

1 Environmental performance: Trends and recent developments

Chapter 1 provides an overview of the main environmental trends observed in Luxembourg since 2005. It describes the country's progress and challenges on its path towards decoupling environmental pressures from economic growth and achieving national and international goals, based on data from national and international sources. It reviews the main economic and social developments, takes stock of changes in the energy, carbon and material levels of the economy and measures progress towards sustainable management of natural resources. Where possible, trends are compared with those of other OECD member countries.

1.1. Introduction

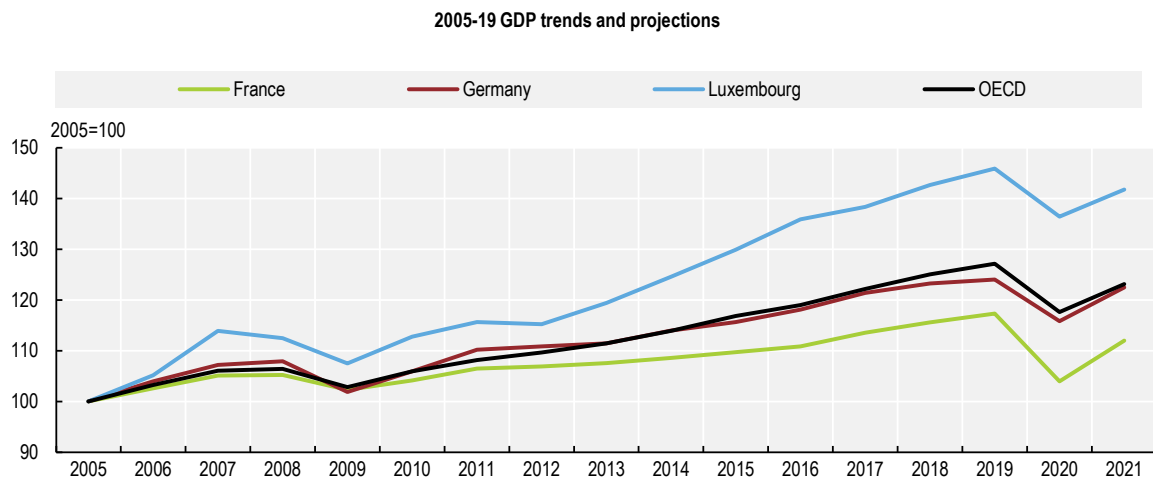
Luxembourg is a prosperous economy that has been experiencing strong growth, driven by banking and financial activity. Its per capita income is the highest among OECD member countries. These characteristics influence levels and patterns of production and consumption, and infrastructure needs. The resulting pressures on the environment are strong. Since 2010, progress has been made in decoupling several environmental pressures from economic growth (e.g. GHG and air pollutant emissions; waste generation; energy consumption; water abstractions) and in wastewater treatment. However, progress remains insufficient to restore a natural environment conducive to biodiversity conservation and to alleviate the growing pressures of demographic development and urbanisation.

1.2. Main economic and social developments

Economic outcomes and structure of the economy

Luxembourg has experienced strong economic growth since 2005 (+39% between 2005 and 2019, i.e. a rate of 2,8% per year on average), well above that of the OECD. It slowed down in 2009 and 2012 as a result of the financial crisis, but continued to grow until 2019 (Figure 1.1). The COVID-19 pandemic hit the economy hard. In the best case scenario, GDP is expected to shrink by 6.5% in 2020 and recover by 3.9% in 2021. New virus outbreaks later in 2020 would make GDP drop by 7.7% in 2020 and rebound by only 0.2% in 2021 (OECD, 2020a). The country managed to maintain a positive productivity differential with other OECD economies, thanks to high-end businesses and skilled workers (OECD, 2017).

Figure 1.1. Luxembourg's economy grew faster than the economies of neighbouring countries



Note: GDP expressed at 2015 prices and purchasing power parities. Projections for a single hit-scenario, i.e. without new virus outbreaks.

Source: OECD (2020), "OECD Economic Outlook No 107 - Single-hit scenario - (Edition 2020/1)", *OECD Economic Outlook: Statistics and Projections (database)*.

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The economy is dominated by the service sector, which creates 87% of value added – well above the OECD average (73%) (Basic Statistics). This is due to the dynamism of the financial sector, particularly banks and insurance companies, which alone account for 28% of gross domestic product (GDP) and 10% of jobs (OECD, 2019a). Luxembourg is drafting a strategy called the Third Industrial Revolution. This aims to diversify its economy around digital technologies and renewable energies to reduce dependence on the financial sector. Apart from forests, Luxembourg has few exploitable natural resources (OECD, 2017).

The labour market is dynamic and attractive: it continues to show sustained job creation and a low unemployment rate (5.5% in 2017). Cross-border workers and immigrants (in the sense of residents born abroad) are the fundamental pillars of the Luxembourg labour force, representing 44% and 28% of the workforce, respectively. These immigrants are on average younger and have a higher employment rate than native residents. This reflects their positive impact on the economy, as well as their successful integration into the labour market (OECD, 2017).

Public finances are sound and should remain so. Luxembourg has a fiscal balance surplus (+1.5% in 2017). Public spending has been on the rise since 2015, driven by investment in infrastructure. Government debt is well below the euro area average (EC, 2018). In contrast, environment-related tax revenues have declined and are below the OECD average as a share of total tax revenues (Chapter 3; Basic Statistics).

Population, quality of life and regional disparity

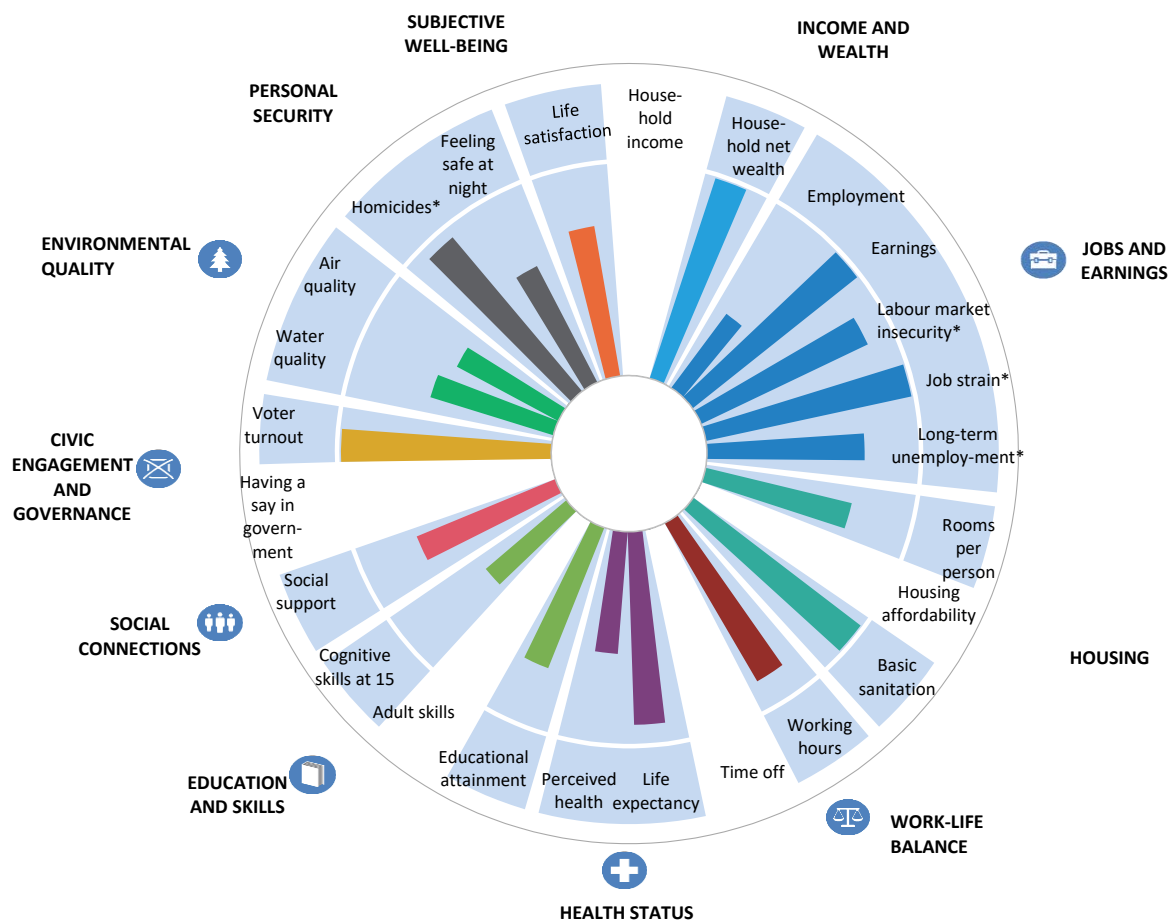
Luxembourg's population has increased by almost 30% since 2005, which was largely due to immigration. Almost half of its residents were born abroad, predominantly in the three neighbouring countries, Italy and Portugal (Basic Statistics). These trends affect energy consumption, urbanisation, urban development and the resulting environmental pressures.

The territorial organisation of Luxembourg is made up of 105 municipalities, the most populated of which are Luxembourg City and Esch-sur-Alzette. Activities and jobs are concentrated in the capital (STATEC, 2018).

Luxembourg has low inequality compared to other OECD member countries, thanks to a system that redistributes taxes and transfers. Despite a recent increase, this system keeps income inequality at a moderate level (OECD, 2019a; EC, 2018). Work stress and poverty are also relatively low, while housing conditions and social connections are better than the OECD average. However, the country is below the OECD average in terms of education and skills and has room for improvement in the area of energy and the fight against climate change (OECD, 2019a; Figure 1.2).

A public opinion study shows that environmental, climate and energy issues are more important at a personal level in Luxembourg than on average in the European Union (EU) (EC, 2019a). According to another EU survey, 86% of respondents in Luxembourg feel directly affected by environmental problems in their daily lives and health. Climate change is seen as the most pressing issue. However, a large majority of respondents are concerned about the presence of plastics and chemicals in everyday products and their impacts on health and the environment. At least half of respondents have seen or heard about EU ecolabels, a higher level than in most other countries. On the other hand, there is a comparatively high level of distrust of ecolabels (EC, 2017).

Figure 1.2. Perceived well-being is generally high in Luxembourg



Note: This figure highlights the areas that constitute Luxembourg's strengths or weaknesses in terms of well-being compared with OECD countries as a whole. For both positive and negative indicators (such as homicides, marked with an asterisk ***), a longer bar always indicates a better outcome (i.e. a higher level of well-being), while a shorter bar always indicates a worse outcome (i.e. a lower level of well-being). If data are missing for an indicator, the corresponding segment of the circle is white.
Source: OECD (2018), *How's Life? 2017: Measuring Well-being*.

1.3. Transition to a low-carbon and energy-efficient economy

Climate and energy policies are closely linked. They are supported by numerous projects and initiatives in line with EU policies, financial aid and information campaigns. Targets are ambitious and progress has been made since the 2010 OECD Environmental Performance Review. The government has launched a climate pact to offer municipalities the opportunity to play an active role in the fight against climate change and to optimise their energy use in return for financial support and technical assistance. A draft National Energy and Climate Plan (NECP) was submitted to the European Commission (EC) in early 2019. The final plan, including the EC's recommendations, will be submitted with a slight delay in April 2020. Luxembourg is drafting a legal framework on climate change to strengthen the governance and the efficiency of national climate policy. This law provides an opportunity to enshrine GHG mitigation targets and other Paris Agreement commitments in legislation. The draft law also provides for the transposition of elements of the European legislation in this area.

