – with cooperation	11.1 %	13.5 %	13.1 %	11.4 %	17.0 %	17.4 %	20.1 %	19.9 %	20.8 %	25.1 %	32.6 %

Source: STATEC-MEA modelling 2023

Comparing the scenarios for national renewable energy production in 2030, there is an increase of 10 percentage points between the WEM and WAM scenarios. The gap widened further in 2040, almost doubling. The WAM's more ambitious objectives do not require more significant European statistical transfers than for WEM; in 2030, 3.500 GWh instead of 3.700 GWh and in 2040 the 4.070 GWh instead of 4.000 GWh (Table 64). The additional measures significantly increase the share of renewable energy in gross final energy consumption in order to achieve the more ambitious targets without substantially increasing the need for statistical transfers and cooperation under the REFM.

Table 65: Share of renewable energy by sector and global by 2040 – WAM and WEM scenario

Wam scenario	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
RES share – electricity sector	14.2 %	16.5 %	18.9 %	24.8 %	28.0 %	30.0 %	31.8 %	33.2 %	35.2 %	37.3 %	41.0 %
RES share – heat sector	11.2 %	13.9 %	15.4 %	22.8 %	24.8 %	27.1 %	29.7 %	32.8 %	36.0 %	40.3 %	84.4 %
RES share – Transport *	8.7 %	9.0 %	9.0 %	9.4 %	10.5 %	11.2 %	12.1 %	13.4 %	14.9 %	18.0 %	74.7 %
Overall RES share – without cooperation	10.9 %	10.7 %	11.6 %	15.0 %	16.5 %	18.0 %	19.7 %	21.6 %	23.7 %	26.1 %	48.2 %
Overall RES share – with cooperation	11.1 %	13.7 %	14.0 %	16.2 %	24.0 %	24.2 %	29.0 %	30.2 %	33.8 %	37.0 %	62.1 %
Indicative trajectory and overall target	11.0 %	13.5 %	11.0 %	11.0 %	24.0 %	11.0 %	29.0 %	11.0 %	11.0 %	37.0 %	62.0 %

* with multipliers (Article 27 Directive 2018/2001/EC)

Source: STATEC-MEA modelling 2023

At sectoral level, renewable energy production in the renewable electricity sector increases significantly by 10 points in 2040 and the share of the renewable heat sector is twice as high in the WAM scenario in 2030 and shows a dramatic increase in 2040, notably through the input of heat pumps and renewable hydrogen and its derived products (Table 65 and Table 66). The transport sector saw an increase of almost 5 percentage points in 2030 and, supported by electro-mobility and renewable hydrogen and its derivatives, recorded a significant increase of more than 50 percentage points in 2040 in the WAM scenario.

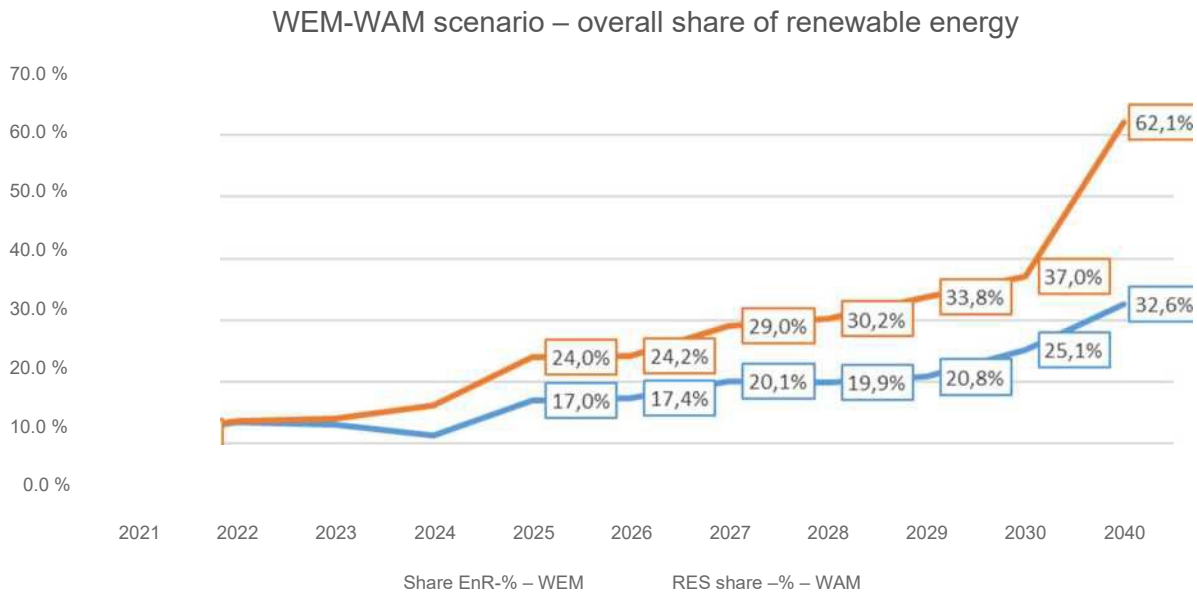
Table 66: Comparison: Share of renewable energy by sector and overall by 2040 – WAM and WEM scenario

WAM-WEM compares –%	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
RES share – electricity sector	0.0 %	0.0 %	1.5 %	5.8 %	6.5 %	6.6 %	7.3 %	8.3 %	9.6 %	10.8 %	11.0 %
RES share – heat sector	0.0 %	1.6 %	2.2 %	8.6 %	9.9 %	11.4 %	13.1 %	15.2 %	17.4 %	20.7 %	56.8 %
RES share – Transport *	0.0 %	0.0 %	— 0.2 %	— 0.2 %	0.1 %	0.5 %	1.1 %	1.9 %	2.8 %	4.5 %	55.4 %
Overall RES share – without cooperation	1.6 %	0.5 %	0.9 %	3.7 %	4.3 %	5.1 %	6.2 %	7.5 %	8.9 %	10.5 %	26.7 %
Overall RES share – with cooperation	0.0 %	0.2 %	1.0 %	4.9 %	7.1 %	6.8 %	8.9 %	10.2 %	13.1 %	11.9 %	29.5 %

Source: STATEC-MEA modelling 2023

Figure 64 compares the evolution of the overall share of renewable energy in the two scenarios.

Figure 64: WEM-WAM scenario: — Evolution of overall share 2021-2030 and 2040



Source:
STATEC-MEA modelling 2023, MEA Graphic

5.2 macroeconomic impacts of planned policies and measures and investment needs

5.2.1 Introduction

The NECP aims to increase energy efficiency and reduce greenhouse gas emissions. Beyond emissions, it is worth considering the possible impact of this transition on the Luxembourg economy. The energy transition involves a transformation of the whole economy,

comparable to industrial revolutions. The macroeconomic impact could therefore be considerable.

It should be noted that this is not a matter of assessing the impact and usefulness of climate actions in general, as various reports have already shown that the cost of inaction would considerably exceed the cost of actions to contain climate change (e.g. Stern, 2007 or OECD, 2012). Moreover, given the global dimension of warming, such an approach would make little sense if the analysis were limited to Luxembourg. The main objective of this analysis is narrower and focuses on the macroeconomic impacts of the update of the Luxembourg NECP. The assessment is made against the WEM (With Existing Measures) which includes all measures adopted before 31.12.2021.

This analysis will review the different channels through which the transition could affect GDP and then apply a range of impacts from a literature review to the With Additional Measures (WAM) scenario of this NECP update. Beyond the impact on economic growth and emissions, the analysis will also address the expected consequences on employment, energy expenditure and excise revenues, and detail the investments, private and public, as well as the public expenditure needed to accelerate Luxembourg's energy transition.

5.2.2 The main channels for the transmission of climate action to the economy

5.2.2.1 Investment as the main driver of the impact on growth

The transition to climate neutrality requires substantial investment, and the latter will largely determine the impact of the transition on GDP. The additional investments in the WAM scenario[60] act as fiscal injections that stimulate the economy. The energy transition would thus represent a positive demand shock, leading to increased activity. Indeed, the initial impetus for increased investment is passed on through the entire economy through a traditional Keynesian effect: the additional demand would lead to higher output, which would require more labour so that employment would increase, which would have a positive effect on income and encourage consumption, which would again stimulate activity. In this way, GDP in the WAM scenario could be higher than in the WEM scenario.

However, the above mechanisms consider that investments to achieve climate neutrality are (at least partially) additional and do not replace other investments or consumption. On the other hand, if the funds required for the transition would avoid other productive investments, this would limit the positive impact on activity. Thus, the way energy transition investments would be made, and modelled, strongly influences the estimated impact on GDP.

Beyond financing, determining the amount of additional investment required to become carbon-neutral is important as it determines the initial budget injections that will generate the activity through multiplier effects. Estimates vary between studies, but are broadly around 2 % of GDP in 2030 (Pisani-Ferry, 2022). These investment needs would not be constant over time, it is generally estimated that they would gradually increase before declining towards 2050. The additional investments identified under the Luxembourg NECP would correspond to around 1.7 % of GDP in 2030, which would be slightly lower than in other studies. The detailed composition of these investments is analysed in a later part of this document.

Economically, the energy transition creates capital substitution for fossil energy spending. The counterpart to the increase in investment is a fall in future energy expenditure. For the Luxembourg economy, which imports all fossil fuels, this is another potential economic stimulus, because the income would be reallocated to other goods and services with necessarily lower import content.

5.2.2.2 Uncertain productivity developments

Productivity is a component of GDP growth[61], and its evolution in the WAM scenario compared to the WEM scenario can determine whether the impact of the transition on GDP is positive or negative. For example, for France, Pisani-Ferry & Mahfouz (2023) estimates that, with the same productivity in both scenarios, GDP would be slightly higher in 2040 in the case of climate neutrality. On the other hand, with lower productivity growth in the scenario that meets the climate targets, GDP would be below the baseline scenario.

There is no consensus in the literature on such a negative development in productivity. The authors (Pisani- Ferry & Mahfouz, 2023) justify it with possible adaptation costs or reallocation of factors of production with the aim of reducing emissions, which could be detrimental to productivity. Another possibility is that investments to increase productivity are not made because these funds should be used to achieve climate objectives. This amounts to the crowding out effect already mentioned above, while assuming a persistent

60Wam = With Additional Measures, scenario that includes new measures to meet climate and energy targets
GDP growth61 consists of productivity and employment growth.

adverse effect on productivity that goes beyond the mere cyclical impact of investment.

