2017

ESTONIA'S SEVENTH NATIONAL COMMUNICATION

Under the United Nations Framework Convention on Climate Change

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Estonia
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Forword

I am pleased to present Estonia's 7th national report on the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) that gives an overview of main developments and activities with regard to Estonia's efforts to reduce greenhouse gas emissions. The report has been prepared in collaboration with Estonian government agencies and experts from scientific and research institutions.

Climate change has become one of the defining issues of our time. It is a global threat that the international community must address together through collaboration and concerted efforts. For Estonia, this has provided an opportunity to choose a developmental pathway that offers additional value, while also mitigating negative environmental impacts and effects on human health.

In December 2015, Estonia was among the 195 countries that signed the Paris Climate Agreement that aims to keep the increase in global average temperature to well below 2 °C above pre-industrial levels. The Paris Agreement is a landmark achievement in stepping up the joint response of the international community and for accelerating the global transition to a low-carbon and climate resilient future.

Compared to 1990 levels, Estonia has managed to reduce its total greenhouse gas emissions by 55.3%. Pursuant to the Kyoto Protocol adopted in 1997, Estonia committed to reduce its greenhouse gas emissions from 2008 to 2012 (1st commitment period) by 8% compared to 1990 levels. At the 2012 UN climate change conference, the Parties adopted the Doha Amendment to the Kyoto Protocol, that stipulates emission reduction targets for the next period (2013–2020), committing Estonia, together with other EU Member States, to reduce their greenhouse gas emissions by 20%. In order to enter into force, the Doha Amendment must be ratified by 144 Parties to the Kyoto Protocol. Estonia finished the national ratification process of the Doha Amendment already in 2015 and has thus began working towards the emissions reduction target set for the 2nd commitment period of the Kyoto Protocol. Estonia deposited the instruments of ratification on 21 December 2017 together with the EU

In 2015, the energy sector was responsible for 87.93% of Estonia's greenhouse gas emissions. The majority of energy emissions are due to extensive use of fossil fuels in the production of heat and electricity. In October 2017, the Estonian Government adopted the Estonian Energy Development Plan until 2030 that aims to reduce greenhouse gas emissions in the energy sector by 70% compared to 1990 levels, while also increasing the share of renewable energy sources in final energy consumption to 50%.

In April 2017, the Estonian Government adopted the General Principles of Climate Policy until 2050 that sets forth the long-term vision for Estonia's climate policy, national targets, and sectoral policy guidelines. Estonia's long-term goal is to transition to a low-carbon economy, a comprehensive process that entails the gradual transformation of the economy and the energy system into a more resource efficient, productive and environmentally sustainable model. By 2050, Estonia aims to reduce its greenhouse gas emissions by 80% compared to 1990 levels. As a result, Estonia's greenhouse gas emissions should decrease from 18 million tons in 2015 to approximately 8 million tons CO_2 equivalent by 2050. Initial impact assessment has confirmed that these targets are achievable and will bring about positive effects not only for the environment but also for the economy and Estonia's energy security.

In March 2017, the Estonian Government adopted the Climate Change Adaptation Development Plan until 2030, together with relevant implementation measures, with a view to increasing Estonia's readiness and capacity for adaptation at the national, regional and local levels.

In the future, Estonia will continue its efforts to fulfill its international commitments by implementing relevant policy measures and contributing actively at the global level.

Minister for the Environment

Siim Kiisler

Tallinn, December 2017

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Glossary

A	Afforestation
AAU	Assigned Amount Units
AEA	Annual Emission Allocation
AWMS	Animal waste management systems
BACC	BALTEX Assessment of Climate Change for the Baltic Sea Basin
BAT	Best available technologies
boe	Barrels of oil equivalent
BREFs	Reference documents for BATs
BSN	Baltic Science Network
BSRN	Baseline Surface Radiation Network
CAP	Common Agricultural Policy
CERs	Certified Emissions Reductions
CF	Cohesion Fund
CH_4	Methane
CHP	Combined heat and power
CMIP	Coupled Model Intercomparison Project
CNG	Compressed natural gas
CO_2	Carbon dioxide
COP21	United Nations Climate Change Conference in Paris in 2015
COPERT	European road transport emission inventory model
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CRF	Common Reporting Format
CSEUR	The Consolidated System of EU Registries
D	Deforestation
DES	Data Exchange Standard
DJF	Winter (December, January, February)
EC	European Commission
EEAP2	Second Energy Efficiency Action Plan of Estonia
EEDP 2030	Estonian Energy Development Plan until 2030