Energy supply and demand

Luxembourg has established a National Energy Efficiency Action Plan (NEEAP) and a National Renewable Energy Action Plan (NREAP). It thus contributes to the EU's energy and climate targets for 2020 and 2030.

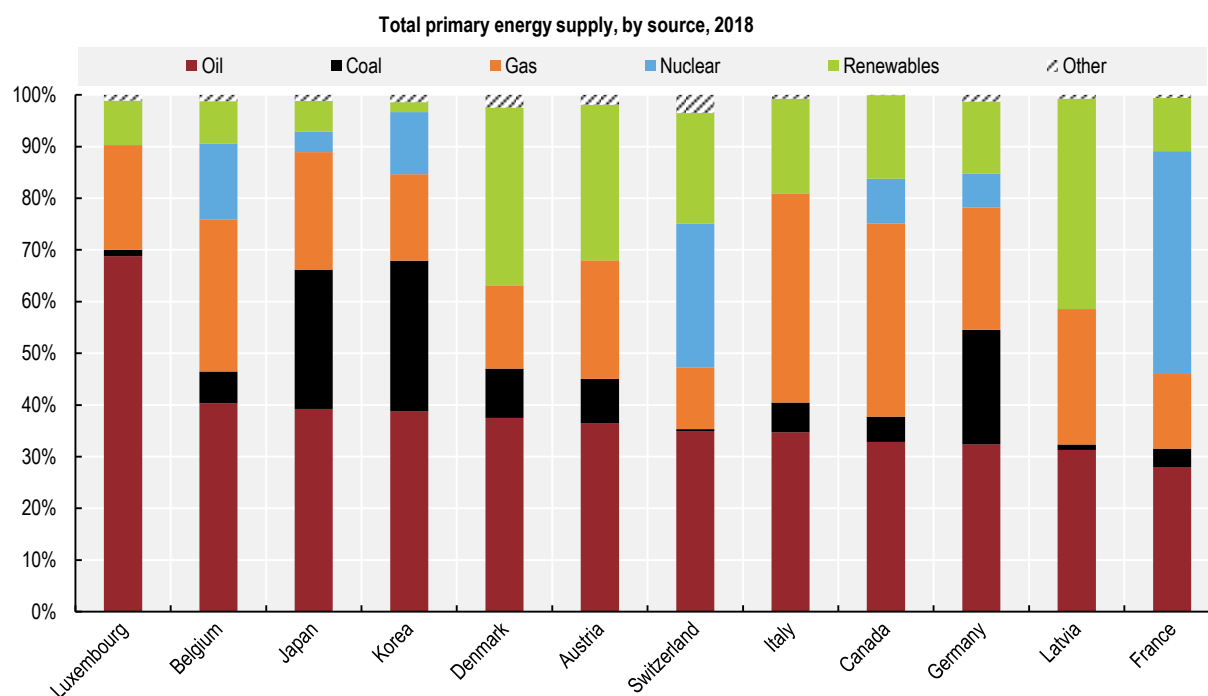
The National Energy Strategy is integrated into the NECP 2021-30. Luxembourg has introduced feed-in tariffs, calls for tender and mandates for the use of biofuels to encourage the development of renewables in the various sectors. Measures to increase the energy efficiency of buildings include financial support for energy-efficient construction and renovation; and the introduction of energy performance certificates and high-performance certificates for new residential ("nearly zero-energy buildings") and non-residential construction (IEA, 2020).

Energy supply and electricity

In 2018, fossil fuels accounted for 78% of the total primary energy supply (TPES),¹ a share slightly below the OECD average (79%) and a significant drop from 91% in 2005. The energy mix consists mainly of oil (59%) and natural gas (17%) (Figure 1.3). Luxembourg depends mainly on imports to meet its energy needs: it neither produces fossil fuels nor refines oil products and it has no nuclear power generation capacity. Since 2005, the share of oil and gas in the energy mix has been declining, replaced by electricity imports and renewable energies. This contributed to a 36% decrease in energy intensity between 2005 and 2016, which has since been stable (Figure 1.5).

Since 2016, there has been a 6% increase in the TPES, driven by an increase (+9%) in oil (Figure 1.3). However, the TPES decreased more rapidly in Luxembourg (-16%) between 2005 and 2018 than the OECD average (-5%). This decline is explained by the financial crisis of 2008-10, the gradual closure of the TWINerg power plant since 2012, and a drop in sales of road fuels (especially to non-residents), which reduced energy consumption.

Figure 1.3. Oil dominates Luxembourg's energy mix



Note: Total primary energy supply excludes electricity trade.

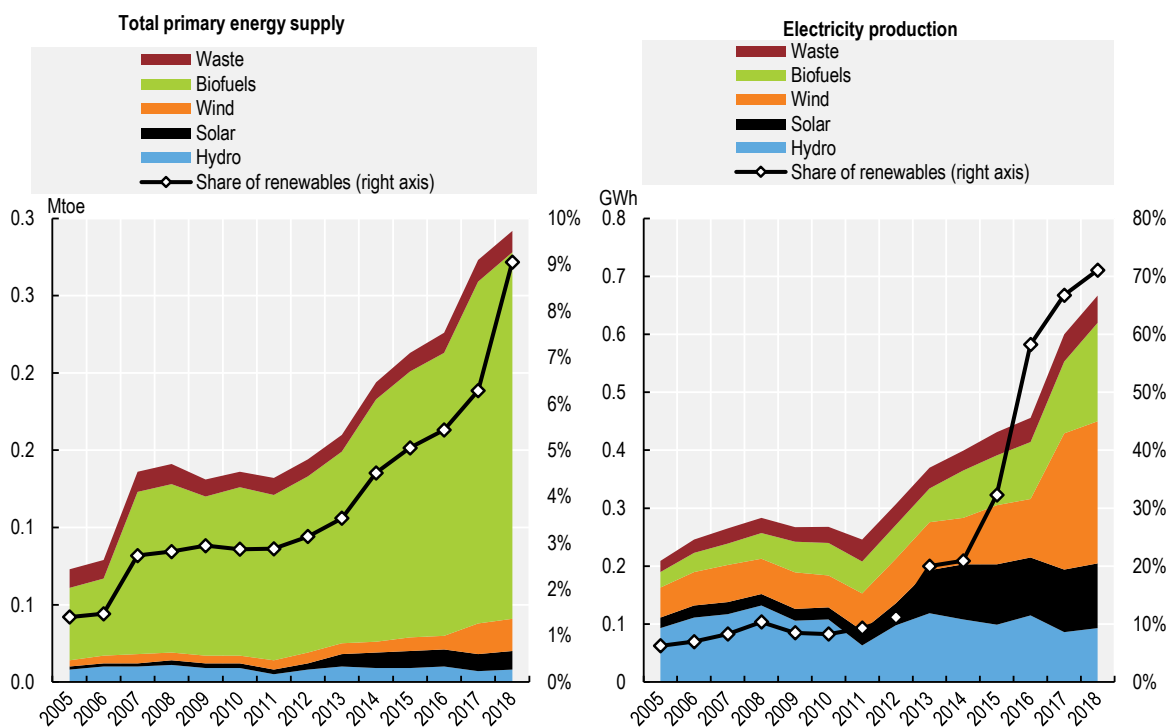
Source: IEA (2019), "World energy statistics", IEA World Energy Statistics and Balances (database).

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Renewables account for only 7.5% of the TPES in 2018, below the OECD average of 10.5% (Basic Statistics). Biofuels and biogas account for 81% of renewable energy sources, followed by wind power (7%) and waste (5%) (Figure 1.4).

Domestic electricity production covers only a small share of demand, but it consists of 71% renewables. Between 2005 and 2018, domestic electricity production decreased by 72% following the closure in 2016 of the Esch-sur-Alzette gas and steam turbine power plant. However, production from renewable energy sources has increased threefold since 2005. It consists of wind (37%), solar (17%), biofuels (14%), hydropower (14%) and waste (7%). This, combined with the 1997 cessation of coal use in electricity generation, has reduced the carbon intensity of the electricity mix (Figure 1.4).

Figure 1.4. The share of renewables is increasing



Note: Total primary energy supply excludes electricity trade.

Source: IEA (2019), "World energy statistics", IEA World Energy Statistics and Balances (database); Eurostat (2020), "Share of renewable energy in gross final energy consumption".

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Measures to promote the use of renewable energies include bonus systems for renewable electricity generation, feed-in tariffs for injecting biogas into the natural gas grid and financial incentives for households. The creation of a one-stop-shop and limits on the duration of authorisation procedures also simplify development of renewable energies (EC, 2018). These measures have boosted the production of biofuels and biogas from biomass and waste, which doubled between 2010 and 2018. Electricity production from wind power also doubled between 2016 and 2018 (Figure 1.4).

The share of renewable energies in gross final consumption increased rapidly. However, it remains relatively low compared to the objectives, set in the NREAP, of 11% in 2020 and 23-25% in 2030 (Eurostat, 2019a). The country uses the co-operation agreements established in the European Directive on renewable energy to reach the 2020 target. It has signed two agreements on statistical transfer² of renewable energy with Estonia and Lithuania. These transfers allow countries that have already reached their target and have an accounting "surplus" of renewable energy to transfer it to other countries with a

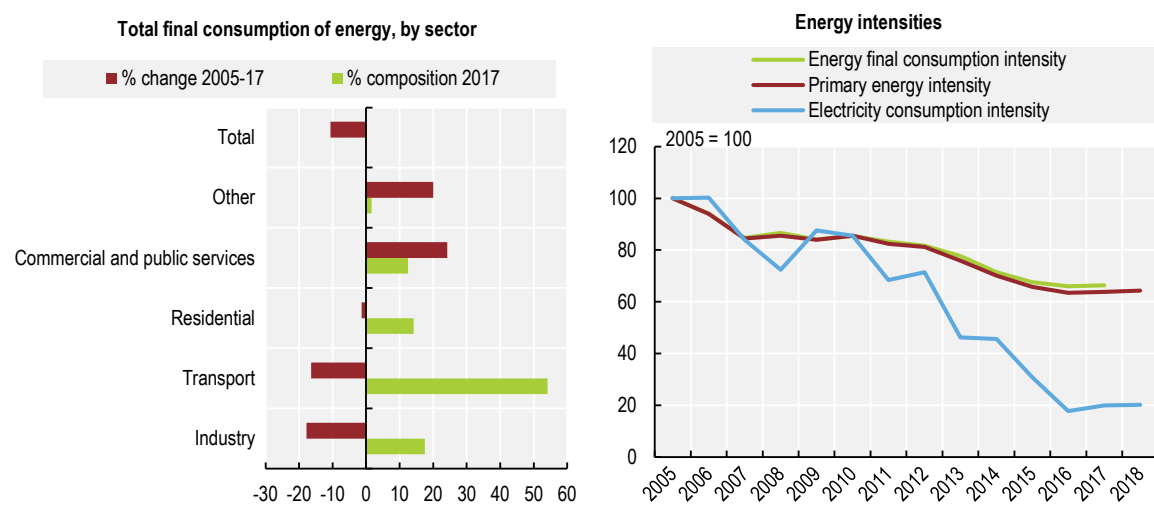
deficit (EC, 2018). These transfers enabled Luxembourg to increase the share of renewable energies in gross final consumption to 9.1% in 2018.