However, there is no evidence that total investment is limited, and investments to reduce emissions may generate productivity gains at the same time. In addition, environmental regulations could also be growth-friendly, particularly if they encourage innovation (Porter hypothesis) or drive productivity-enhancing changes (Epaulard, Pommeret & Schubert, 2023). Moreover, decarbonised technologies generally allow companies to reduce both their emissions and their energy bills, which would mechanically increase productivity (since for the same production fewer intermediate consumption is required).

In general, empirical analyses give ambiguous results that are often specific to the context of the study. For example, the differences between companies, sectors and countries, but also the approach chosen, ranging from macroeconomic models to microdata estimates, lead to quite mixed results. However, this ambivalence is partly due to the fact that many studies do not cover the long-term impact, which is the objective of this analysis. Other studies show that productivity is affected differently over time, negative for one or two years, but subsequently positively (Epaulard, Pommeret & Schubert, 2023).

Depending on the type of enterprise, the impact on productivity may also differ, often being positive for companies that are already more productive initially. At the aggregate level, the impact could thus be multiplied if the most productive companies would gain market share or less productive firms would disappear from the market (OECD, 2021).

It should be noted that climate change also directly affects productivity developments and that the baseline scenarios, based on historical developments, are therefore likely to be overly optimistic about productivity developments. Global warming would have a negative impact on labour productivity in Western Europe, with productivity suffering at high temperatures, particularly in heatwaves (IPCC, 2022). However, such climate change-related damage is generally excluded from the baseline scenario, as is the high financial costs of inaction.

5.2.2.3 The international dimension to be considered

Although this analysis focuses on measures taken at national level, climate action and the resulting macroeconomic impacts depend on the international context. This is all the more important given that Luxembourg is a very open small economy and that (non-) climate actions in the rest of the world are likely to influence the economic impact of the energy transition in Luxembourg.

If European countries were considerably more ambitious in reducing emissions than the rest of the world, this could lead to a deterioration in the price competitiveness of European products. Higher costs, for example due to higher energy prices, would exert upward pressure on European production prices, leading to lower exports (Pisani-Ferry & Mahfouz, 2023). Not all sectors of activity would be affected in the same way, especially energy-intensive products exposed to world trade, such as metallurgy (European Commission, 2018). It can be noted, however, that during the transition, with improved energy efficiency, energy consumption is expected to gradually decline, reducing the long-term adverse competitive effects.

Aware of the risks of carbon leakage to countries with less restrictive environmental regulation (by shifting production or replacing European production with more emitting imports), the European Union (EU) has developed the Carbon Border Adjustment Mechanism (CBAM). The aim of this mechanism is to ensure that the carbon price is the same for imported and domestic products. In practice, importers62 need to purchase CBAM certificates for emissions associated with production in a non-EU country (which are not yet covered by a carbon price). The price of these certificates would correspond to the price of the EU ETS allocations63 that producers in Europe have to pay (European Commission, 2023).

However, this mechanism only targets imports into the EU, but it does not protect European exports on international markets. Moreover, if the prices of certain basic materials increase, either directly or through the CBAM, this may increase the cost of processes that use these products as inputs. As a result, the price of these products is also expected to increase, but as not all goods are covered by the CBAM, there is a risk of loss of competitiveness for these European products downstream of production. Another factor to be taken into account is the end of free emission allowances in parallel with the introduction of the CBAM, which corresponds to the end of a fossil subsidy (Fonla et al., 2023). According to the European Commission (2021), CBAM would reduce carbon leakage, but

62As a first step, the products covered by the CBAM are: cement, iron and steel, aluminium, fertilisers, hydrogen and electricity.
EU emissions trading63 system (ETS)

would have a very small negative impact on GDP (around -0.2 % in 2030).

Moreover, coordination of climate ambitions across the world does not necessarily prevent distortions of competitiveness. Indeed, different countries and economic zones can choose other instruments to achieve climate objectives. This became apparent with the Inflation Reduction Act in the United States, which relies more heavily on subsidies, linked to local content constraints64, and less on a carbon price (Fonla et al., 2023).

In addition to competitiveness effects, foreign demand in Luxembourg may change. If it is estimated that the transition would have a positive impact on GDP, then international climate action would lead to higher activity worldwide, necessarily leading to an increase in global demand. Comprehensive climate action would thus benefit Luxembourg as the climate action plans of different countries and regions would mutually reinforce each other at the economic level. If, on the other hand, the transition is considered to be unfavourable to growth, the effect would obviously work in the opposite direction (European Commission, 2018).

5.2.3 Potential impacts on economic activity and employment by 2050

5.2.3.1 Low impact of the energy transition on GDP according to literature

As illustrated above, multiple effects, which could counteract each other, should be considered when assessing the impact of the energy transition on macroeconomic figures. However, a review of the literature suggests that the overall impact of the energy transition would be very limited, especially in view of the remote time horizon.

Estimates of the impact of the energy transition on GDP are between -1.3 % and + 3.8 % in 2050 compared to the baseline scenario in the studies under consideration (see Table 1). In general, the majority of studies indicate that GDP would be slightly higher in the case of climate neutrality. Differences between studies may have multiple origins (see below) and studies often consider several scenarios with opposite assumptions in order to obtain a range of possible impacts that reflects the significant uncertainty attached to any assessment of the macroeconomic effects of the transition.

The baseline scenario is an important part of any macroeconomic assessment, as deviations are calculated from the baseline scenario. Indeed, if more climate actions are already considered in the baseline scenario, the gap between the two scenarios will be narrower. In this regard, it should be noted that the WEM closing date for the update of the Luxembourg NECP is later than those of the majority of the studies considered, more measures have been included in the baseline scenario of the Luxembourg NECP update65.

64These subsidies are partly conditional on the fact that a given proportion of inputs must be produced in the United States, with the explicit aim of supporting the domestic industry.
65E.g. standards at building level.

Table 1: Impact of the energy transition on GDP

Study	Horizon	Region,	Impact on GDP
Commission European (2018) (model JRC-GEM-E3)	2050	EU	— 0.6 % (fragmented action); — 1.3 % (overall action)
Commission European (2018) (model E3ME)	2050	EU	+ 1.5 % (fragmented action); + 2.2 % (overall action)
Commission European (2018) (model QUEST)	2050	EU	+ 0.7 %
Commission European (2020) (model JRC-GEM-E3)	2030	EU	— 0.4 %; —0.3 %
Commission European (2020) (model E3ME)	2030	EU	+ 0.2 %; + 0.5 %
Commission European (2020) (model QUEST)	2030	EU	— 0.3 %; + 0.1 %
OECD (2017)	2050	Advanced fossil fuel importers	+ 2.2 %
Pisani-Ferry & Mahfouz (2023)	2040	France	+ 1 %; —1 % (without resp. with productivity shock)
Callonnec & Cancé (2022)	2030	France	+ 2.5 %
Callonnec & Cancé (2022)	2050	France	+ 3.8 %
Federal Planning Bureau (2016)	2030	Belgium	+ 1.9 %; + 2.5 %
NGFS (2022) (NiGEM model)	2050	Europe	+ 1.7 %
NGFS (2022) (NiGEM model)	2050	Germany	+ 0.6 %
NGFS (2022) (NiGEM model)	2050	France	+ 2.1 %
NGFS (2022) (NiGEM model)	2050	Belgium	+ 2.4 %

Sources: as indicated in the table. If several impact estimates are given, they refer to different configurations.

The implementation of measures to decarbonise the economy influences the evolution of macroeconomic figures. For example, a carbon price generates government revenue which, depending on how it is to be used (e.g. transfers to households, reductions in other taxes, etc.), will have a different impact on GDP developments66. For example, Darracq-Pariès et al. (2022) estimate that GDP changes most favourably if income is

66A ‘double dividend’ is referred to as the fact that environmental taxes can reduce both emissions and tax distortions, since the revenues generated by the carbon tax would reduce other taxes, in particular labour taxation.

used to increase public investment, since in this way the stimulus to the economy is more direct than it was through tax cuts or transfers.

The specification of the model used in the analysis of macroeconomic impacts also plays a decisive role on results, as illustrated by the European Commission (2018)67.In one of its models (JRC-GEM-E3), it is assumed that there are no initially unused resources, meaning that the financing required for the transition is made at the expense of other uses (other investments or consumption). Thus, the crowding out effect is fully effective and the GDP deviation from the baseline becomes even negative in 2050. On the other hand, in the other two models, additional resources can be mobilised (e.g. debt) leading to higher activity than in the baseline scenario.

In addition, the geographical and temporal scope varies between the studies considered, which may lead to diverging estimates in relation to local specificities (e.g. the relative importance of certain sectors of activity or dominant energy sources). On the other hand, the impact on GDP may hide divergent developments across sectors. Sectors directly linked to the energy transition would be significantly impacted, negatively for fossil fuels and energy and positive for renewable energy. Construction would also evolve favourably, linked to the necessary energy renovations at building level. For other sectors the estimated impact could depend on the international configuration of the transition, for example for metallurgy (European Commission, 2018).

Studies that see several pathways towards climate neutrality show that a delayed transition would be less favourable in the long term. Allen et al. (2020) compare an orderly transition scenario with two other scenarios68, where a disorderly transition leads to a higher carbon price, which would weigh on GDP developments, which in 2050 would be between 2 % and 6 % lower than the optimal transition. It follows that a timely and coordinated transition between sectors of activity is more favourable in terms of GDP than more drastic measures taken late.