EEIC	Estonian Environment Information Centre
EERC	Estonian Environmental Research Centre
EFDP 2020	Estonian Forestry Development Programme until 2020
EFN	Estonian Fund for Nature
EGM	Estonian Green Movement
EIC	Environmental Investment Centre
EMEP	European Monitoring and Evaluation Programme
EMHI	Estonian Meteorological and Hydrological Institute
EEDP 2030+	Estonian Energy Development Plan until 2030
EPBD	Energy performance of buildings
eq	Equivalent
ERDF	European Regional Development Fund
ERDP	Estonian Rural Development Plan
ERR	Estonian Public Broadcasting
ERUs	Emission Reduction Units
ESD	Effort Sharing Decision
ESTEA	Estonian Environment Agency
ETS	Emissions Trading System
EU	European Union
EUA	European Emission Allowances
EULS	Estonian University of Life Sciences
EUR	European Euro
EUTL	European Union Transaction Log
FM	Forest management
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEO	Group on Earth observations
GHG	Greenhouse gas
GIS	Green Investment Scheme
GLOBE	Global Learning and Observations to Benefit the Environment

GPCP 2050	General Principles of Climate Policy until 2050
GSN	GCOS Surface Network
GWP	Global warming potential
HFC	Hydrofluorocarbon
HWP	Harvested wood products
ICAO	International Civil Aviation Organization
ICT	Information and Communications Technology
IET	International Emissions Trading
IPCC 2006 GL	Guidelines for National Greenhouse Gas Inventories
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
ITL	Independent Transaction Log
ITU	International Telecommunication Union
JI	Joint Implementation
JJA	Summer (June, July, August)
KP	Kyoto Protocol
LEAP	Long Range Energy Alternatives Planning System
LULUCF	Land use, land-use change and forestry
MAC	Mobile air conditioners
MAM	Spring (March, April, May)
MEPC	Marine Environment Protection Committee
MO	International Maritime Organization
MoE	Ministry of the Environment
MoEAC	Ministry of Economic Affairs and Communications
MoER	Ministry of Education and Research
MoI	Ministry of the Interior
MoRA	Ministry of Rural Affairs
MSW	Municipal solid waste
N_2O	Nitrous oxide
NAP	National Allocation Plan

NC	National Communication
NDC	Nationally determined contributions
NFI	National Forest Inventory
NGO	Non-governmental organisation
NIR	National Inventory Report
NMVOC	Non-methane volatile organic compounds
NREAP	National Renewable Energy Action Plan
NWMP	Estonian National Waste Management Plan
ODS	Ozone-depleting substances
PaM	Policies and Measures
Peipsi CTC	Peipsi Centre for Transboundary Cooperation
PFCs	Perfluorocarbons
QA	Quality assurance
QC	Quality control
R	Reforestation
R&D	Research and Development
RCP	Representative Concentration Pathway
RES	Renewable energy sources
RMK	State Forest Management Centre
RMUs	Removal Units
SEN analysis	Sensitivity scenario
SF_6	Sulphur hexafluoride
SHC	Solid heat carrier
SMEAR	Station for Measuring Ecosystem-Atmosphere Relations
SON	Autumn (September, October, November)
SRES	Special Report on Emissions Scenarios
TUT	Tallinn University of Technology
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

UNFCCC	United Nations Framework Convention on Climate Change
WAM	With Additional Measures
WM	With Measures
WMO	World Meteorological Organization

Executive summary

1.1. National circumstances relevant to greenhouse gas emissions and removals

This sub-chapter provides an overview of different topics that describe Estonia's national circumstances and historical trends which are covered in Chapter 2, incl., among other topics, government structure, energy, transport, population, geographical, climate and economic profile of Estonia.

The total area of Estonia is 45,339 km^2 and on 1 January 2017, the population of Estonia was 1.32 million, it follows that population density is 30.3 inhabitants per km^2. In 2016, 68.5% of the population lived in urban areas. With regard to the developments of the urban system in the last decade, urban expansion is occurring in Estonia, which is resulting in the weakening of the position of most of the county towns and small towns in the settlement system. The growing model of urban areas, especially in Tallinn and Tartu, is characterised by suburbanisation, as well as remote urbanisation in the form of increasing commuting related to employment, education, and services from further-away areas.