Energy consumption

The main public policy to reduce energy consumption is the NEEAP. Each action plan since 2008 has set more ambitious energy consumption reduction targets. To achieve them, subsidies (i.e. PRIME House subsidies), voluntary agreements with industries, an obligation mechanism (since 2015) and energy performance of buildings standards are in place (Ministry of the Economy, 2017).

Luxembourg is on track to meet its 2020 energy efficiency target of limiting its final energy consumption to 49 292 GWh. Final energy consumption has fallen much faster (-11% since 2005) than the OECD average (-1%). Policies have led to a decline in household consumption, despite population growth. Luxembourg's energy intensities have decreased – except during the financial crisis, due to the fall in GDP (Figure 1.5). (Ministry of the Economy, 2017). However, energy consumption has increased since 2016, particularly in transport. This shows that challenges remain and that efforts must be sustained and even strengthened to meet the 2030 efficiency target (to limit final energy consumption to 35 568 GWh). In a context of sustained economic growth and low energy prices, the increase in energy consumption coupled with the high purchasing power of a growing population are also stalling progress.

Figure 1.5. Energy consumption has decreased, but progress is slowing down



Source: IEA (2019), "World energy statistics", *IEA World Energy Statistics and Balances* (database); OECD (2019), "Aggregate National Accounts, 2008 (or SNA 1993): Gross Domestic Product", *OECD National Accounts Statistics* (database).

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Transport

The transport sector is the largest consumer of energy: it accounted for 54% of final consumption in 2017, compared with 34% on average across OECD member countries (Figure 1.5). Almost all the energy consumed by the transport sector (94%) comes from petroleum products (78% of which is diesel). This makes transport the main emitter of GHGs and a major source of air pollution. Situated at the heart of the main traffic roads in Western Europe, Luxembourg has relatively dense transit of road traffic for goods and people (especially cross-border workers). This phenomenon is exacerbated by fuel sales to non-residents generated by the relatively low prices and taxes on road fuels compared with neighbouring countries (Belgium and France). Road transport energy consumption has decreased by 19% since its peak in 2005,

due to a drop in international trade and an increase in the price of road fuels (leading to a decrease in fuel sales to non-residents). However, fuel sales to non-residents remain much higher than those to residents (about 70% of total sales), particularly for diesel (almost 60% of total sales) (Chapter 4).

The rate of private car ownership in Luxembourg is the highest in Europe, with 670 cars per 1 000 inhabitants (Eurostat, 2019b). This rate is influenced by cross-border workers whose company cars are registered in Luxembourg. Average CO₂ emissions per km are high for new private cars (127 gCO₂/km) and still far from the 2020 target (95 gCO₂/km) (Eurostat, 2019b). The share of diesel-powered vehicles has decreased but remains high: in 2019 it was 59% for cars, 91% for buses and 97% for trucks (STATEC, 2019c). The share of biofuel is increasing significantly (6.5% in 2018). However, Luxembourg is still below the EU requirement of a 10% share of renewable energy in transport by 2020, which calls for targeted measures in this sector (IEA, 2019; Chapter 4).

Luxembourg has put in place a plan for sustainable mobility called Modu in 2012 (revised in 2018), as well as a sectoral transport plan to improve infrastructure for electric vehicles and to promote public transport (IEA, 2020; Chapter 4). Financial support is also in place to buy low-emission vehicles (Chapters 3 and 4). The vehicle fleet is relatively young, with more than 50% of private cars, buses and vans less than five-years-old (STATEC, 2019a).

Climate change mitigation and adaptation

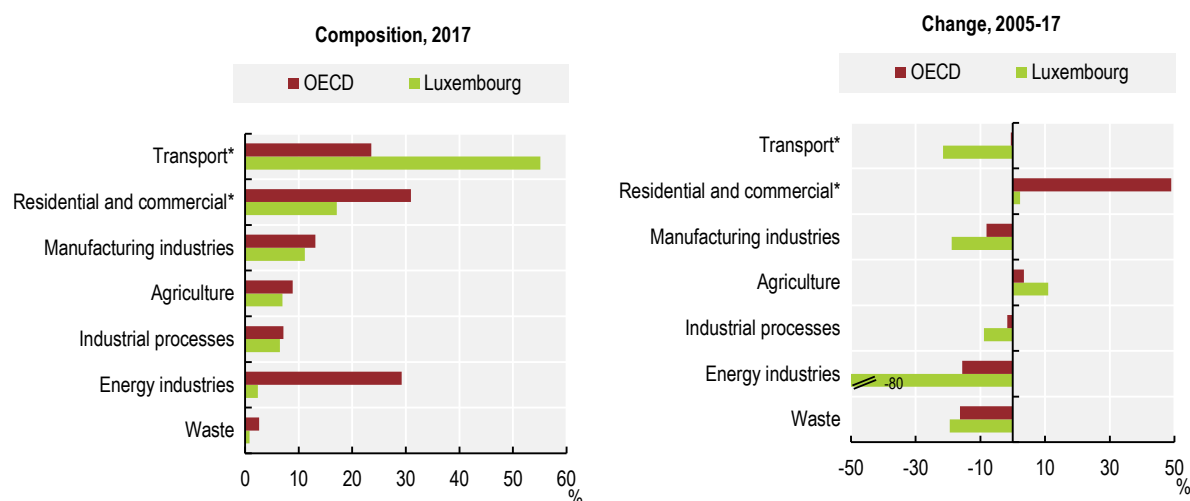
Greenhouse gas emissions profile

Luxembourg's GHG emissions profile is characterised by the importance of the transport sector, which accounted for 55% of national emissions in 2017,³ well above the OECD average (24%). Its geographical location makes it a transit country for road, rail and air transport of goods and people. As a result, the EU Emissions Trading System⁴ (EU ETS), which mainly includes stationary sources and intra-European aviation, covers only a small share (about 15%) of the country's emissions (IEA, 2020). The land use, land-use change and forestry (LULUCF) sector absorbs more GHGs than it emits.

Luxembourg's GHG emissions (excluding emissions and removals from LULUCF) decreased by 21% between 2005 and 2017, much more than the OECD average (-8%). All sectors (except agriculture) contributed to this decline, in particular transport (-22%), energy-producing industries (-80%) and manufacturing (-19%) (Figure 1.6). The financial crisis of 2008-10 followed by the gradual closure of the TWINerg power plant from 2012, as well as a drop in sales of road fuels (especially to non-residents), have reduced energy consumption and made the country more low-carbon. Due to Luxembourg's small size, its emissions are sensitive to changes in energy production processes, as well as to fluctuations in fuel prices that influence sales to non-residents. The quantities of fuel sold in Luxembourg petrol stations – encouraged by differences in taxation in neighbouring countries – are included in GHG emissions inventories. However, a large majority of emissions can be attributed to vehicles registered outside Luxembourg (44% of non-EU ETS emissions in 2017) (IEA, 2020). Diesel sales to transit trucks alone account for 32.5% of non-EU ETS emissions (IEA, 2020). The residential sector remains a significant source of emissions due to oil for heating. Meanwhile, the commercial sector is experiencing the greatest increase as a source due to development of the service sector and economic growth (Figure 1.6). Emissions increased again in 2017 in most sectors.

Emissions of CO₂, which account for 90% of GHG emissions, have declined since 2005 due to the decline in emissions from road transport. GHG emissions per capita and per unit of GDP decreased between 2005 and 2017, due to lower emissions, while population and GDP continued to grow. However, Luxembourg is still the fourth-highest per capita emitter of GHGs in the OECD, mainly due to transport emissions by non-residents (OECD, 2019b).

Figure 1.6. GHG emissions are declining in almost all sectors



Note: Total excludes emissions from land-use, land use change and forestry. Includes emissions from non-residents. The category "Residential and commercial" also includes fugitive emissions.

Source: OECD (2019), "Air and climate: Greenhouse gas emissions by source", *OECD Environment Statistics* (database).

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Main objectives and programmes

Luxembourg contributes to the EU's climate ambitions for 2020 and 2030 under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (Table 1.1). It also contributes to the EU's long-term objective of reducing GHG emissions by 80-95% by 2050. In addition, it signed and ratified the Paris Agreement in 2016.

Table 1.1. EU and Luxembourg climate objectives

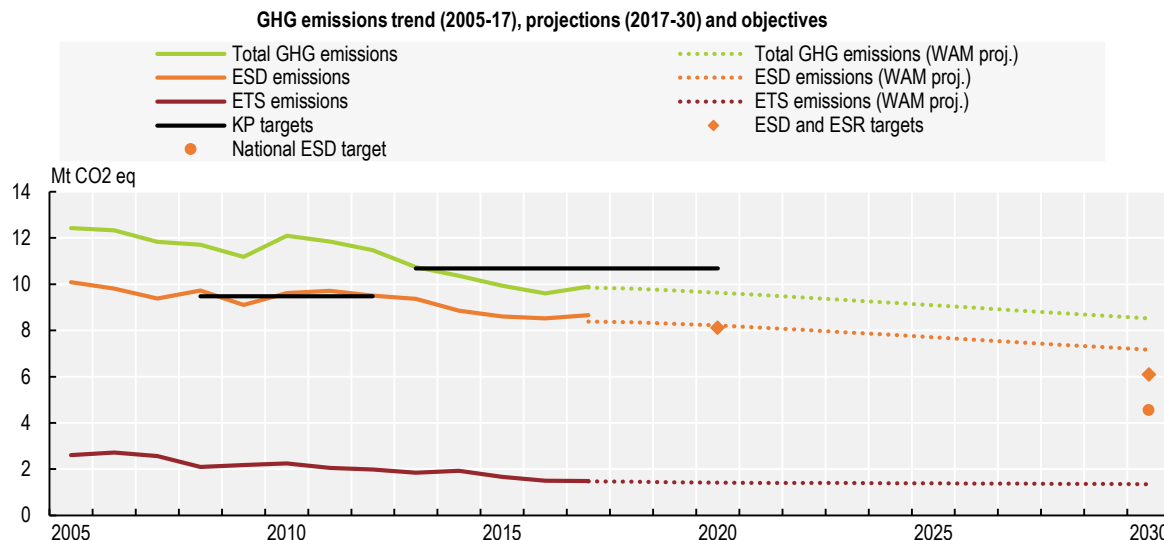
	UNFCCC		EU // non- EU ETS (ESD)		EU // ETS
	EU	LUX	EU	LUX	EU
2008-12	-8% (1990)	-28% (1990)			
2020	-20% (1990)	-14% (2005)	10% (2005)	20% (2005) 8.12 MtCO _{2e}	-21% (2005)
2030	Minimum of -40% (1990)		30% (2005)	-40% (2005) 6.09 MtCO _{2e} National target -55% (2005)	-43% (2005)

Source: Country submission.

Despite a sharp drop in GHG emissions in the 1990s, Luxembourg only met its target (-28% by 2008-12, compared with 1990 levels) by using the flexibility mechanisms in the Kyoto Protocol (Clean Development Mechanism, Joint Implementation and International Emissions Trading). These mechanisms may again be needed to meet current targets. As its 2020 objective within member states of the EU Effort Sharing Decision (ESD), Luxembourg aims to reduce its emissions from sectors not covered by the EU ETS by 20% from 2005 levels. Projections show it can just about be achieved "with additional measures", but that more efforts will be needed for 2030 (-40% compared with 2005) (Figure 1.7). In addition, the country has set an even more ambitious target of a 55% reduction in non-EU ETS emissions (compared with 2005). By 2050, the goal is to achieve climate neutrality. The high level of these ambitions demonstrates a strong political will that must be translated into equally strong concrete measures without losing sight of energy, air quality and mobility objectives. As the EU ETS covers only a small share of Luxembourg's emissions,

efforts to reduce emissions must rely mainly on domestic policies in the transport sector, the residential and commercial sector, and in agriculture.