5.2.3.2 A limited effect over a distant horizon equals a very small impact on annual growth

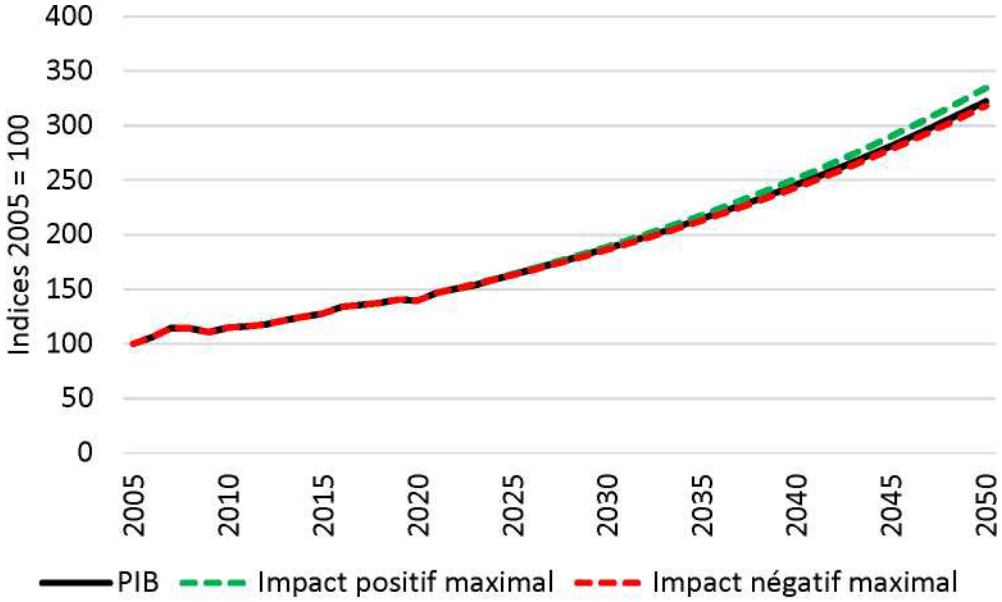
The various studies considered that the impact of the transition on GDP would be rather small by 2050, especially considering this to be a cumulative impact on growth. Thus, according to the European Commission (2018, E3ME model), European GDP would increase by 73.7 % from 2015 to 2050 in the case of climate neutrality, compared to 70.7 % in the baseline scenario. This small gap after more than 30 years means that the annual GDP growth differential is almost zero between the transition and baseline scenario.

Figure 1 illustrates the same point for Luxembourg, representing the projected trajectory of Luxembourg's GDP and two alternative levels based on estimates from the literature (the most positive and negative impacts in Table 1). From 2005 to 2050, GDP would increase by 222 % in the WEM scenario, while in such a transition scenario there would be a range of 218 % to 234 %. Given the size of growth compared to 2005, this deviation appears rather limited, and the evolution would remain close to

67This study has the advantage that the baseline scenario and the policies considered are harmonised between models.
68These scenarios also reach climate neutrality in 2050, but the transition is either started late or policies are not in line with technological advances.

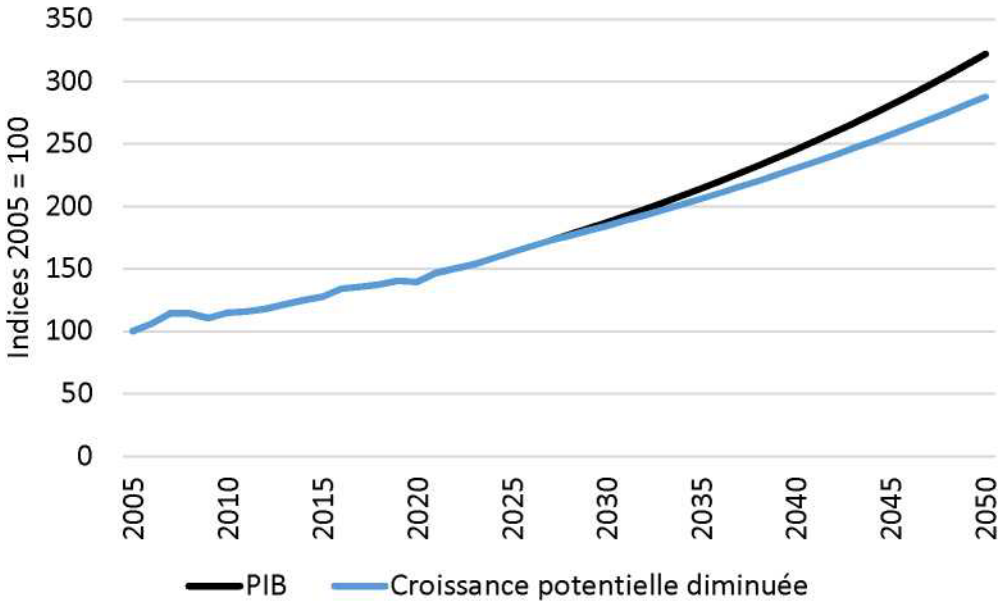
the reference path. The annual growth differential would be between -0.05 % and + 0.1 %, a negligible deviation from the assumption of potential growth of 2.75 % per annum. By 2030, GDP would be virtually unchanged by applying the endpoints of the estimates considered, with the impact range ranging from -0.6 % to + 0.9 % compared to the WEM scenario, i.e. an increase of 86 % respectively, instead of 87 % (from 2005 to 2030). On the other hand, looking at the average of the estimates instead of the extreme values, the impact on GDP in 2030 would be even closer to zero.

Figure 1: Luxembourg's activity would evolve very similarly in the baseline and transition scenario.



Source : STATEC

Graphique 2 : Le PIB est plus sensible à d'autres facteurs qu'à la transition énergétique



Source: STATEC

By contrast, GDP by 2050 could be affected much more strongly by changes that are unrelated to the energy transition. Thus, a downward revision of potential growth (e.g. to + 2.25 % per annum instead of + 2.75 %69) would lead to GDP in 2050 which would

69This downward revision is based on the latest macroeconomic forecasts published on 12 June in the 1-2023 BCS. This was the basis for the analysis of the sensitivity of the emissions trajectory to GDP growth.

be more than 10 % lower than the path chosen. This far exceeds the estimates of the impact of the energy transition, and compared to such a downward revision (which would occur in both the WEM and WAM scenarios), the potential effects of the transition appear negligible.

While the literature review shows that reducing emissions has little impact on economic growth, it is estimated that economic growth in Luxembourg would also have a very limited impact on emissions. A sensitivity analysis has indeed been carried out to estimate the impact of GDP developments on emissions. Assuming a lower annual GDP growth of 0.5 pt.%, emissions would be around 50 $ktCO_2e$lower in 2050 than in the original WAM (-2 % deviation). This figure should be linked to a reduction in emissions of about 7 000$ktCO_2e$ already in the WAM between 2021 and 2050. This illustrates the weak influence of activity developments on emissions by 2050, especially considering that the GDP growth differential in this sensitivity analysis is about 5 times higher than the high range previously considered (around + 0.1 pt.%).

Figure 3: The decline in emissions is almost unaffected by a different GDP trajectory

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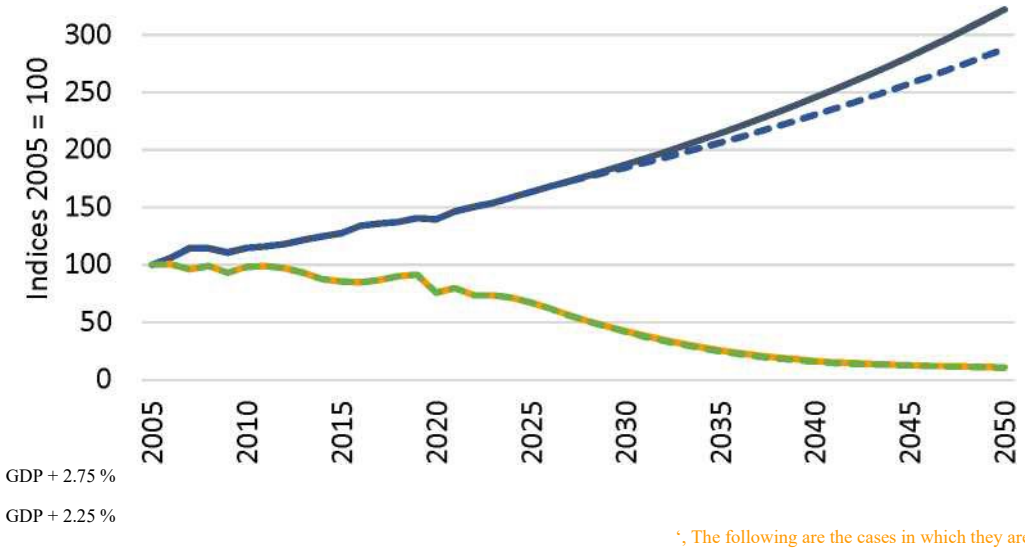


Source: STATEC

5.2.3.3 Probably even lower impact in Luxembourg?

None of the above studies focus on Luxembourg, so its particularities are not taken into account when replying to the impact of these studies on Luxembourg GDP. However, there are indications that the impact of the energy transition on GDP would be lower in Luxembourg than in other countries (for which estimates already indicate a low impact).

Luxembourg is a very open economy, resulting in a high import rate. As a result, the multiplier effects are lower in Luxembourg (STATEC, 2012), and thus budgetary injections linked to the transition will have more limited effects than in large countries or even integrated economic regions.

Luxembourg's emissions are partly reduced by a fall in fuel sales to non-residents, driven by increases in the CO_2 tax, which does not require investment and therefore does not have an injection into the economy (on the other hand, it is associated with a decrease in government revenue).

Luxembourg's investment in the transition also mechanically accounts for a smaller share of Luxembourg's GDP. The latter is inflated by the contribution of border residents, whereas investments mainly concern residents. As a result, for the same unit cost of a measure, its share in GDP is relatively lower in Luxembourg.

In Luxembourg, the measures included in the baseline scenario are already quite ambitious (all measures adopted or decided until 31.12.2021). The difference with the transition scenario is necessarily smaller than in studies that include less measures in their

comparison point.

Beyond upside risks, the negative transition risks also appear to be lower in Luxembourg, with sectors likely to be negatively affected only a small part of Luxembourg's GDP (see Chart 4). This is due to the structure of the Luxembourg economy, which is largely dominated by services. Moreover, the revenue from the CO_2 tax (which could potentially have a negative impact on GDP developments with a view to a negative supply shock) would mostly come from non-residents, while it is redistributed at national level, with the result that Luxembourg's activity as a whole would be affected little (if not positively) (STATEC, 2020).

Overall, it seems that both the potential positive and negative effects of the transition would be more contained in Luxembourg than in other countries. As a result, a close to zero impact of the energy transition on Luxembourg's GDP seems likely by 2030.

5.2.3.4 A similar evolution of GDP in the WAM and WEM scenarios

The literature review above provides a range of estimates of the impact of the energy transition, which highlights the high uncertainties inherent in this type of assessment. Despite this, the different estimates converge around a limited impact of the transition on GDP, and several factors mentioned above suggest that the impact of the transition on GDP would be even lower in Luxembourg. It was thus assumed that the same GDP trajectory would be assumed in the WEM and WAM scenarios.