In terms of its biological diversity, the nature of Estonia is quite outstanding. Almost half of the land is covered by forests (ca 51%). The area of agricultural land in Estonia has dropped from 1,458,400 hectares in 1990 to 995,000 hectares in 2016. Utilised agricultural land covers 30.5% and the bogs cover 5.5% of the territory. Very few countries in Europe can afford to have more than 15% of their land under nature protection. In total, 572 species are protected by law in Estonia, while 18% of land is under legal protection. In addition, the country is illustrated by a very flat coastline and there are a number of islets (ca 2,222). Also, a large number of lakes and rivers can be found in Estonia.

Estonia's biodiversity is caused by differences in the climatic conditions. Country's climate, in turn, is mostly influenced by its geographical position. Local climatic differences are due to, above all, the neighbouring Baltic Sea, which warms up the coastal zone in winter and later, especially in spring, has a cooling effect. Since the middle of the last century, the average annual temperature has increased slightly faster in Estonia compared to the world as a whole. The warming trend of the winter, especially January, is the clearest. The increase in the average annual precipitation in the second half of the 20th century has been significant in Estonia. The ice and snow cover period has shortened.

The economy of Estonia is small, but open and flexible. As the market in the country is rather small for many enterprises, the volume of the export of products and services amounts to 90% of the Estonian gross domestic product (GDP). Estonian export is diverse, the most important economic partners are Finland, Sweden, Latvia, and Russia. According to Statistics Estonia, in 2016 the annual GDP increased by 1.7%. In 2017–2018 Estonian economic growth is expected to stabilise at around 3%. The growth of Estonian GDP has been successful during the last 20 years despite the fact that Estonian greenhouse gas (GHG) emissions (without Land use, land use change and forestry sector) have remained at the level of approximately 20,000 kt of CO_2 equivalent (eq.) in the last decade.

In 2017, added value from the industrial sector formed 14.5% of Estonian economy, which is similar to the EU average. Compared to 2010, the volume of the Industrial sector has increased by approximately 38% and compared to 2005, it has almost doubled in current prices. The growth of processing industry has for many years mainly been led by the wood industry and higher added values are generated by the appliance and metal industries of increasing production volumes. Estonian economy is export-oriented and the share of export forms over 50% of the processing industry and it started to increase after 2013. Approximately 70% of the output of the processing industry was exported in 2017, most of which was sold in the EU market, mainly in the Nordic countries. Thus, a stronger growth of the European economy can greatly benefit the Estonian processing industry.

Estonia is among the EU countries that are least dependent on energy imports. Thanks to the use of oil shale and increasing use of renewable fuels, Estonia can largely meet the energy requirements of the country. Estonia ranks among the top EU Member States in terms of primary energy production per capita. In 2015, the production of electricity in Estonia totalled 10,400 GWh – 16% less than in 2014. The decline in the electricity production was caused by a 46% increase in import compared to 2014. 15.6% of the electricity generated in 2015 came from renewable sources. Historically, Estonia has almost always been a net exporting country. In 2015, 6.37 TWh (61.3%) of produced electricity was exported to Latvia and Finland. The main fuels imported to Estonia include natural gas, liquid fuels, coal, and coke. Natural gas imports have gradually dropped, as the consumption has continuously been decreasing.

Estonia's transport network consists of the infrastructure needed for road, rail, water, and air traffic. The total length of national roads at 1 January 2017 was 16,594 km, in addition to this, 87.6 km of temporary ice roads in the case of suitable weather conditions. In Estonia, the main form of public transport used by passengers is the bus, followed by the train. Compared to 2012, the number of passengers travelling by train has increased significantly – by 57.1%, and the volume of freight decreased by 16.4% in 2016. A steady decline in freight transport can be observed, with the lowest level of the last fifteen years reached in 2016. The lower volume of goods being transported by railway, is primarily caused by the decreasing transit volumes between Estonia and Russia since 2011. This is also one of the reasons why the GHG emissions in the subcategory of railway transport have decreased by 35.3% in the same period. Road transport has, however, been growing steadily after the end of the economic downturn and reached the pre-crisis level in 2016.

Any consumption assumes the producing of waste on some level. In order to keep the environment decent and save natural resources, the producing of waste must be avoided as much as possible, also the existing waste must be collected and managed in an environmentally friendly way. In 2015, Estonia had 5 functioning municipal solid waste (MSW) landfills which are fully conformed to environmental and technical requirements and standards and are capable to serve more than one service area. MSW generation makes up just 1.2% of total waste generation. Estonia continuously produces a large amount of waste incl. hazardous waste from the oil shale industry. New and better solutions for reducing and recycling waste are also being explored in this area.