Figure 1.7. Additional efforts are necessary to achieve non-EU ETS targets



Note: GHG emissions exclude emissions from land use, land use change and forestry (LULUCF). Dotted lines refer to national projections with additional measures (WAM). Reduction targets linked to the Effort Sharing Decision (ESD) and to the Effort Sharing Regulation (ESR) cover most sectors that are not part of the EU ETS, except the LULUCF sector and international maritime transports. The Kyoto Protocol (KP) covers 2008-12 and 2013-20 periods. Source: Eurostat (2018), "ESD Emissions"; CDR (2018), "Projections"; EEA (2019), EU ETS Dataviewer; OECD, "Air and climate: Greenhouse gas emissions by source", *OECD Environment Statistics* (database); MDDI (2018), "Seventh National Communication of Luxembourg under the United Nations Framework Convention on Climate Change".

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Discussions in 2018 for a third National Action Plan for the Reduction of Greenhouse Gas Emissions have fed into the NECP project required by the EU. The "climate package", adopted in 2011, identifies 35 priority measures aimed at spatial planning and the construction sector, mobility, energy and environmental technologies, biodiversity, forests, water and agriculture (MDDI, 2018a). The "climate bank and sustainable housing package" includes financial aid (PRIME House) dedicated to the construction and energy renovation of sustainable housing. Various support measures promote the production of electricity and heat from renewable energy sources. The measures also include a gradual increase in excise duties on road fuels. Part of the revenue from these duties is earmarked for Climate and Energy funds to finance mitigation, among other measures.

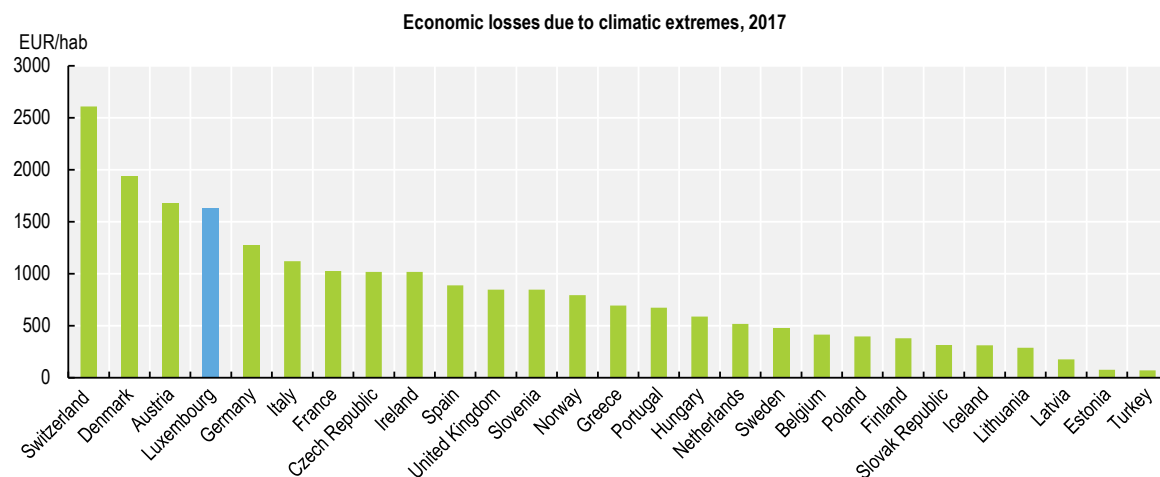
An agreement between the state and the 102 municipalities (the Climate Pact with municipalities) complements action at the local level. Municipalities are required to implement the European Energy Award quality management and certification system and an energy accounting system. In return, the state guarantees financial support and technical assistance to the municipality, which may increase according to the level of certification. Operational since 2013, this pact has included air quality criteria since 2016 and circular economy criteria since 2017 (MDDI, 2018a; Box 3.2; Chapter 3).

Adaptation to climate change

The temperature in Luxembourg City is on average higher than during the last century, especially in winter (MDDI, 2018a). Extreme weather events, including floods, caused significant damage in 2016 and 2018. In August 2019, a strong storm accompanied by a tornado caused a lot of damage in the south-west of the country. In the same month, the temperature in Luxembourg reached 40.8°C, the highest temperature

since the country began keeping weather records in 1838. Scientific forecasts indicate the trend towards higher temperatures will intensify in the future. These damages create greater economic losses in Luxembourg than in most other European countries. These losses, measured by the direct costs of physical damage (for example, destruction of infrastructure) and indirect costs (interruption of economic activity), are explained by the country's high GDP per capita (Figure 1.8).

Figure 1.8. Economic losses due to climatic extremes are high



Note: Prices in Euros (2017), based on damage data from Munich Re's NatCatSERVICE and Eurostat structural indicators.

Source: EEA (2019), *Impacts of extreme weather and climate related events in the EEA member countries (1980–2017)* (database).

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The National Climate Change Adaptation Strategy, adopted in 2011, was revised and expanded in 2018. It identifies 13 sectors⁵ affected by climate change and presents priority actions. The first strategy enabled Luxembourg to analyse the impacts of climate change and to make projections on future climate conditions and their effects on vegetation, agriculture, viticulture, forests, biodiversity and water. Water management is one of the priority issues, which has led to increased subsidies for flood control and river ecological-restoration. Other measures aim to save energy, expand infrastructure for solar energy and responsible biomass, and adapt infrastructure to an increase in natural disasters (MDDI, 2018a). The strategy must be complemented by a monitoring framework to supervise the implementation of adaptation measures.

1.4. Atmospheric emissions and air quality

Main plans and programmes

The high level of road traffic in Luxembourg exacerbates air pollution, particularly nitrogen oxides (NO_x). In response, the government has put in place plans and programmes to combat air pollution. These include the national air quality programme and the air quality plan for the City of Luxembourg and surrounding areas (MDDI, 2017a). Luxembourg is also preparing a National Action Plan under a European Directive (2016/2284) on the reduction of national emissions of certain atmospheric pollutants. Under Directive 2008/50/EC on ambient air quality and cleaner air for Europe, limit values, target values and objectives for concentration and exposure are defined. The 2018 strategy for sustainable mobility (Modu 2.0) sets targets for 2025 (Chapter 4).

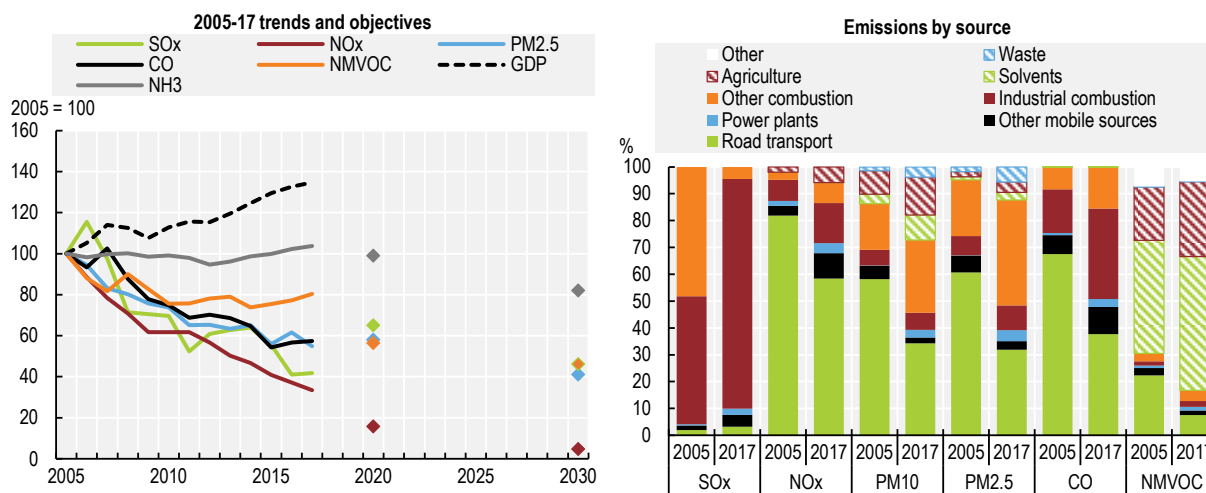
Atmospheric emissions

Luxembourg has succeeded in decreasing emissions of most of the main air pollutants: NO_x, carbon monoxide (CO), sulphur oxides (SO_x), fine particulate matter (PM_{2.5}) and non-methane volatile organic compounds (NMVOC) (Figure 1.9). This success can be explained by the economic crisis; less road transport following a decrease in international trade; a higher price for road fuels (leading to a decrease in fuel sales to non-residents); and the continuous renewal of the car fleet (more efficient cars, EURO standard 3 and 4). Other measures have contributed to these results. These include industry's introduction of catalytic converters and limits for solvents; more efficient technologies (particularly in combustion and processes in the metallurgical industry); as well as reductions in the sulphur content of petroleum products and fuels; and the substitution of coal with natural gas in the energy mix (MDDI, 2017b). On the other hand, the increase in agricultural production, and in particular that of livestock, led to an increase in NH₃ emissions compared to 2005 (+4%).

Fewer emissions made it possible to meet the 2010 targets under Directive 2001/81/EC for all atmospheric pollutants except NO_x. However, additional efforts will be necessary to meet the 2020 and 2030 targets. NMVOC, NH₃ and PM_{2.5} emissions have all increased again (since 2012 for NH₃, since 2014 for NMVOC and since 2017 for PM_{2.5}) and projections show they will be above the cap (EEA, 2018a). Still, emissions have been decoupled from economic growth and intensities per unit of GDP are well below the OECD average (OECD, 2019b) (Figure 1.9).

Although decreasing, road transport remains the largest source of NO_x (58%), PM₁₀ (34%), PM_{2.5} (32%) and CO (38%) emissions in 2017. Industrial combustion is the largest source of SO_x emissions (86%) and the second largest source of CO (16%) and residential combustion remains a significant source of particulate matter. Solvents and agriculture are the largest emitters of NMVOC and their share continues to increase (Figure 1.9). Agriculture is responsible for 96% of NH₃ emissions. To achieve its objectives, Luxembourg will therefore have to step up its efforts in reducing emissions from transport, industrial combustion, solvents and agriculture (Chapter 4).

Figure 1.9. Atmospheric emissions are declining, but more effort is needed to achieve the targets



Note: GDP expressed at 2010 prices and purchasing power parities. Estimates based on fuel sold.

Source: OECD (2019), "Air and climate: Air emissions by source", *OECD Environment Statistics* (database); EEA (2018), *National Emission Ceilings Directive Emission Inventory Data* (database).

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Air quality

Air quality has improved over the past decade. Average population exposure to fine particles (PM_{2.5}) has decreased by 17% since 2005, but its level – 10.2 micrograms per cubic metre (µg/m³) – remains slightly above the maximum value of 10 µg/m³ recommended by the World Health Organization (OECD, 2019c). The annual average concentrations of PM₁₀ and nitrogen dioxides (NO₂) have decreased and are below the daily limit values set by EU legislation (EEA, 2018b). NO₂ concentrations in ambient air still exceed the annual limit value at several critical locations with heavy traffic (canton of Luxembourg). Rural Luxembourg has exceeded the target values and long-term objectives for ozone concentrations.