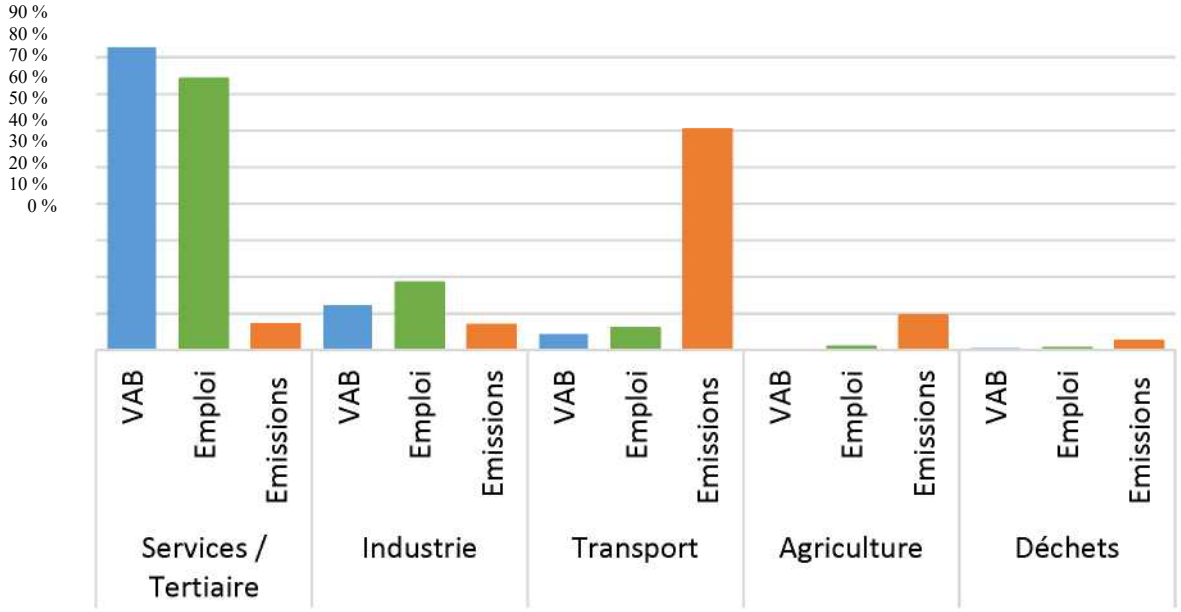
5.2.3.5 Low positive impact on employment

Estimates in the literature of employment developments in the climate neutrality scenario are closely linked to those of the activity. Indeed, the more favourably the activity evolves, the more employment also increases in order to meet the excess demand. Thus, Callonnec & Cancé (2022), which projects a favourable GDP gap of + 3.8 % in the transition in France in 2050, projects employment to increase by 3.1 % compared to the baseline scenario. The European Commission (2018) estimates a lower trend in activity, and their employment estimates are expected to be between 0 % -0.9 % above the baseline scenario. Interestingly, even in their model predicting a small negative gap in GDP, the impact on employment would be neutral in 2050.

Along with the small and slightly positive impact on the total economy, the effect on employment would vary across sectors (as for activity). As a result, the transition is likely to require reallocation of labour, both within and across sectors. This reallocation could be facilitated in Luxembourg as it is unlikely to contain a geographical dimension (unlike other larger countries with some activities concentrated in remote regions). However, these reallocations go beyond the scope of a macroeconomic analysis, as total employment would not be affected. However, a delayed reorientation of skills could temporarily lead to less favourable employment developments. For example, in its assessment of an increased ambition for 2030, the European Commission (2020) finds in some models and configurations a slight negative impact in 2030 (-0.3 % in 2030). However, other specifications lead to estimates of a slightly positive impact over the same horizon (up to + 0.5 %), illustrating the high uncertainties associated with this type of assessment.

The low impact on employment is also explained by the fact that the sectors that are likely to be most negatively affected by the transition, and those emitting a significant share of emissions, account for only a relatively small proportion of workers. This should help to limit any negative impact on employment by 2050. Thus, the service sector excluding transport accounts for the majority of employment and generates most of the value added, while the majority of emissions are linked to transport.

Figure 4: Employment and GVA concentrated in sectors other than emissions



Source: STATEC, MECDD

Energy production and distribution activities will be most directly affected by the transition, with potentially negative consequences for fossil energy employment and positive renewable energy employment, but both sectors are relatively small in terms of employment. A sector that should clearly benefit from the transition is construction, which will be strongly mobilised to achieve emission reduction at building level, including through heating system replacements, future renovations and solar panels (European Commission, 2018).

5.2.4 Macroeconomic impacts by 2030: bottom-up calculation from NECP trajectories

The additional investments and expenditure required to achieve the updated NECP objectives are estimated by a bottom-up calculation, considering all quantifiable measures. To carry out these calculations, unit costs were determined for renovations and new decarbonised technologies (heat pumps, electric cars, etc.). Unit costs are then multiplied by the evolution of the volume in question, resulting from STATEC projections. These calculations were made for both scenarios, but the analysis is based only on the additional investments of the WAM scenario compared to the WEM baseline.

The amounts are expressed in constant EUR of 2023 (EUR_{2023}) and include private and public investment, as well as other public expenditure such as subsidies. Overall, investment is gradually increasing over the current decade, reaching around 1.7 % of GDP in 2030 (EUR 1.3 $billion_{2023}$). Combined over the whole period, investment and expenditure would amount to EUR 8.4 $billion_{2023}$.

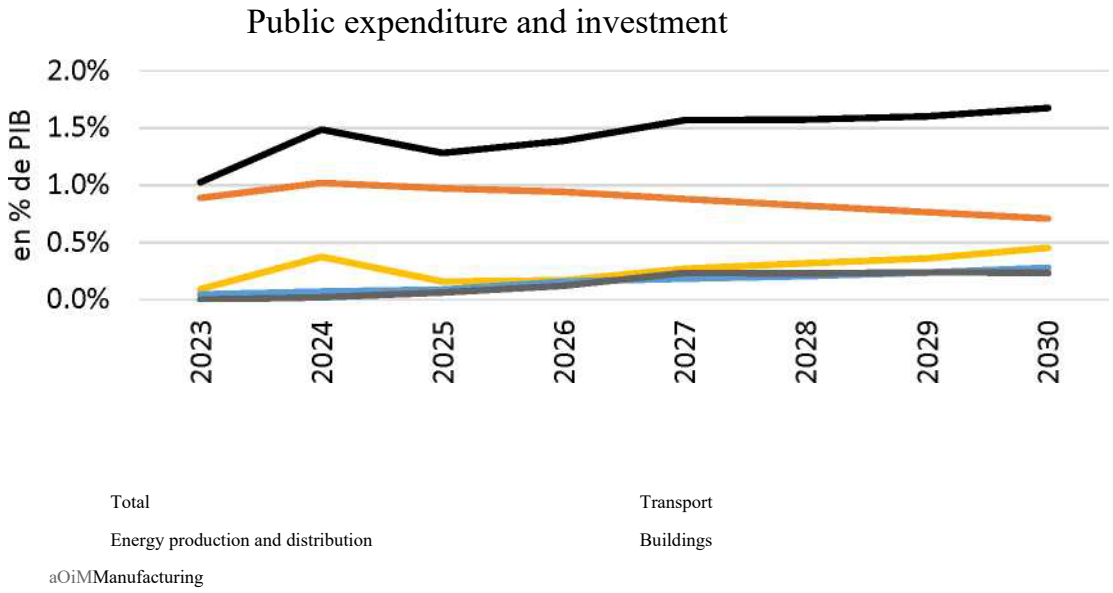
Table 2: Additional investment and expenditure required for the energy transition would amount to EUR 8.4 billion by 2030

Additional investment and expenditure (EUR 2023 million)	2023	2024	2025	2026	2027	2028	2029	2030	Total
Buildings	30	48	60	113	134	154	183	223	945
Transport	580	687	674	671	644	618	590	563	5 '027
Manufacturing	0	14	43	86	171	171	186	186	857
Energy production and distribution	59	251	109	120	199	240	279	359	1 '617
Total	669	1 '000	887	989	1 '149	1 '184	1 '238	1 '330	8 '4461

Sources: MECDD, MEA, STATEC

To summarise, investments have been grouped according to the classification of emission sectors, namely transport, energy production and distribution, buildings and industry. The transport sector would require the majority of investments, representing between 0.7 % and 1 % of GDP over time. This high level is mainly due to the investments needed to develop the mobility infrastructure foreseen under the 2035 National Mobility Plan (NMP). The energy production and distribution sector required investments of up to 0.45 % of GDP in 2030. The increase in investment in energy production and distribution in 2024 was explained by a large investment in energy production by a Luxembourg company. Industry and buildings would require investments of a similar scale, below 0.3 % of GDP by 2030.

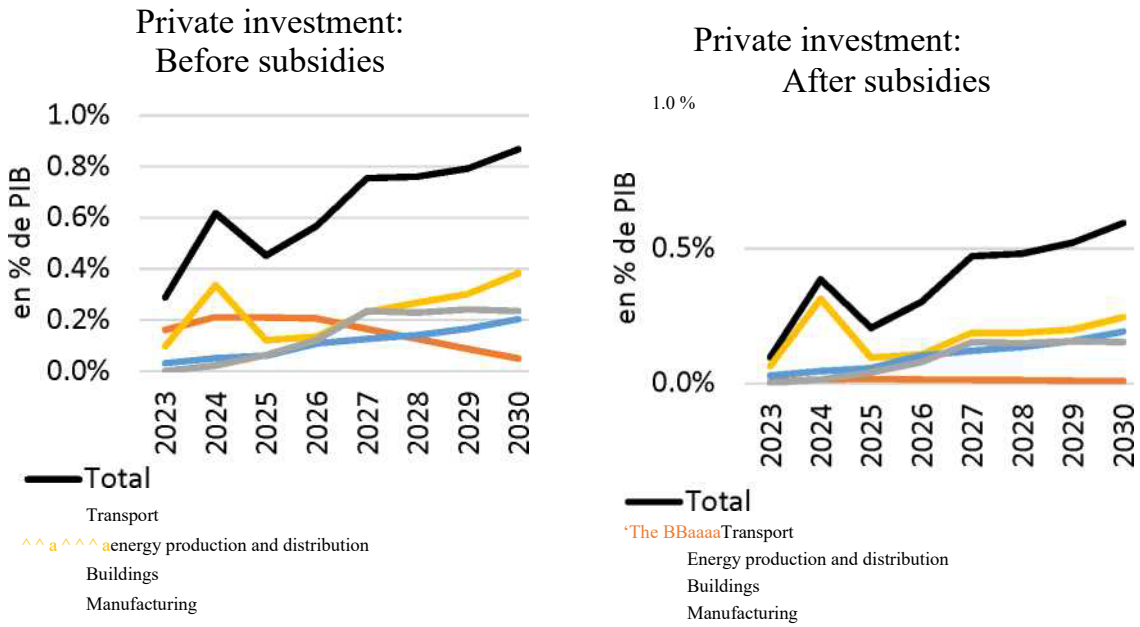
Figure 5: Total investment and expenditure is gradually increasing by 2030



Sources: MECDD, MEA, STATEC

Only private investment, before subsidies, accounts for half of total investment. After state subsidies, they account for only one third (around 0.6 % of GDP in 2030), distributed similarly in the buildings, energy and industry sectors.