1.2. Greenhouse Gas Inventory information

Estonia's total GHG emissions in 2015 were 18,040.48 kt CO_2 eq. (with indirect CO_2), excluding net emissions from Land use, land-use change and forestry (LULUCF). Emissions decreased by 55.3% in 1990–2015 (see Table 1.1) but increased around 5% between 2010 and 2011. Estonia's Kyoto Protocol (KP) target was to reduce GHG emissions by 8% during the period of 2008–2012 compared to the level of 1990. Estonia has met its commitments for the first commitment period (2008–2012) under the KP.

The Energy sector is by far the largest producer of GHG emissions in Estonia. In 2015, the sector accounted for 87.9% of Estonia's total GHG emissions. The second largest sector is Agriculture, which accounted for 7.4% of total emissions in 2015. Emissions from the Industrial processes and product use (IPPU) as well as Waste sectors accounted for 2.9% and 1.8% of total emissions, respectively.

The LULUCF sector, acting as the only possible sink of GHG emissions in Estonia, plays an important role in the national carbon cycle. In 2015, the LULUCF sector acted as a CO_2 sink, with a total uptake of 2,359.2 kt CO_2 eq. Uptake of CO_2 has increased by 36% compared to the base year (1990) and by 34% compared to the previous year (2014).

Table 1.1. GHG emissions and removals by sector in 1990, 1995, 2000, 2005 and 2010–2015, kt CO_2 eq.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
Energy	36,397.4	17,855.2	14,974.9	16,787.4	18,939.3	18,887.8	17,496.6	19,181.2	18,691.2	15,863.9
Industrial processes and product use (incl. indirect CO_2)	965.7	637.4	697.6	726.4	537.6	660.5	904.4	996.0	707.7	512.9
...Indirect CO_2 (from NMVOCs reported under IPPU 2.D.3 Solvent use and road paving with as-phalt) *	20.9	20.6	19.2	19.1	18.7	16.5	13.5	12.9	14.0	14.6
Agriculture	2,669.7	1,326.1	1,078.0	1,129.1	1,192.4	1,218.4	1,307.4	1,303.5	1,341.9	1,337.6
Waste	369.9	397.7	562.8	513.9	474.2	416.1	409.6	375.5	340.3	326.1
Total (excl. LULUCF incl. indirect CO_2)	40,402.7	20,216.4	17,313.3	19,156.6	21,143.5	21,182.7	20,118.1	21,856.3	21,081.1	18,040.5
Land use, land-use change and forestry	–1,734.7	–1,807.2	–3,396.7	–2,690.9	–1,924.4	–2,078.6	–2,083.6	–1,487.3	–17,54.9	–2,359.2
Total (incl. LULUCF and indirect CO_2)	38,668.0	18,409.2	13,916.6	16,465.9	19,219.1	19,104.1	18,034.4	20,369.0	19,326.2	15,681.3

* Indirect CO_2 emissions are calculated from NMVOCs reported under Industrial processes and product use 2.D.3 (CRF) Solvent use and road paving with asphalt.

In 2015, the main GHG in Estonia was CO_2, accounting for 88.1% of the total GHG emissions (with indirect CO_2 and without LULUCF) expressed in CO_2 eq., followed by CH_4 with 5.9% and N_2O with 4.8%. Fluorinated gases (the so-called F-gases) collectively accounted for about 1.2% of overall GHG emissions.

Emissions of CO_2 (with indirect CO_2) decreased by 57.2% from 37,069.2 kt in 1990 to 15,885.4 kt in 2015. Especially decreased the CO_2 emissions from the Energy subsector Public electricity and heat production, which is a major source of CO_2 in Estonia.

Methane (CH_4) is the second most significant contributor to GHG emissions in Estonia after CO_2. Emissions of CH_4 decreased by 44.5% from 1,909.6 kt CO_2 eq. in 1990 to 1,059.1 kt CO_2 eq. in 2015. The downturn was especially noticeable in the Agriculture sub-sector Enteric fermentation, which is a major source of CH_4 in Estonia.

Emissions of N_2O decreased by 38.3% from 1,423.9 kt CO_2 eq. in 1990 to 871.0 kt CO_2 eq. in 2015, especially N_2O emissions from the Agriculture sub-sector Agricultural soils, which is the main contributor of N_2O emissions in Estonia.

Emissions of F-gases (HFCs, PFCs and SF_6) increased from 0 kt CO_2 eq. in 1990 to 225.1 kt CO_2 eq. in 2015. Especially increased the HFC emissions from Refrigeration and air conditioning, which is a major source of halocarbons in Estonia. A key driver behind the growing emission trend in the Refrigeration and air conditioning sector has been the substitution of ozone depleting substances with HFCs.