Networks of measurement stations measure air quality. In addition to fixed stations in the larger cities (Luxembourg City, Esch-sur-Alzette), temporary measures are taken in sensitive areas (MDDI, 2017a). Since 2007, the concentrations of certain pollutants can be consulted in near-real time through a mobile application (MECDD, n.d.).

Exposure to PM_{2.5} and ozone in outdoor air is responsible for the premature death of about 326 in every 1 million people in OECD member countries. This mortality level is slightly lower in Luxembourg (248 people in every 1 million in 2017, i.e. 150 people in Luxembourg). Premature deaths in the OECD translate into a welfare cost comparable to 2% of GDP in 2017 (OECD, 2020; Chapter 4).

1.5. Transition to efficient resource management

The wealth and development of Luxembourg's economy generate relatively high material consumption and waste production. For many years, the government has been pursuing an active waste and materials management policy based on prevention and recovery, as well as on the use of quality secondary raw materials in the economy. However, efforts have been difficult to translate into results, particularly due to slow implementation of certain measures and a lack of coherence and harmonisation at national level.

Material consumption

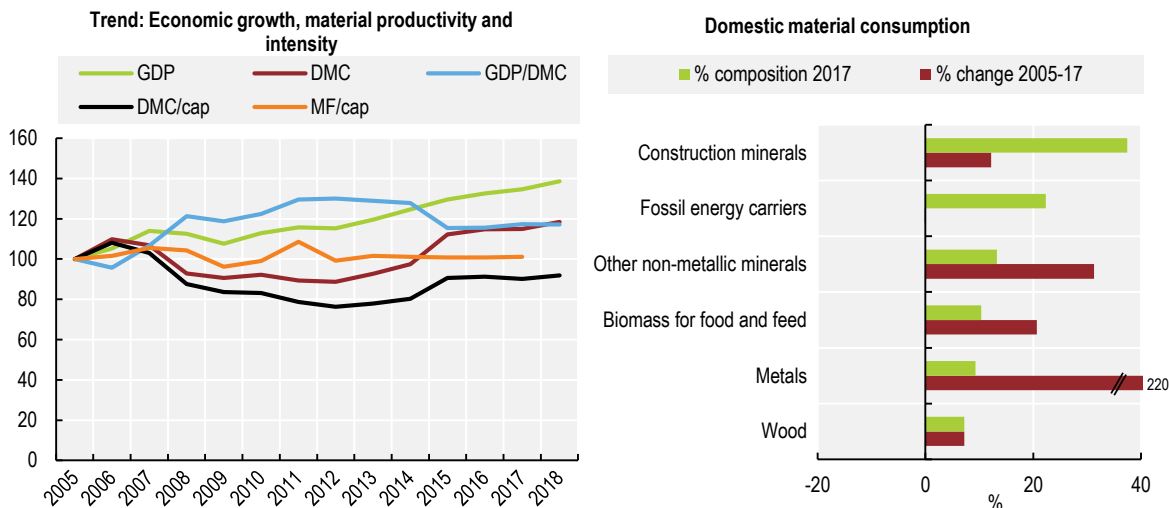
Because of its small size, the country imports a large quantity of materials: those extracted within the country represent only 15% of what is consumed. The country mainly imports fossil fuels (27%), construction materials (23%) and metals (22%).

Domestic material consumption (DMC) consists mainly of construction materials (37%), fossil fuels (22%), biomass (18%), non-metallic minerals (13%) and metals (9%) (Figure 1.10). DMC declined following the financial crisis in 2008, then rose again from 2013 onwards, but less rapidly than GDP and population growth. Material productivity is among the highest among OECD member countries. For 1 tonne of materials consumed, Luxembourg creates approximately USD 3 800 or EUR 3 400 of economic wealth in terms of GDP. This compares with an average of EUR 2 000 in the EU or USD 2 600 in the OECD. Material productivity increased by 30% between 2005 and 2012. It then fell by 11% in 2015 and has since remained stable. This stagnation is partly explained by the increase in DMC due to the creation of infrastructure for public transport, such as the first tramway line and new bus lanes in the City of Luxembourg.

Material intensity per capita is high, particularly because it includes the consumption in Luxembourg of cross-border workers, who, on the other hand, are not included in the population. A person living in Luxembourg thus “consumes” on average 24 tonnes of materials per year. This level is well above the OECD average (15 tonnes per capita) and is the source of significant amounts of waste. In 2016, waste generated in the country accounted for almost 75% of the materials consumed, with a higher per unit of GDP rate than in most OECD member countries.

Considering the raw materials extracted worldwide to satisfy the final demand of the economy, Luxembourg's material footprint amounts to 103 tonnes per inhabitant. At almost four times higher than the average, this intensity is the highest in the OECD (Figure 1.10).

Figure 1.10. Material productivity has strongly increased, but progress is slowing down



Note: GDP expressed at 2010 prices and purchasing power parities. DMC is the sum of domestic extraction of raw materials used by an economy and the physical trade balance (imports minus exports of raw materials and manufactured goods). Material footprint (MF) includes all materials extracted (including from abroad) to satisfy the final demand of the economy.

Source: OECD (2019), "Material Resources", *OECD Environment Statistics* (database); OECD (2019), "Aggregate National Accounts, 2008 (or SNA 1993): Gross Domestic Product", *OECD National Accounts Statistics* (database).

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Waste prevention and management

Status and trends

Luxembourg produced 17 tonnes of waste per capita in 2016: 3.5 times more than in the EU. The construction sector generates 76% of waste, a larger share than in other OECD member countries. Industrial waste accounts for only 7.5% of the total and is largely dominated by metallurgical industries (Figure 1.11). Total waste generation increased by 21% between 2006 and 2016. Following fluctuations in the construction sector, it peaked in 2010, then decreased as a result of the economic slowdown caused by the financial crisis, before growing again from 2014 onwards. Progress has been made in waste recovery: in 2016, 35% of the waste treated in Luxembourg was recycled, 24% was used for backfilling and 2% was incinerated with energy recovery. The rate of landfilling dropped from 49% to 39% between 2010 and 2016 (Eurostat, 2019d).

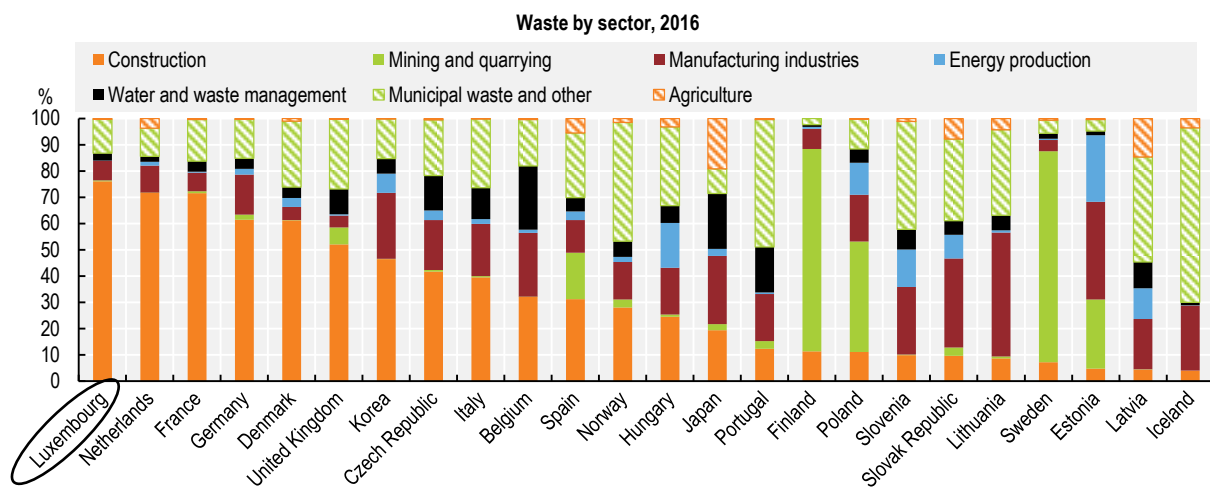
Municipal waste

A person living in Luxembourg produces 614 kg of municipal waste per year, a decrease of 10% (69 kg) compared with 2005, but still among the highest levels in the OECD. This is partly due to the waste produced by cross-border workers on Luxembourg territory, as well as to the economy's high level of consumption. Quantities produced have increased (+19%), but less rapidly than the population and GDP (OECD, 2019f; Figure 1.12). The promotion of sorting at the source and the strengthening of separate collection have helped increase the recovery rate (recycling and composting), which reached 48% of the amounts treated in 2012 and has stagnated since then (MDDI, 2018b). This rate is higher than the OECD average but still lower than that of neighbouring countries (Germany, 66%; Belgium, 54%). In addition, it

still has strong growth potential, particularly for organic waste, paper and cardboard, which still account for two-thirds of the mixed waste collected (MDDI, 2018b).

A large number of municipalities do not yet have all separate collections and/or do not apply a tax on residual waste by weight. Similarly, the target for reducing bulky waste has not been achieved due to inconsistent application of the polluter-pays principle at national level. Similarly, this principle is not applied uniformly in all municipalities (MDDI, 2018b). These issues were raised in the previous review, which recommended (i) introducing harmonised and differentiated pricing for municipal waste management throughout the country; and (ii) achieving economies of scale by encouraging municipalities to better co-ordinate their actions.

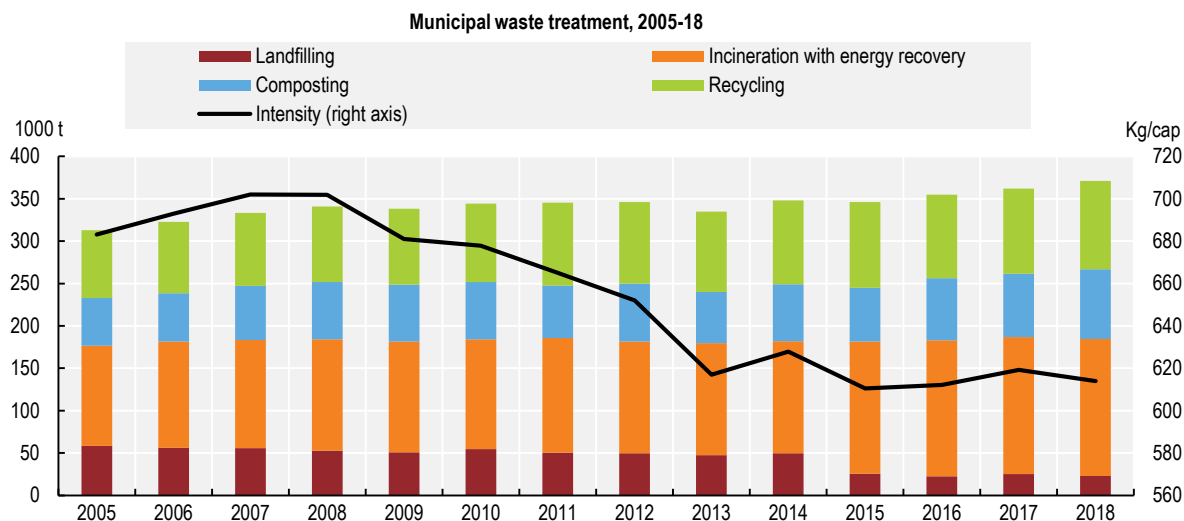
Figure 1.11. The construction sector generates the most waste



Note: Data for Japan refer to 2015.
Source: OECD (2019), "Waste: Waste generation by sector", OECD Environment Statistics (database).