Figure 6: Private investment (after subsidies) would reach 0.6 % of GDP in 2030

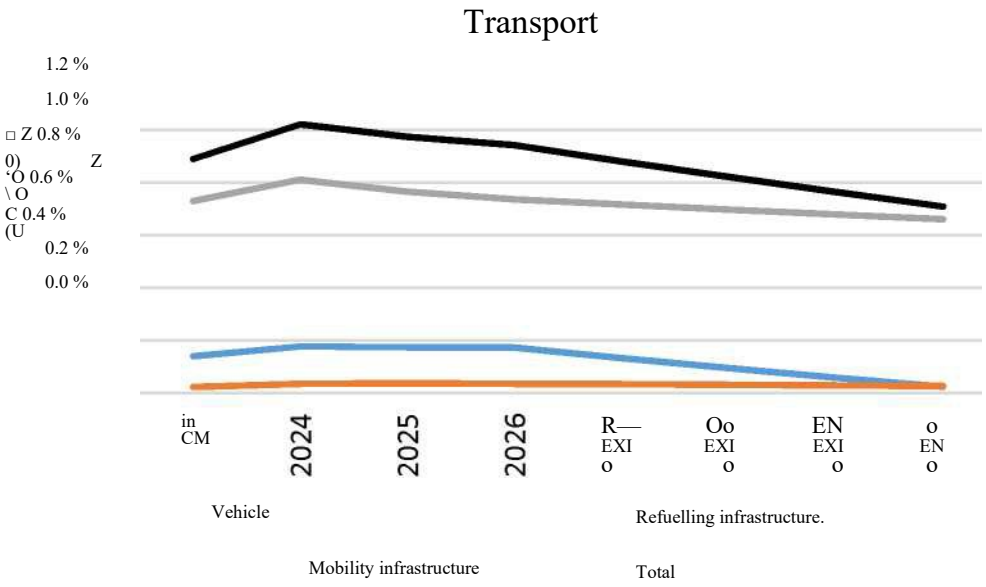


Sources: MECDD, MEA, STATEC

5.2.4.1 Transportation: Infrastructure would require significant investment

As already mentioned, most investments in transport would be needed to improve and develop mobility infrastructure in order to enable better multimodal mobility. Electrification of cars, which is faster in the WAM scenario, would also represent additional expenditure as electric models are currently even more expensive than thermal models. However, this cost gap is narrowing and according to the Global EV Outlook 2023 (IEA, 2023), parity would be reached at the end of the current decade. It was assumed that the subsidies in this respect would correspond to and evolve with this price differential. This would mean that the additional costs of electric cars would be borne by the State and not by households and businesses. Charging infrastructure would also require additional investments, but these were already high in the baseline scenario (EUR 60 million in 2030 in the 2020 NECP). The number of terminals to be installed is assumed to be proportional to the number of new registered electric cars and the costs vary according to the location of the installation (residential, corporate and public).

Figure 7: Investment in mobility infrastructure, high in the short term, would slightly decrease over time



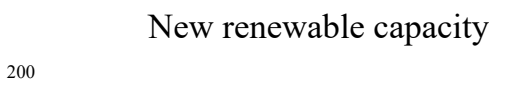
Sources: MECDD, MEA, STATEC

5.2.4.2 Energy production and distribution: financing the expansion of renewable energy production

In the field of energy production, the majority of additional investments would be concentrated on renewable energy. With an expected increase of around two thirds of photovoltaic and wind production capacity (compared to the baseline in 2030) as well as increases in electricity production through biomass and biogas, it was estimated that the expansion of renewable electricity compared to the baseline would require additional cumulative investments of around EUR 700 million until 2030. This is complemented by the cumulative investments in centralised renewable heat production of almost EUR 350 million until 2030.

The strengthening and expansion of the electricity grid needed to enable the electrification of the Luxembourg economy and the development of a hydrogen network would attract the rest of the energy sector's investments.

Figure 8: Increase in renewable electricity generation capacity



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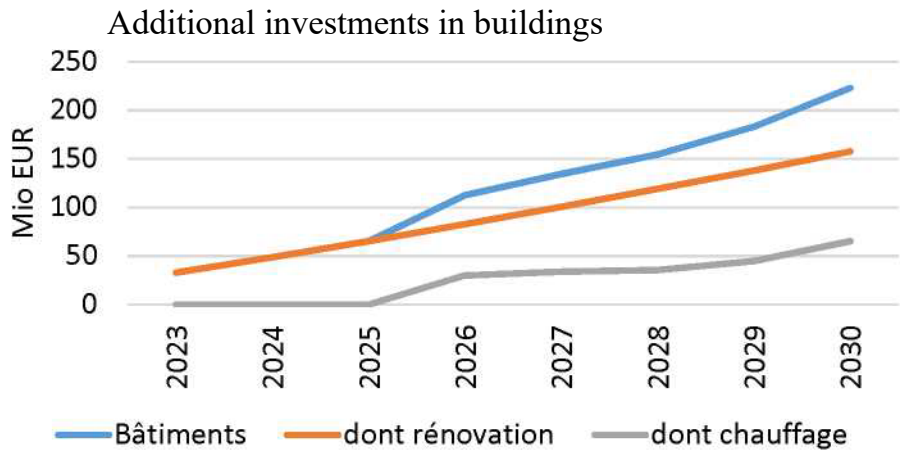
IN THELIGHT OF THE FACT THAT THE WEM WAM

Sources: MEA, STATEC

5.2.4.3 Buildings: a gradual increase in investment

The buildings sector, which includes residential and tertiary buildings, is a relatively slow sector to decarbonise due to the longevity of buildings and technical installations. Investment in this area would increase over time. In the beginning, they would be concentrated mainly in the tertiary sector, alongside the planned energy audits and the replacement of fossil boilers for large tertiary buildings. In the residential sector, the shift to heat pumps when replacing fossil boilers would gain momentum towards the end of the 2020s (heat pumps are already the reference in all new buildings). Another factor that would increase the investment of functional buildings compared to residential investment is the higher cost of energy renovation (estimated at EUR 1.000/m^2 for functional buildings compared to EUR 350-750/m^2 for a residential building depending on the renovation depth).

Figure 9: Growth in investment in the buildings sector

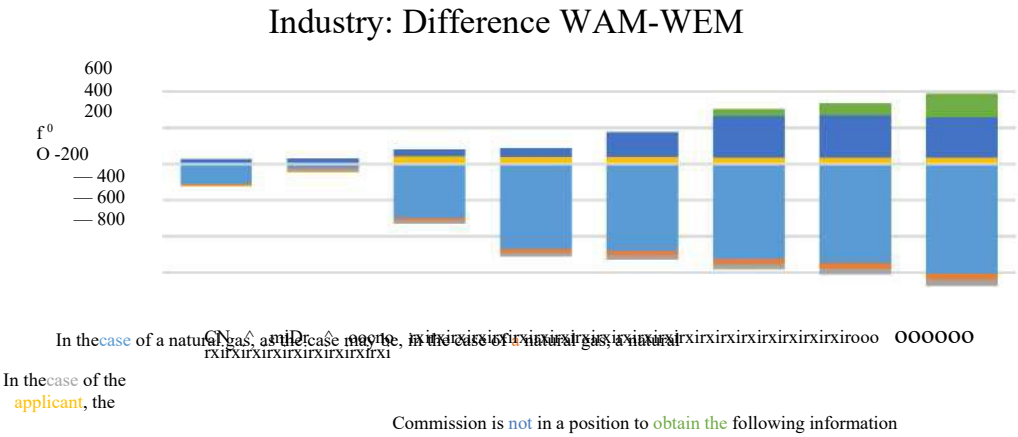


Sources: MEA, STATEC

5.2.4.4 Industry: ambitious decarbonisation dependent on renewable hydrogen supply

Industry would require additional investments similar in scale to buildings. On the one hand, manufacturers would seek to invest in more efficient processes to improve their energy efficiency. On the other hand, they would seek to decarbonise their production chain, either by electrification or by using hydrogen for processes requiring high temperatures. However, hydrogen has only a secondary role to play by 2030, so that it can only be supplied with the necessary amounts of renewable hydrogen after 2030 (production is still very limited and transport infrastructure is still missing). Investments in the industrial sector have been determined by estimating the subsidies that would be allocated to industrial projects in the coming years, the latter covering around 35 % of the investment. It was thus estimated that industry would make additional investments of around EUR 850 million cumulatively by 2030.

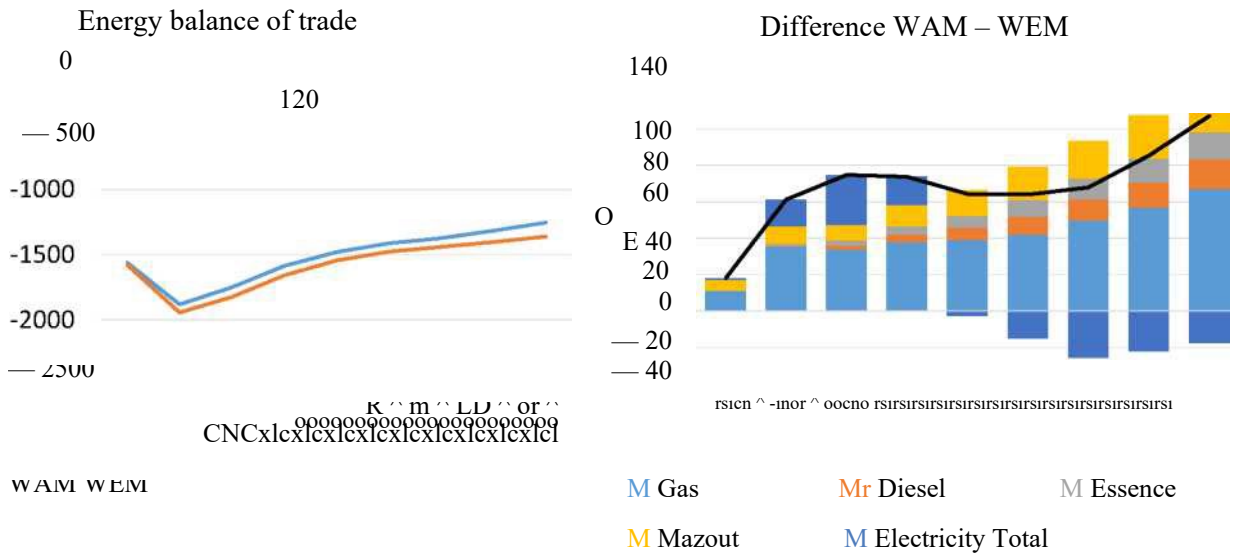
Figure 10: Reducing fossil fuels in industry



Source: STATEC

5.2.4.5 Theenergy component of the trade balance would improve with the energy transition. Additional investments required for decarbonisation not only reduce emissions, but the transition also affects other macroeconomic aggregates. The trade balance70, which is a component of GDP71, will in particular be affected through its energy component. Electrification thus leads to a gradual decrease in fossil imports, while the associated energy efficiency gains (a heat pump being 3 times more efficient than fossil technologies) and the projected increase in electricity production in Luxembourg would limit the increase in electricity imports. The impact on the energy balance thus depends on several factors which form an integral part of the scenarios developed by STATEC: the price trajectory for fossil fuels and electricity, the consumption of different types of energy, and national energy production.