The Ministry of the Environment (MoE) is the national entity with overall responsibility for organising and coordinating the compilation of GHG inventory reports and submitting them to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat and the European Commission. The inventory is produced in collaboration between the MoE, Estonian Environmental Research Centre (EERC) and Estonian Environment Agency (ESTEA). The EERC is responsible for preparing the estimates for the Energy, IPPU, Agriculture and Waste sectors. The Data Management Department of the ESTEA is responsible for LULUCF and KP LULUCF estimates. Sectoral experts collect activity data, estimate emissions and/or removals, implement quality control (QC) procedures and record the results, fill in sectoral data to the Common Reporting Format (CRF) Reporter and prepare the sectoral parts of the National Inventory Report (NIR). These experts are also responsible for archiving activity data, estimates and all other relevant information according to the archiving system.

The UNFCCC, the KP and the EU greenhouse gas monitoring mechanism require Estonia to submit annually a NIR and CRF tables. The annual submission contains emission estimates for the years between 1990 and the year before last year. The methodologies, activity data collection and emission factors are consistent with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006 GL). The quality requirements set for annual inventories are continuous improvement, transparency, consistency, comparability, completeness, accuracy and timeliness.

1.3. Policies and Measures

The Parliament is the highest legislative body in Estonia. The major documents on environment-related issues are either passed by the Parliament (Riigikogu) or adopted by the Government. The relevant measures can be taken at the national and/or local level. The Government of Estonia is the supreme executive body and the MoE is the highest executive body responsible for carrying out national environmental policy. The Ministry of Economic

Affairs and Communications is responsible for energy-related issues, incl. energy efficiency and conservation, transport and the use of renewable sources in the energy sector. The Ministry of Rural Affairs advises the Government in the field of agriculture and rural life. Some responsibilities of the Ministry of Finance include matters important to environmental management – taxation, use of state budget funds etc. All ministries are in charge of national development plans and programmes.

Estonia signed the KP to the UNFCCC on 3 December 1998. The Protocol was ratified by the Estonian Parliament in September 2002. Estonia has fulfilled its emission reduction commitment under the KP which was set to reduce the emissions by 8% in the period of 2008–2012 compared to 1990. Parties to the KP adopted an amendment to the KP by decision 1/CMP.8 in accordance with Articles 20 and 21 of the KP held in Doha, Qatar, in December 2012. Estonia finished the national ratification process of the Doha Amendment the first half of 2015 and deposited the instruments of ratification on 21 December 2017 together with the EU. The second commitment period is consistent with the 2009 climate and energy package of legislation and reflects the package's reduction measures at EU and member state level to gradually transform Europe into a low-carbon economy and to increase energy security. The inclusion of the effort sharing decision (ESD) within the EU's climate and energy package ensures that the abatement potential from non-ETS (emission trading system) sectors contribute to the delivery of the EU-wide target of reducing GHG emissions by 20% below 1990 levels by 2020. For Estonia, the GHG emissions from non-ETS sectors have to be limited at least by 11% by the end of the period of 2013–2020 compared to 2005. For the period up to 2030, the European Council set out in its October 2014 conclusions an EU-wide binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990. The non-ETS sectors will need to reduce emissions by 30% by 2030 compared to 2005, continuing the methodology and elements of the ESD, incl. a linear trajectory of annual targets and flexibility instruments to help achieve them. For that purpose, the Commission introduced a proposal for a regulation on the 20 July 2016, which is currently under negotiation. According to the proposal, Estonia would have a target of -13% compared to 2005.

The Government of Estonia has approved a strategy for moving towards long-term emission reduction target (General Principles of Climate Policy until 2050, GPCP 2050) which is set to reduce the emission of GHG by 80% by 2050 in comparison with the emission levels of 1990. GPCP 2050 is a vision document that sets a long term GHG emissions reduction target and policy guidelines for adapting to the impact of climate change or ensuring the preparedness and resilience to react to the impact of climate change. Principles and guidelines in the document have to be taken into account when renewing and implementing the cross-sectoral and sectoral strategies and national development plans. Estonia will be transformed into an attractive environment mainly for the development of innovative technologies, products and services reducing the emission of GHG. In addition, the export and global implementation of such technologies, products and services shall be facilitated for the resolution of global problems.