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Figure 1.12. Waste recovery is growing faster than production



Source: OECD (2020), "Waste: Municipal waste", OECD Environment Statistics (database).

StatLink <https://doi.org/10.1787/888934168531>

Specific waste flows and problematic waste

Luxembourg has achieved its targets for recycling and recovery⁶ of packaging waste under Directive 94/62/EC: in 2017, 67% of packaging waste was recycled and the material recovery rate reached 98%. Glass, metals and paper/cardboard exceed 75% recovery rates, but wood and plastics have stagnated at around 35%. The targets for end-of-life vehicles have also been exceeded, with a recovery rate of 97% and a recycling rate of 87% in 2015 (MDDI, 2018b).

The generation of hazardous waste almost doubled between 2006 and 2016. It consists mainly of mixed construction and demolition materials, as well as wood, and chemical and pharmaceutical waste. Because of its small size and cost-efficiency considerations, Luxembourg does not have any installation to treat hazardous waste. As a result, it incinerates 11% of this waste within the country and exports the rest for treatment in neighbouring countries.

In 2015, the health sector produced 2.4 tonnes of waste, 77% of which is infectious. Although recommended in the previous review, there is no national co-ordination between the various health sector actors to sort and collect their waste. In addition, Luxembourg dissolved the SANIDEC Association in 2011. This entity had partnered with the Environment Agency and the Ministry of Health to discuss the quantification and categorisation of waste from the health sector. Consequently, each establishment now decides how it sorts and collects waste based on the available recovery and treatment options. Nevertheless, in 2014, 132 health and care institutions were awarded the SuperDrecksKëscht (SDK) quality label, which guarantees compliance with environmental criteria (MDDI, 2018b) (Box 1.1).

Box 1.1. The SuperDrecksKëscht© (SDK)

Since 1985, the SuperDrecksKëscht© (SDK), an initiative of the Ministry of Sustainable Development and Infrastructure (MECDD) in co-operation with municipalities and the Chambre des métiers has enabled Luxembourg to make important progress and to be a leader in the management of problematic waste. The SDK is based on the principles of waste prevention, reduction and recovery. All recoverable materials are recycled to extract as many secondary materials as possible. At the same time, all problematic substances are treated to minimise negative environmental impacts. Flows of substances from production to processing into new raw materials or their environmentally sound disposal must be clearly presented so they can be monitored at any time.

The enterprise component of the SDK action was launched in 1992. It includes assistance in setting up recycling centres on large construction sites. The SDK is ISO 14001 certified and may, since 2009, award a quality label (ISO 14024 certified) for the concrete implementation of prevention measures. In 2018, 5 107 companies were members of the SDK; 61% had the quality label.

The scope of the SDK activities has gradually expanded: it collects separately 159 types of problematic waste from households, sets up separate collection structures in residences and supermarkets, and has initiated prevention measures such as the EcoBox, a multi-use deposit system, and the Eco-Sac [Eco Bag]. The EcoBox is a recycled plastic container, available in participating restaurants, that allows customers to take away their meal in exchange for a EUR 5 deposit. After use, the EcoBox can be taken back to the restaurant to collect the deposit or exchanged for another professionally cleaned EcoBox to take away another meal. Defective EcoBoxes can be exchanged free of charge. The Eco-Sac is a reusable bag made of recyclable materials sold at supermarket checkouts. It has helped reduce the consumption of single-use bags at supermarkets by more than 90% (or 840 million bags) since 2007.

Key plans and programmes

Luxembourg has a comprehensive legislative and regulatory framework in line with European legislation. The government's 2018-23 coalition agreement also foresees the transposition of the "Circular Economy Package" directives on the basis of a "Luxembourg Zero Waste" strategy. The national Waste and Resource Management Plan, adopted in 2018, incorporates the principle of a circular economy: it guides policy implementation and defines qualitative and quantitative targets. It follows on from the general Waste Management Plan, which established general principles (polluter pays, precautionary, extended producer responsibility) and targets by type of waste (MDDI, 2010).

According to the overall review of the 2010-15 plan, almost half of the 110 planned measures have been implemented, 35 have been partially implemented and 17 have not been implemented. The shortcomings identified relate to the management of inert waste, construction and demolition waste, food waste, waste from the health sector and waste from sewage treatment plants. According to the Environmental Implementation Review of EU environmental policy, Luxembourg is on track to meet the 2020 target of recycling 50% of municipal waste. However, further efforts will be required to reach the 65% recycling target that the EU directive sets for 2030 (MDDI, 2018b; EC, 2019b). The 2018 plan incorporates the EC's recommendations to intensify efforts to prevent and reduce waste at the source, as well as to recover waste. In addition, it brings forward to 2022 the targets set by EU directives at more distant years. These include the 55% recycling rate for municipal waste (by 2025 for the EU), limiting municipal waste landfilling to 10% (by 2035 for the EU) and recycling at least 70% of packaging waste (by 2030 for the EU) (MDDI, 2018b).

Separate collection at home includes paper and cardboard, metals, hollow glass, green waste, bio-waste and clothing. However, despite being required by the 2012 Waste Act, separate collection of bio-waste is not yet offered in all municipalities. In 2015, Luxembourg had 22 recycling centres, covering 93% of the population. The new plan aims to strengthen the network of recycling centres, with one centre for every 10 000 to 15 000 inhabitants. The "drive-in recycling" project and the ReBox project aim to increase the sorting and recovery rate of municipal waste. They provide customers with free collection boxes for returning waste and with additional infrastructures (in supermarkets and shopping centres) to sort plastic films and bags, pots, cups, trays and other recyclable items. In 2016, the ReBox was installed in the car parks of 11 supermarkets. The "residences" project, co-managed by the SDK and the *Groupement des syndicats professionnels du Grand-Duché de Luxembourg*, aims to install a site dedicated to selective sorting in residences, as imposed by law. In 2019, 320 residences already had such an infrastructure.

The principle of extended producer responsibility was introduced in 2003 and progressively expanded. It applies to end-of-life vehicles, batteries and accumulators, waste electrical and electronic equipment and packaging. This principle is being applied well and could be further extended to other types of waste such as tyres, furniture or coffee capsules (MDDI, 2018b).

Several initiatives have also been launched on the circular economy concept. In particular, the strategic study of the Third Industrial Revolution, which sets out the country's economic and social development strategy for 2050, has addressed the circular economy (Ministry of Economy, Chamber of Commerce and IMS, 2017). Since 2010, several actions – including by the SDK, trade unions and municipalities – have been taken to prevent waste from being generated particularly through advice to businesses and households. Communication and awareness-raising campaigns on waste prevention (Eco-Sacs, reusable cups and the SDK's "Clever Akafen" [Buy Smart] campaign, among others) have been carried out. Second-hand shops in recycling centres have been set up for books, clothing and household items made of metals, plastics or porcelain, among other things. "Repair cafes", run by volunteers, have also been set up in co-operation with the SDK to help extend objects' lifespan through short circuits. An inter-ministerial committee has been set up to bring together all public stakeholders, exchange information and co-ordinate implementation. For instance, as part of a government initiative, the city of Wiltz has been designated future "hotspot" for the circular economy in Luxembourg. This pilot project (Wunne mat der Wooltz) for the

rehabilitation of former industrial wastelands focuses on the sharing economy, materials passport (for buildings) and multimodal mobility. The Fit 4 Circularity programme of the national innovation agency (LuxInnovation) in co-operation with the SDK, has been designed to facilitate and accelerate companies' transition to the circular economy (MDDI, 2018b).

1.6. Land use and natural resource management

Physical context and land use

At 2 586 km², Luxembourg is the smallest country in the OECD. It stretches 82 km from north to south and 57 km from east to west, and its altitude ranges from 130 to 560 m above sea level. From a geographical and geological point of view, it is composed of two main regions, Oesling in the north and Bon Pays in the south.

Agricultural land makes up 54% of the country (26% arable land and permanent crops, and 28% permanent meadows and pastures), followed by forests which cover 37.5% of the country. Artificial areas have increased and cover 14.5% of the country: 10% built-up areas and 4.5% infrastructure (STATEC, 2018). The economic development of the Greater Region⁷ is accompanied by growth in both its population and the number of cross-border workers, which exacerbates the demand for infrastructure and built-up areas. Luxembourg is the European country that suffers most from a strong fragmentation of its landscapes. (EEA, 2019a), which affects biological diversity and increases soil erosion. Limiting urban sprawl is one of the objectives of the sectoral Landscape Plan, in connexion with other plans relating to transport, economic activity areas and housing (MEA, 2018).

Agriculture and agricultural inputs

Agricultural production increased slightly (+4%) between 2005 and 2016. Luxembourg's agriculture focuses on the production of milk, fodder crops and cattle. Large farms (50 ha and more) account for more than half of the country's farms and have gradually replaced small farms (STATEC, 2019c).

Nutrients

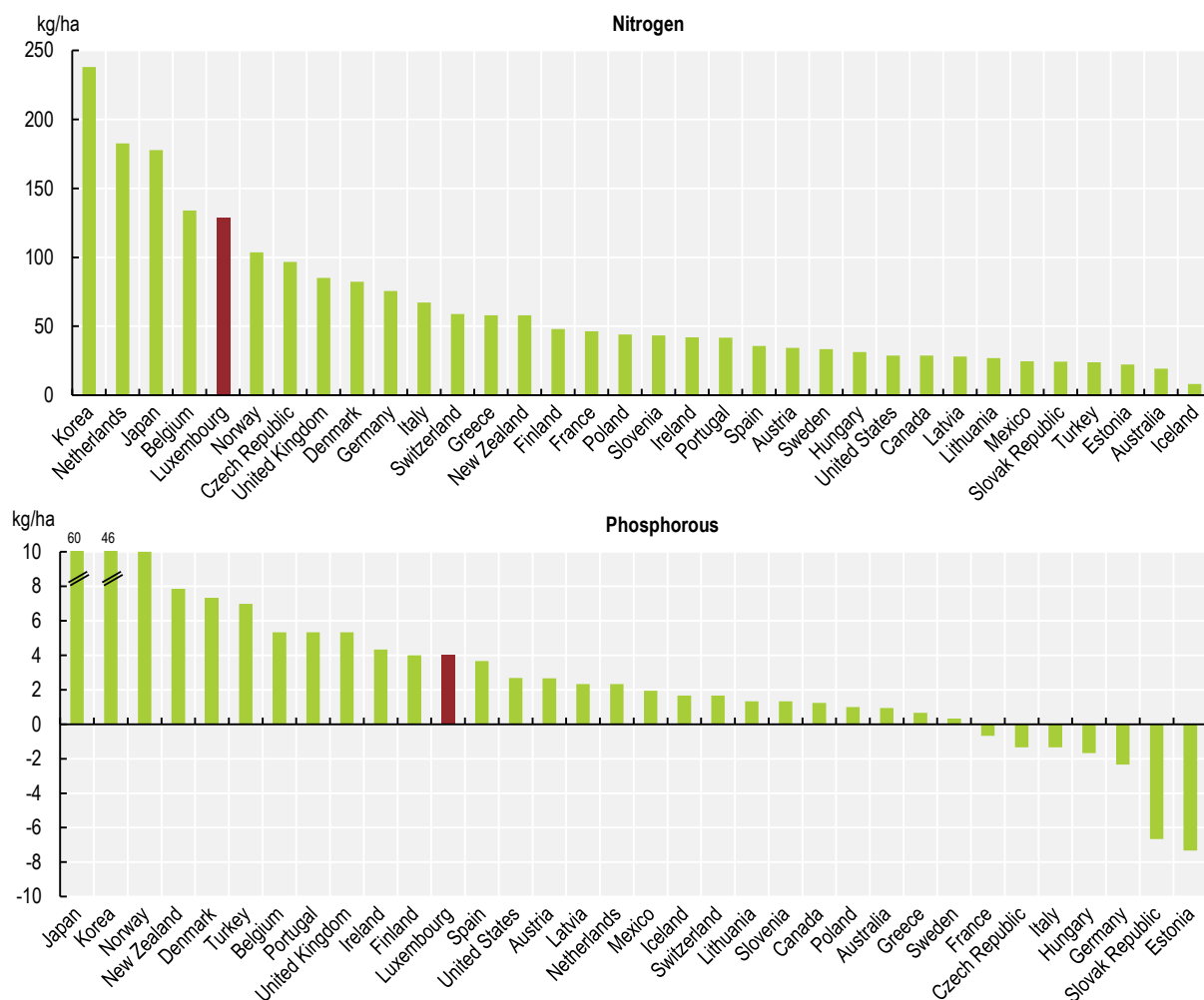
Nutrient surpluses from agricultural sources (nitrogen and phosphorus) indicate a risk of soil, water and air pollution. Luxembourg is among countries in the OECD with the highest nutrient surpluses (Figure 1.13). Nitrogen surpluses are high compared with other OECD member countries (OECD, 2019f; STATEC, 2019c). After a decline between 2006 and 2009, these surpluses stagnated again at their 2005 level. On the other hand, phosphorus levels have decreased by almost 50% since 2005, both in absolute (tonnes of nutrients) and relative (kilograms per hectare of agricultural land) terms. Livestock density is among the highest in the OECD, and 46% of NH₃ emissions come from livestock farming. To help farmers adopt sustainable practices, Luxembourg should review the environmental effectiveness of the different economic instruments that apply to agriculture.