Figure 12: Lower energy imports would improve the energy balance



Source: STATEC

Energyimports would decrease in both scenarios, but this decrease would be stronger in the WAM scenario than in the WEM. The corresponding improvement in the energy trade balance is increasing over time to reach EUR 100 million in 2050. The major impact would come from lower gas imports in the WAM scenario, accompanied by energy efficiency gains. Electricity imports would still increase during the energy transition72, but due to higher domestic production, the surplus of these imports would remain contained. As the decline in fossil imports is higher than the increase in electricity imports, the energy trade balance would become less loss-making. It should also be noted that the reduction of fossil imports leads to less energy dependence on non-European countries, often associated with risks of geopolitical tensions, while electricity imports come from partner countries in the European electricity market.

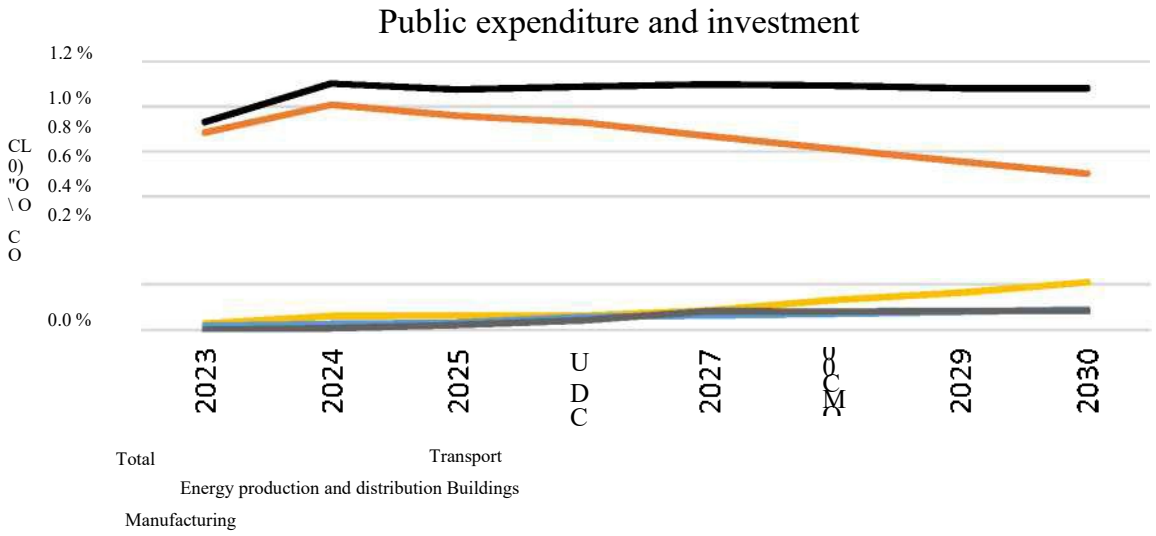
70The trade balance is the difference between the value of exports and imports (X-M)
71From the expenditure perspective, GDP consists of final consumption, investment, government expenditure and the trade balance: GDP = C + I + G + (X-M)
72The difference in electricity imports between WAM and WEM is the largest in around 2040.

In order to achieve these savings in energy imports, changes in equipment (heat pumps, electric cars, etc.) are necessary73. As these investment goods are mainly imported and have a price even higher than their fossil equivalent (at least in the coming years), this could limit the positive impact on the total trade balance initially. On the other hand, this impact would be neutral on GDP, as these (relatively higher) imports are at the same time additional investment or expenditure (see footnote 9).

5.2.4.6 Public expenditure: continued state support for the energy transition

All investments linked to the NECP have a direct or indirect impact on government expenditure. In addition to public investment, private investment would indeed be incentivised by state subsidies. Feeding the compensation mechanism would also represent an additional cost to the State, estimated at around EUR 60 million in 203074. Public investment includes renovation of public buildings and investment in mobility infrastructure. They would typically range between EUR 550 million and EUR 600 million per year. The subsidies concern subsidies for residential renovation, vehicles and electric charging infrastructure, subsidies for industry and support for renewable energy. These would roughly double by 2030 compared to the WEM scenario to EUR 220 million. Thus, government expenditure linked to the NECP is estimated at 1.1 % of GDP in the current decade, of which 0.8 pt% is linked to the MNP.

Figure 13: Public investment and expenditure would amount to 1.1 % of GDP



Sources: MECDD, MEA, STATEC

5.2.4.7 Public finances: excise revenues would fall with fossil fuels

In addition to public expenditure, the NECP measures would also have an impact on the state budget by impacting government revenue. With lower fuel sales, especially to non-residents, the corresponding excise revenues would decrease compared to the baseline scenario. This reduction in traditional

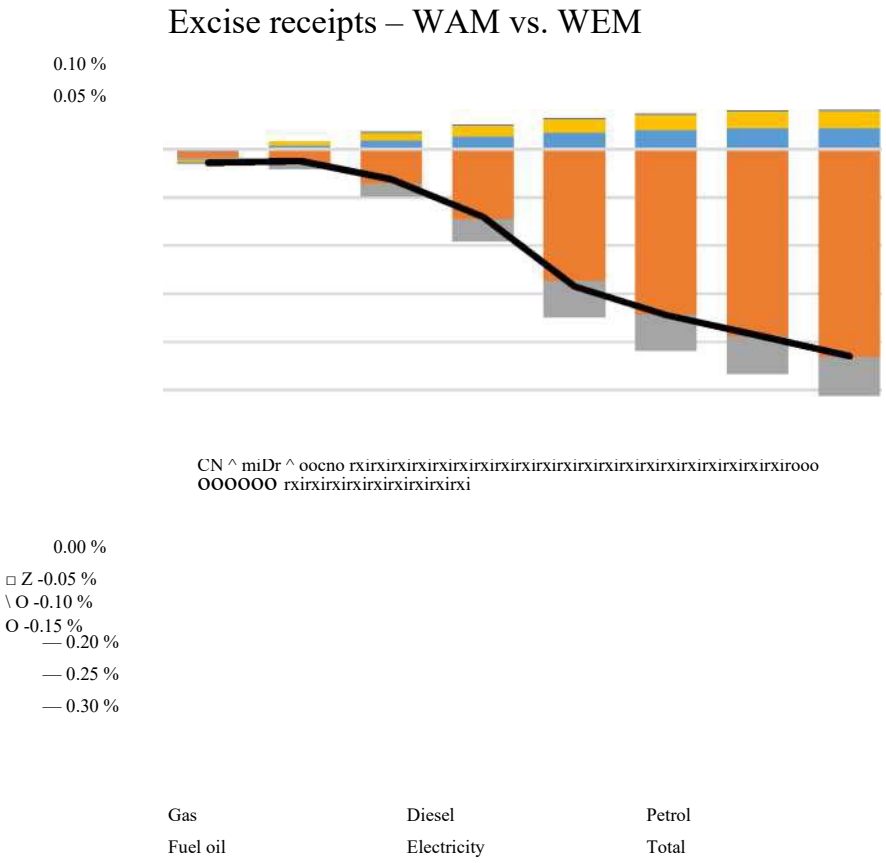
73These investment goods are also recorded in the trade balance, beyond the energy component alone.
74The amount foreseen for the compensation mechanism in 2030 amounts to more than EUR 140 million in the WAM scenario and almost EUR 90 million in the WEM scenario.

excise duties would be only partially offset by the increase in revenue from the CO_2 tax. For excise revenue only on gas and fuel oil, the increase in CO_2 tax would nevertheless outweigh the effect of the fall in consumption, meaning that the revenue generated by those products would increase. Overall, the loss compared to the WEM baseline would amount to around 0.2 % of GDP in 2030.

The CO_2 tax raises part of the funds needed to support the energy transition, as 50 % of the revenue from the CO_2 tax is intended to finance part of the above mentioned state subsidies, the other half being for social compensation measures in favour of low-income households.

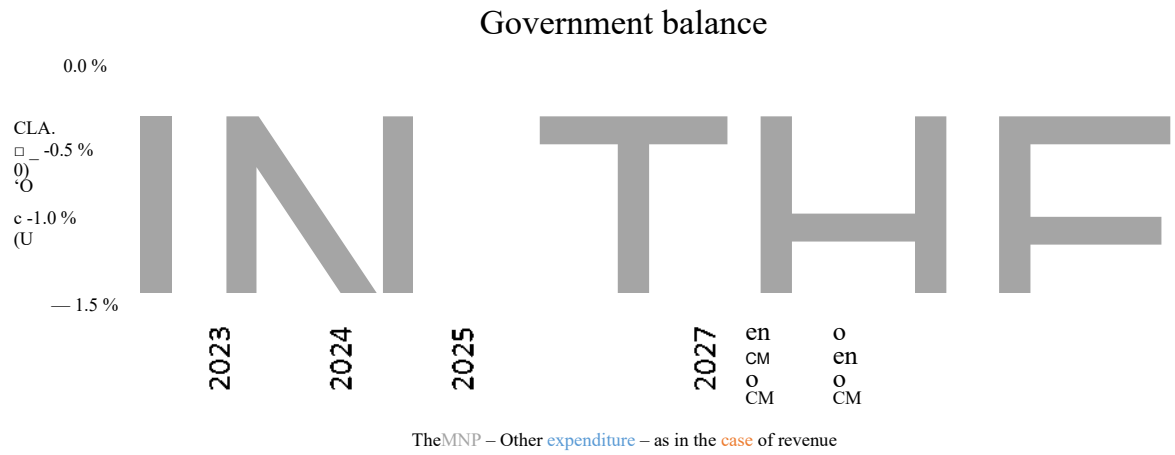
Taking into account both the additional expenditure of the State and the losses in revenue received by the State, the impact on the public balance, which would be in the order of 1.3 % of GDP in 2030 compared to the WEM baseline scenario, can be quantified.

Figure 14: The increase in CO2 tax would not compensate for the decrease in other excise duties



Source: STATEC

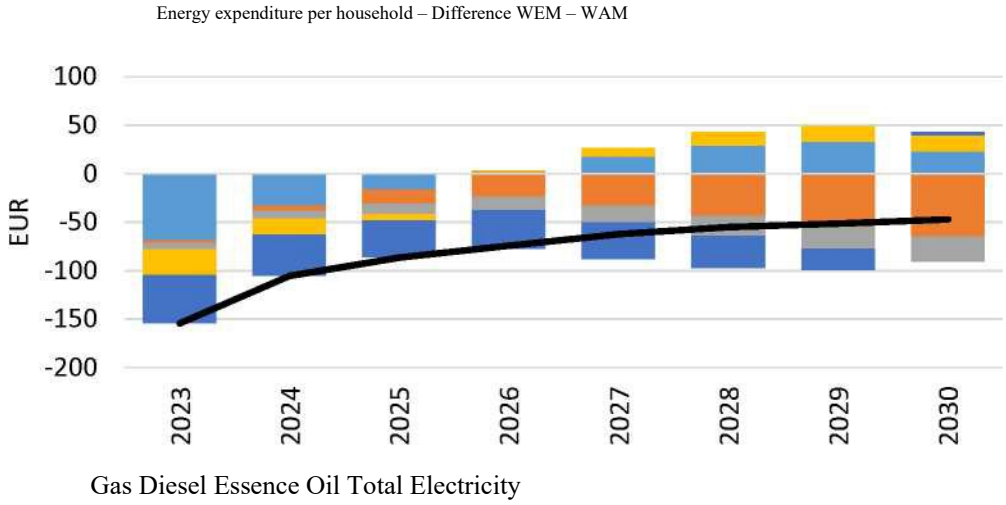
Figure 15: The cost to public finances would increase to 1.3 % of GDP in 2030



5.2.4.8 households: lower energy bills as a consequence of the energy transition

The energy transition reduces household energy bills as efficiency gains would lead to lower energy consumption. This downward effect would outweigh the upward effect on fossil fuel prices75. Energy consumption and related expenditure would thus decrease more strongly in the WAM scenario.

Figure 16: Household energy bills would be reduced



Source: STATEC

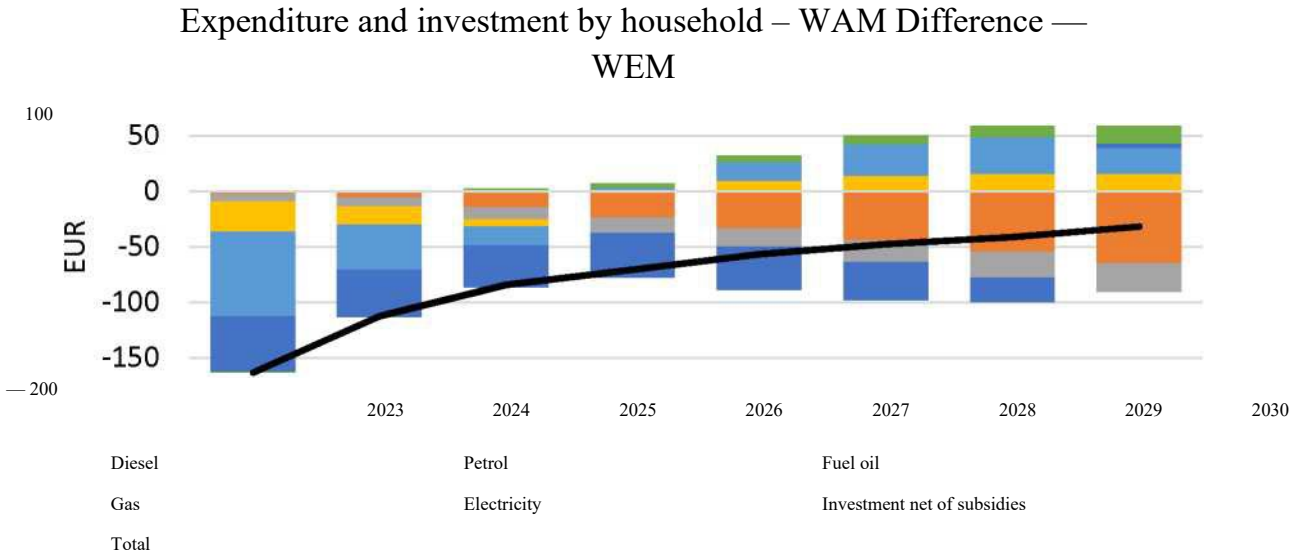
The more pronounced reduction in energy expenditure in the WAM scenario would mean that households would have more money at their disposal for alternative uses. Reallocation to other products and services, whose import content would be lower than for fossil fuels (for which it is close to 100 %), could have a positive impact on the country's economic activity.

While the energy transition would gradually materialise in lower energy costs, it also requires investments to change technology. These additional household investments (after subsidies) can be amortised over 20 years to compare them with

75The evolution of energy prices in the WEM and WAM scenarios has been calculated on the basis of the price trajectories recommended by the European Commission, as well as the measures of the update of the NECP with price effects, including the CO_2 tax. Network costs have been estimated taking into account the necessary investments as well as the projected evolution of the number of connections and the volume of consumption.

the lowest annual energy bill. It can therefore be seen that the reduction in energy expenditure outweighs the cost of the additional investment required.

Figure 17: Lower energy spending overcompensates higher investment

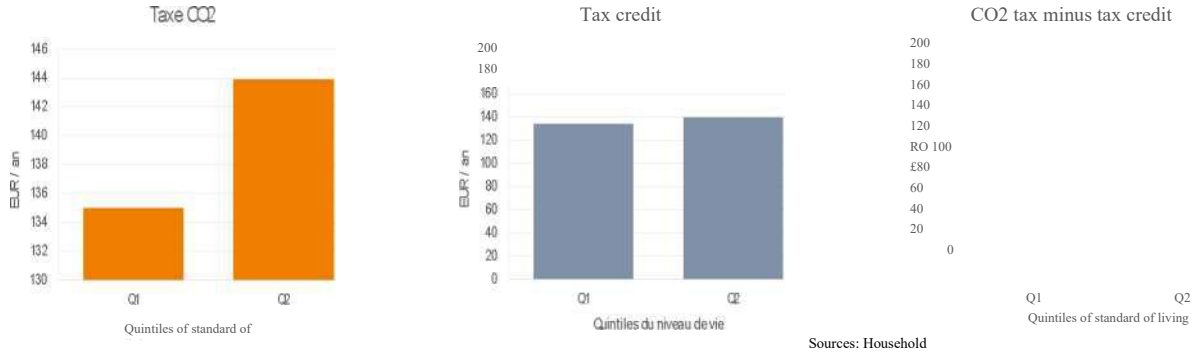


Sources: MECDD, MEA, STATEC (note: investments amortised over 20 years)

The CO_2 tax increases the price of fossil fuels, which account for a relatively larger share of the expenditure of low-income households (in absolute amounts, the opposite is the case). In order to support smaller households, it was decided to spend half of the revenue generated by the CO_2 tax on social compensation for lower-income quintiles (via a tax credit and expensive living allowance)76. When the CO_2 tax was introduced, STATEC had already analysed the issue77 and showed that the tax credit would fully offset the CO_2 tax for the first quintiles, so that their average budget would not be negatively affected during the transition. Above average expenditure, it should be noted that there are necessarily differences at the level of individual households, in particular depending on the type of heating or the use of a thermal vehicle.

The76 other half of the revenues will be directly used to finance climate measures.
77See “Assessment of the impact of the CO_2 tax”, STATEC (2020)

Figure 18: The tax credit compensates the CO2 tax for the lowest income



Sources: Household

Budget Survey (version 2019), University of Luxembourg (Department of Finance), STATEC calculations

5.2.5 Conclusion

The NECP aims to decarbonise the Luxembourg economy. This transition requires capital substitution for fossil fuel expenditure, which requires significant additional investment. These constitute injections into the economic circuit and could thus lead to a higher activity. Indeed, most international studies estimate that the transition would have a positive impact on GDP, but on a limited scale. Applying to Luxembourg the ends of the estimation range resulting from a literature review for 2050 would result in an annual growth differential between -0.05 % and + 0.1 %. This range is probably too broad, with various factors suggesting an even more limited impact of the energy transition on activity in Luxembourg. The potential impact of the transition thus seems negligible, especially by 2030. Moreover, the decoupling of emissions from economic activity means that a slightly different trajectory of GDP did not undermine national climate targets. Consequently, the same economic growth was retained in the WEM and WAM scenarios.

A bottom-up quantification of additional investment and expenditure required would amount to up to 1.7 % of GDP in 2030. These investments and expenditure would be mobilised by both private and public actors. In addition to public investment, the State would financially support the efforts of businesses and households. In addition to increases in public expenditure, the fall in fuel sales would lead to a reduction in government revenue. The cost to public finances would thus gradually increase to 1.3 % of GDP in 2030. Households, on the other hand, would benefit from lower energy spending. Moreover, this decline would be more pronounced than the required increase in investment.

Overall, the increase in investment (private and public) and the fall in energy expenditure (then available for consumption) are likely to have a positive impact on activity, but which would be very limited. In fact, the energy transition, which will drastically reduce emissions and be accompanied by significant changes at several levels, would probably have only a negligible impact on activity from a macroeconomic point of view.

5.2.6 Bibliography

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5.3 Impact of planned policies and measures on other Member States and regional cooperation

Luxembourg is part of the European Union's internal energy market. Due to its size and demographic and geographical characteristics, Luxembourg is more than one reason dependent on developments in other European countries, and in particular in neighbouring countries. For the same reasons, Luxembourg's direct influence on the rest of the European energy market can be considered to be weak. An exception is the Vianden pumping plant, which makes an important contribution to the security of supply of the central European electricity system.