Pesticides

Available data indicate that pesticide sales declined between 2011 and 2016. Herbicides, whose sales fell by 18%, account for 83% of the total. However, the limited number of sellers of plant protection products in Luxembourg means that data on a number of active substances are confidential and limits the evaluation of progress. The country adopted a first National Action Plan for the sustainable use of plant protection products in 2013 and revised it in 2017. The plan foresees a 30% reduction in the use of "big movers" (the most dangerous or widely used plant protection products) by 2025 and a 50% reduction in the use of pesticides by 2030 (compared to 2017). These objectives will be evaluated using indicators such as the

number of unit doses (NODU in French) or the Indicator of Frequency of Treatment, which were developed in the French Ecophyto Plan. The plan also foresees 25 measures, including untreated buffer zones around surface waters; identification, management and prohibition of plant protection products likely to pollute groundwater in at-risk areas; improved knowledge of how these products impact the soil; and more organic farming (MAVPC, 2017). Luxembourg is the first European country to ban glyphosate on its territory: in January 2020, the government announced the withdrawal of the market authorisation from 1 February, a ban on sales from 1 July and a ban on its use from 31 December 2020.

Figure 1.13. Nitrogen surplus remains high



Note: Average on the latest 3 years available.

Source: OECD (2019), "Environmental performance of agriculture - nutrients balances", *OECD Agriculture Statistics* (database).

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Organic farming

Although organic crop areas have increased to 4.39% of the used agricultural areas in 2018, their share remains well below the EU average (7%) (Eurostat, 2019e). Organic agriculture in Luxembourg is specialised in the production of milk, meat, poultry and eggs; most of the organic products consumed are

imported. To support this progress and to better match the supply and demand of organic products, a National Action Plan for the Promotion of Organic Agriculture has been in place since 2009 (MAVPC, 2018). The government seeks to increase the areas under organic crops to 20% of the used agricultural areas by 2025 (MAVDR, 2020).⁸ However, current levels of development will not be sufficient to achieve this ambitious goal. A roadmap with concrete and well targeted measures is needed.

Biodiversity and ecosystems

Biodiversity has been declining for more than 40 years due to the loss and degradation of natural habitats (including changing hydrology), landscape fragmentation, agricultural intensification and climate change (MDDI, 2017b; MDDI, 2015).

The law on the protection of nature and natural resources provides for the development of a National Plan for Nature Protection (PNPN) every five years. The first plan (2007-11) identified national priorities and established collaboration between the national government and municipalities in certain sectors. However, it only partially achieved its objectives due to the vagueness of certain measures; inadequate budgetary and human resources; and a lack of inter-ministerial collaboration in implementing certain measures. The review also points to the lack of indicators to evaluate implementation of the measures along the way. As a result, most measures were often localised and restricted. The most recent plan, PNPN 2017-21, includes the National Biodiversity Strategy. It aims to adapt the strategy and measures to address the weaknesses of the first plan (MDDI, 2017c) (Chapter 5).

Natural habitat and protected areas

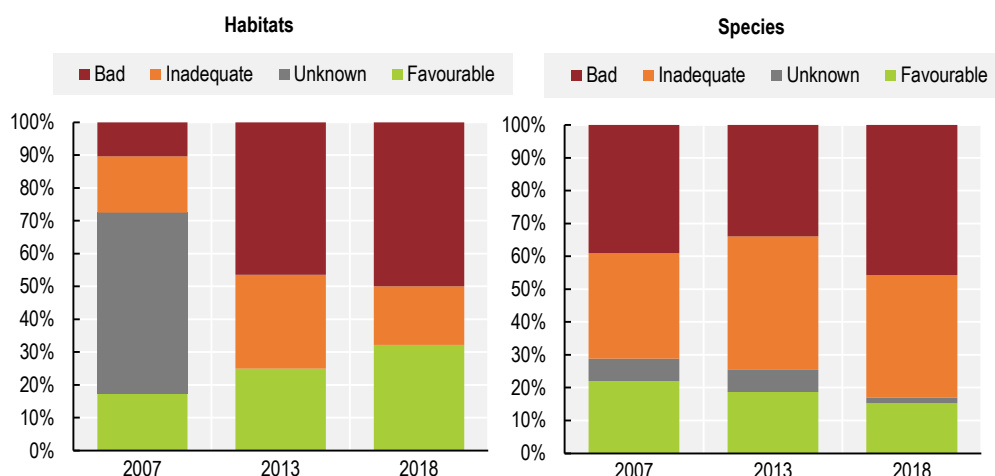
The Natura 2000 network implements the EU Habitats Directive on the conservation of fauna and flora and the EU Birds Directive. Natura 2000 sites cover 27% of Luxembourg's territory, a higher level than the EU average. The network includes 48 special areas of conservation (41 588 ha) and 18 special protection areas (41 893 ha), some of which overlap (MECDD, 2019). Their identification paved the way for the creation of area-specific management plans for biodiversity conservation. Most areas have management plans, as recommended by the previous review (OECD, 2010). However, efforts must be sustained throughout their implementation (BirdLife International et al., 2018).

This European network has stimulated the designation of protected areas, which increased from 46% to 50% of the country between 2005 and 2019 (categories I to IV of the International Union for Conservation of Nature). This national average was well above the OECD average (16%) and the 11th Aichi target (17% by 2020) enshrined in the Convention on Biological Diversity. National parks (category II) cover 33% of the territory and Habitat and Species Management Areas (category IV) cover 15%. The PNPN identifies protected areas of national interest, particularly due to their status as ecological corridors (MDDI, 2017c). They are important tools for connecting Natura 2000 protected areas and thus counteracting habitat fragmentation.

Information on the condition of habitats has improved significantly, but half of them remain in poor condition and 18% are in an inadequate condition. The conservation status of aquatic environments, amphibian areas and open environments along with the species that live in them are of the greatest concern.

The conservation status of the species covered by the Habitat Directive (92/43/EEC) is also of great concern and continues to deteriorate: only 15% are in good condition compared to 22% in 2007 (Figure 1.14) (Chapter 5). Under the Birds Directive, the 2013-18 evaluation shows a decreasing long-term trend for 38% of breeding birds, while the population is increasing in the long term for 25% of them. However, knowledge has improved compared with the previous evaluation (2008-12) (EEA, 2019c).

Figure 1.14. The conservation status of habitats and species is far from favourable



Note: These figures show the percentage of biogeographic assessments in each conservation status category for habitats and species.

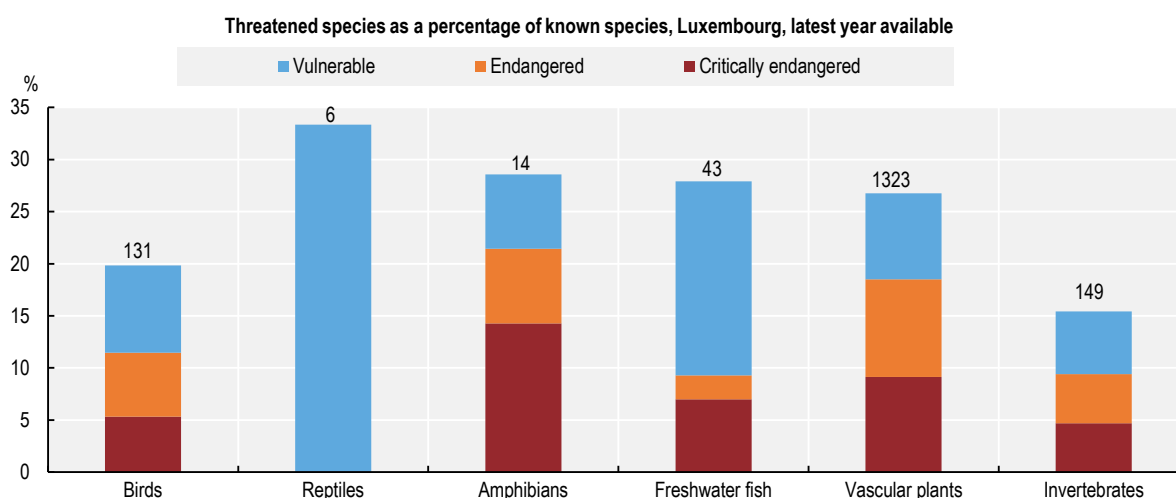
Source: EEA (2019), "Conservation status and trends", *State of Nature in the EU: Article 17 national summary dashboards*.

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Species status

Luxembourg has more than 1 500 known species, which are mostly vascular plants. The status of these species is critical and has not improved (except for reptiles) since the last review, despite conservation efforts under the first PNP (OECD, 2010). One-third of reptile species and more than one-quarter of fish, amphibian and vascular plant species are threatened (Figure 1.15, Chapter 5).⁹ Plants associated with agricultural environments are more threatened, hence the importance of better integrating conservation into agricultural practices (MDDI, 2015).

Figure 1.15. One-quarter of species are threatened



Note: Invertebrates refers to dragonfly only.

Source: OECD (2019), "Biodiversity: Threatened species", *OECD Environment Statistics* (database)

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Forests

Forests cover 36% of Luxembourg's territory and more than half of them are privately owned. According to the 2013-18 evaluation, 4 of 7 forest habitats – and 8 of 11 species living in these habitats – were in poor or unfavourable condition (EEA, 2019b). In 2018, 31% of trees were "significantly damaged", an improvement from 38% in 2016 (STATEC, 2019d). By 2020, the government aimed to double the area of forests under the forest regime as freely growing forest reserves. These areas without logging should increase to at least 5% of forest area (compared with 2.5% in 2015). Forest management plans, consistent with sustainable forest management practices, are in place for all public forests, as well as for private forest estates exceeding 10 ha (MDDI, 2015).