Due to the importance of regional and European integration, Luxembourg proactively engages at different levels, in particular through the Penta and the NSEC. For more details on these regional cooperation and the impact on the respective neighbouring countries, see Chapters 1.4.1 and 1.4.2.

5.4 Contribution of planned policies and measures to the achievement of the Union's climate-neutrality objective

The amended Climate Law of 15 December 2020 stipulates climate neutrality, which is to achieve 'net zero emissions', by 2050 at the latest, as Luxembourg's long-term climate target. WAM projections for 2050 (see Table 67 and Figure 65: WAM projection of total emissions and removals (ESR emissions/climate law + ETS emissions + net LULUCF removals) from 2031 to 2050 (with WAM projection of ESR emissions/climate law compared to the trajectory of annual emission allocations by 2030 (climate law) and historical emissions from 2015 to 2021)) suggest that the policies and measures of the NECP update would already allow to approach climate neutrality in 2050. Indeed, in the WAM scenario, total net emissions of around 1 million t CO_{2eq} remain in 2050, adding up all GHG emissions and removals, which represents a reduction of more than 91 % compared to 2005.

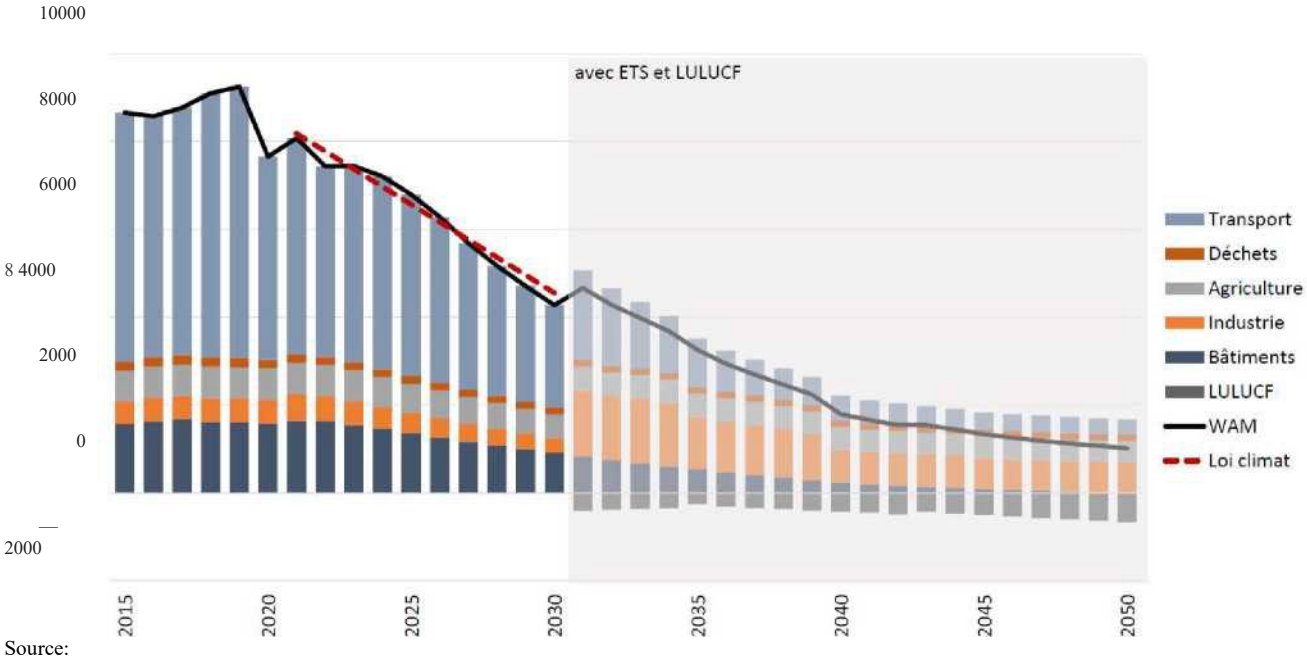
Table 67: Projections of GHG emissions and removals until 2050 based on additional (new and reinforced) policies and measures (WAM scenario)

[Thousand tonnes CO_{2eq} (AR5)]	2025	2030	2035	2040	2045	2050
Energy and manufacturing industries, construction	471	330	256	182	127	109
Transport	4128	2326	1104	566	394	342
Residential and service sector buildings	1360	915	538	236	98	1
Agriculture and forestry	658	545	528	511	496	484
Treatment of waste and waste water	174	157	156	154	155	158
Emissions ESR/Climate Law	6790	4273	2583	1649	1270	1093
ETS EMISSIONS	1304	1227	932	571	562	583
Emissions TOTALES – ESR/Climate Law & ETS	8094	5500	3514	2220	1832	1676
LULUCF	— 431	— 430	— 256	— 428	— 493	— 660
Total Balance Sheet – ESR/Climate Law & ETS &LULUCF	7663	5070	3258	1792	1339	1016

Source: STATEC, AEV &SER (2023)

Thesectors with the highest residual emissions in 2050 are industry and agriculture. Although additional efforts, measures and solutions are needed and possible, it seems difficult if not impossible to reduce emissions to zero in both sectors due to emissions from certain industrial processes or livestock farming. In order to fill the gap, it is all the more important to consolidate natural carbon sinks (LULUCF) and to develop carbon capture and utilisation (CCU) technologies (Direct Air Capture and Utilisation (DAC)). It should be noted that carbon capture and utilisation technologies have not yet been taken into account in the projections.

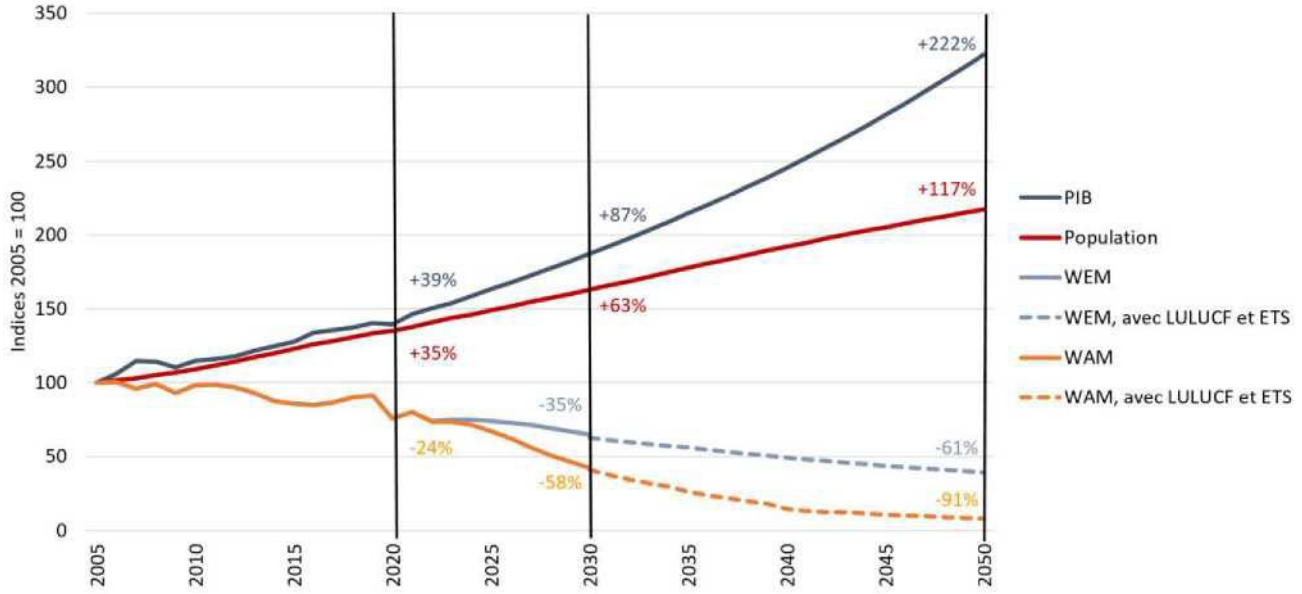
Figure 65: WAM projection of total emissions and removals (ESR emissions/climate law + ETS emissions + net LULUCF removals) from 2031 to 2050 (with WAM projection of ESR emissions/climate law compared to the trajectory of annual emission allocations by 2030 (climate law) and historical emissions from 2015 to 2021)



Source:
STATEC, AEV &SER (2023); GHG emissions inventory (submission of March 2023); Climate law

Luxembourg's projected population growth is anothermajor challenge facing the objective of climate neutrality. However, as illustrated in Figure 66, projections suggest that a decoupling of population growth from GHG emissions is possible.

Figure 66: Decoupling of growth from GHG emissions



Source: STATEC (2023)

List of abbreviations

EIB	European Investment Bank.
BIM	Building Information Modelling
HTA	EU Emissions Trading System
NRF	National Research Fund
GHGS	Serre Effect Gas
IPCC	Intergovernmental Expert Group on Climate Change (IPCC)
kt CO_{2eq}	kilotonnes of carbon dioxide equivalents
LISER	Luxembourg Institute for Socio-Economic Research
LIST	Luxembourg Institute of Science and Technology
LULUCF	Land Use, Land Use Change and Forestry
MY	Ministry for Agriculture, Viticulture and Rural Development
MDIGI	Ministry of Digitalisation
I	Ministry of State
MEA	Ministry of Energy and Spatial Planning
MECDD	Ministry of the Environment, Climate and Sustainable Development;
MECO	Ministry of the Economy
MENEJ	Ministry of National Education, Childhood and Youth
MESR	Ministry of Higher Education for Research
MFAMIGR	Ministry of the Family, Integration and the Greater Region
MFIN	Ministry of Taxation
MFP	Ministry of Civil Service
MINT	Ministry of the Interior
MLOG	Ministry of Housing
MMTP	Department of Mobility and Public Works
MPC	Ministry of Consumer Protection
MSS	Ministry of Social Security
MTEESS	Ministry of Labour, Employment and the Social and Solidarity Economy
MT CO_{2eq}	million tonnes of carbon dioxide equivalent

NCER	National Centre of Excellence in Research
NSEC	North Seas Energy Cooperation
NZEB	Nearly Zero Energy Building (s)
GDP	Gross Domestic Product
SMES	Small and Medium Enterprises
NECP	Luxembourg’s integrated national energy and climate plan for 20212030
R & D & I	Research, Development and Innovation
TRL	Technology Readiness Level
EU	European Union