Water management

Main plans and programmes

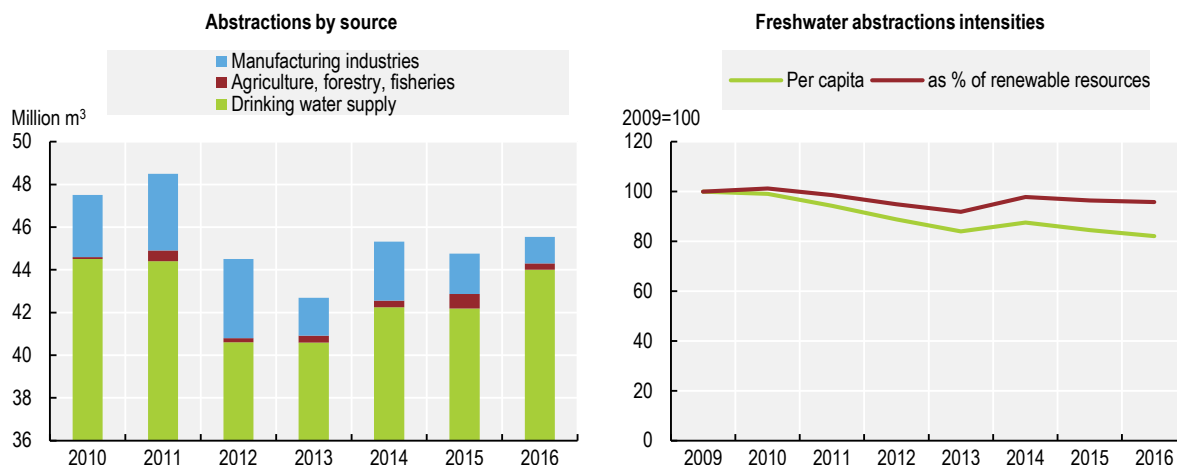
Luxembourg develops its policies in line with the European directives related to water management.¹⁰ The River Basin Management Plan covering 2009-15 has been revised for the second cycle (2015-21). It covers those parts of the international Rhine and Meuse river basin districts within Luxembourgish territory. Public water supply and wastewater treatment are the responsibility of municipalities and associations of municipalities (*syndicats*).

Water resources

Luxembourg extends partly over two international river basin districts of the Rhine and the Meuse, both of which are transboundary. The country has 2 855 m³ of renewable freshwater per capita, which is less than most OECD member countries. Slightly more than half of these abstractions come from groundwater sources (51%), all of which are in good quantitative status, while the remainder comes from surface water (Upper-Sûre Lake) (EC, 2019; OECD, 2019g). Per capita abstractions (78 m³/capita/year) are well below the OECD average (717 m³/capita/year) due to the low share of the agricultural sector. They fell by 17% between 2010 and 2016 as a result of the economic slowdown (lower abstractions in the metal industries) and technological improvements in distribution networks (repair of leaks in sanitation facilities and household appliances) (Figure 1.16). Projections indicate a future increase in water consumption, due to population growth, continued and sustained economic growth, and the expected increase of irrigation. These pressures could be critical during periods of high consumption (between June and October), as well as in the medium term (2030-40).

As the natural groundwater recharge has been largely deficient in the three years between 2016-18, aquifer levels are rather low. To ensure the security of drinking water supply and its sustainability, the government set a strategy based on three axes. First, delimited protection zones were set up around water catchments used for consumption to protect water resources. Second, water conservation projects for major infrastructure projects (construction of housing estates) will draw on new technologies that allow water to go through several cycles. For example, drinking water can be used for toilets before being discharged into wastewater. These projects will be accompanied by awareness campaigns and support for saving measures in the industrial, agricultural and household sectors. Third, additional resources from both surface and groundwater will be captured and rendered potable.

Figure 1.16. Water abstractions for drinking water supply are increasing



Source: OECD (2019), "Water: Freshwater abstractions", *OECD Environment Statistics* (database).

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Water quality

Only 3% of natural surface water bodies were of "good ecological status" in 2015, placing Luxembourg among the worst performing countries in the EU (EEA, 2019d). This is due to poor hydro-morphological quality (interrupted ecological continuity, stabilised banks or bottoms), as well as a high content of nutrients, especially nitrogen. None of the surface water bodies achieved in "good chemical status". These poor results are mainly related to ubiquitous substances. If these substances are not considered, 99 of 110 bodies of surface water achieve "good chemical status" according to the environmental quality standards of Directive 2008/105/EC. Luxembourg was granted an extension of its deadline for achieving its objectives to 2027. The poor results can be explained by delays in implementation of management plans, as well as lack of coherence between water and agricultural policies. In addition, the wastewater discharge tax is relatively low. It does not sufficiently encourage water service providers to reduce the pollutant load of discharged water (Chapter 3). As Luxembourg lies on the dividing line between the Rhine and Meuse river basins, it has mostly small to very small rivers. Each additional discharge thus represents a potential pressure. With a growing population, the loads discharged by wastewater treatment plants are also an increasing pressure. To compensate for this effect, discharge permits for the plants are restrictive, which leads to high construction and operating costs.

As regards groundwater, half of water bodies were classified as being in "poor chemical status" due to high concentrations of nitrates and metabolites of plant protection products. On the other hand, the 11 bathing sites enjoy excellent water quality (EC, 2019b).

The whole of Luxembourg is subject to measures to ensure compliance with the Nitrates Directive (91/676/EEC). To protect water catchments for drinking water supply, 23 Grand-Ducal regulations have been published from 2014 and 29 draft Grand-Ducal regulations are in the regulatory process. Among these projects is the protection zone around the Upper-Sûre Lake. This lake is Luxembourg's main drinking water reserve and accounts for almost half of the water used for human consumption. However, nitrate pollution from both intensive livestock and dairy farming remains a problem (EC, 2019b), particularly due to slow implementation of measures.

Water supply and sanitation

The entire resident population is connected to an urban public sewerage system (OECD, 2019h). In 2017, 75% of the population benefitted from a tertiary ("advanced") treatment and 22% from a secondary treatment. Since 2011, major investments have helped modernise and extend the wastewater treatment plant network. In January 2018, these investments made it possible to close the infringement procedure opened in 2011 by the EC to the Court of Justice of the EU due to the country's failure to comply with the directive. As six treatment plants serving agglomerations of more than 10 000 inhabitants did not comply with obligations in the directive, Luxembourg was sentenced in 2013 to pecuniary penalties. In addition, the government planned to "modernise existing treatment plants with special focus on the treatment of micropollutants and the elimination of microplastics". By 2023, the work to equip the 13 main wastewater treatment plants (87% of urban water) with a fourth level of treatment will have started. Approximately 117 storm basins and about 150 km of sewer/mixed sewerage collectors have been constructed since 2010 (EC, 2019b).

Drinking water is of very good quality: Luxembourg has a high rate (99-100%) of compliance with the microbiological, chemical and other parameters set out in the Drinking Water Directive. Nevertheless, due to pollution by plant protection products (mainly herbicides and their metabolites) and nitrates, many catchments used for human consumption had to be taken out of service. It is estimated that quantities of water that could supply nearly 75 000 people are unusable. This corresponds to 12% of the annual volume of groundwater exploited for drinking water supply. Since 2015, some active substances responsible for a deterioration in water quality have been banned in water protection zones around catchments used for drinking water supply.

Luxembourg should consider a more rigorous preventive approach to guarantee the security of drinking water supply in the long term. For example, it could ban plant protection products in sensitive areas. The country's economic and demographic growth also requires investment in drinking water infrastructure and efficient management of distribution networks.

Recommendations on the management of emissions (air and climate), waste and water

Climate and energy

- Adopt the climate framework law as soon as possible; ensure that it includes binding GHG reduction targets and adequate institutional review systems and stakeholder consultation mechanisms; consider incorporating the commitments of the Paris Agreement on financial flows, as well as carbon pricing, into the law.
- Develop scenarios for achieving the 2030 renewable energy and energy efficiency targets, bearing in mind air quality and climate objectives; specify the contribution of each sector to these objectives, in particular the contribution of current and planned transport measures to reducing road fuel consumption.
- Develop a framework for monitoring the implementation of the Climate Change Adaptation Strategy; ensure that climate change impacts and resilience are duly taken into account in environmental impact assessment (EIA) and strategic environmental assessment (SEA) procedures; include climate risks in insurance products.

Waste and materials management

- Continue implementing the national WRMP; step up efforts to increase the recycling rate of organic, plastic, paper and cardboard waste and to better exploit the stocks of materials in mixed municipal waste; expand the types of products covered by extended producer responsibility: tyres, coffee capsules, furniture, etc.
- Step up efforts to introduce harmonised pricing for municipal waste management throughout the country, taking into account the actual amounts of waste to be disposed of, and encourage municipalities to better co-operate and co-ordinate their actions.
- Adopt a circular economy strategy that sets out the responsibility of each ministry and stakeholder and establishes an implementation roadmap; seek synergies with the development of environmental technologies and green public procurement (GPP); establish a platform for businesses, banks and other stakeholders to meet and co-ordinate their actions.

Water management and agricultural inputs

- Accelerate the implementation of measures to preserve and improve water quality and continue to provide adequate financial and human resources; revise the wastewater discharge tax to strengthen its incentive function; secure the supply of drinking water by applying a more rigorous preventive approach, for example by banning phytopharmaceuticals in sensitive areas.
- Improve the coherence and integration of environmental and agricultural policies; assess the economic and environmental effectiveness of agricultural subsidies; consider introducing taxes or bans on fertilisers and pesticides to help reduce their impact on water and soil quality, biodiversity and human health; encourage the adoption of sustainable agricultural practices by updating the guide on good agricultural practices.

Notes

¹ This includes electricity exchanges.

² The EU's Renewable Energy Directive allows Member States with an abundant and profitable supply of renewable energy to help other countries meet their targets. These agreements stipulate that Estonia and Lithuania will each transfer a certain amount of surplus renewable energy to Luxembourg between 2018 and 2020.

³ Excluding emissions from the land use, land-use change and forestry sector.

⁴ The EU ETS is based on a “cap and trade” principle. A cap (which progressively decreases) is set to limit the total amount of certain GHGs that can be emitted by installations covered by the mechanism.

⁵ These are housing, energy, forestry, infrastructure, crisis management, land-use planning, agriculture, health, biodiversity, tourism, urban areas, water management and the economy.

⁶ Recovery here includes recycling and energy recovery (including incineration with energy recovery).

⁷ The Greater Region is the geographical area comprising Luxembourg, the Walloon Region in Belgium, Lorraine in France and two German states (Saarland and Rhineland-Palatinate).

⁸ The strategic study of the 3rd industrial revolution for the Grand Duchy of Luxembourg (2016), which explores future opportunities for economic development, suggests a transition towards a 100 % sustainable and organic agriculture by 2050.

⁹ Vulnerable, Endangered and Critically Endangered categories of the International Union for Conservation of Nature.

¹⁰ The Water Framework Directive (2000/60/EC); the Floods Directive (2007/60/EC), the Groundwater Directive (2006/118/EC); the Bathing Water Directive (2006/7/EC), the Drinking Water Directive (98/83/EC); the Urban Waste Water Treatment Directive (91/271/EEC); the Nitrates Directive (91/676/EEC).

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