Sectoral policies and measures used for calculating GHG emission projections (Chapter 5) are presented in Chapter 4.3. Energy sector is the largest producer of GHG emissions and therefore the strategies regulating the sector are under closer attention. The Government of Estonia approved the Estonian Energy Development Plan until 2030 (EEDP 2030+) on 19 October 2017. The development plan is aimed at ensuring an energy supply that is available to consumers at a reasonable price and effort and with an acceptable environmental condition, while observing the terms and conditions established in the long-term energy and climate policy of the EU.

1.4. Projections and total effect of policies and measures, and supplementarity relating to Kyoto Protocol mechanisms

Projections in the Seventh National Communication are given for all GHGs considered in UNFCCC and KP, presented in the following sectors (CRF categories): Energy (incl. transport); IPPU; Agriculture; LULUCF; and Waste.

Projections of GHG emissions have been calculated for the period of 2015–2035. 2014 has been used as a reference year. Activity data for the year 2015 is in accordance with the 2017 National GHG Inventory (submitted to the UNFCCC on 15 April 2017).

Methodology used for GHG projections under each sector can be found in Chapter 5.5. There are two projection scenarios. The *With Measures* (WM) scenario evaluates future GHG emission trends under current policies and measures. In the second scenario, a number of additional measures and their impact are taken into consideration in forming the basis for the *With Additional Measures* (WAM) scenario.

Sector specific projections can be found in Chapter 5.2. Estonia's total GHG emissions are expected to decrease by about 22.1% in the WM scenario (without LULUCF) and by about 32.4% in the WAM scenario (without LULUCF) by 2035 compared to the base year of 2014 (Figure 1.1). GHG emissions in the WM scenario (with LULUCF) are expected to decrease by about 22.7% and in the WAM scenario (with LULUCF) by about 34.0% by 2035 compared to the base year of 2014.

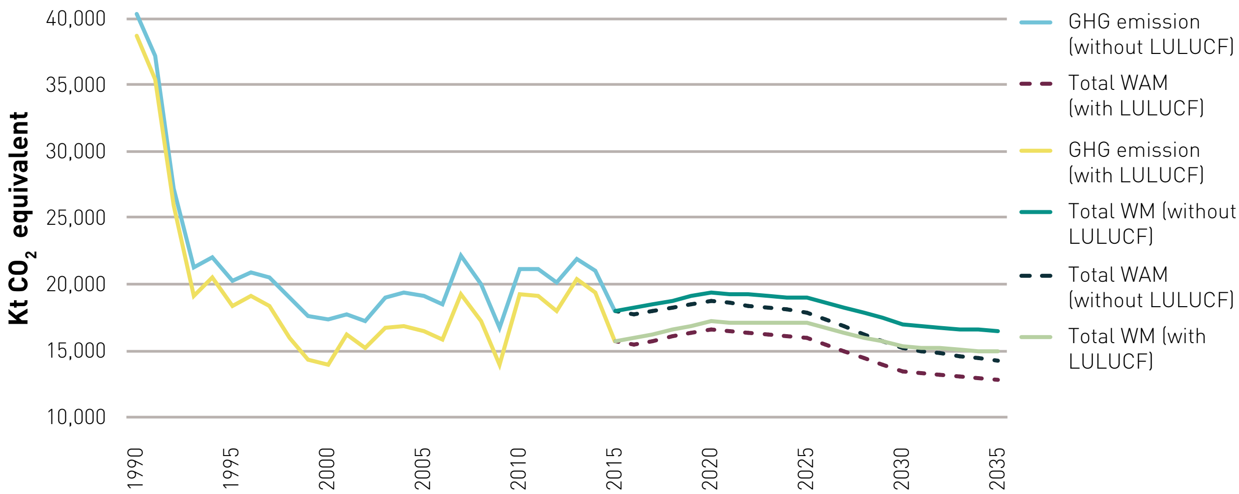

Figure 1.1. Total GHG projections until 2035, kt CO_2 eq.

The main difference in the results of the WM and WAM scenarios is related to measures foreseen to be implemented with regard to energy efficiency and the use of biofuels. This will lead to smaller final consumption of energy in the WAM scenario compared to the WM scenario.

1.5. Vulnerability assessment, climate change impacts and adaptation measures

Amidst rapid environmental changes, it is no longer rational to rely on the spontaneous adjustment of the society and economy to the changes in the environment. The potential impacts of climate change and the vulnerability vary greatly by regions, but adaptation must be based on the location and on territorial risk assessments. The economies, which are able to adjust to the changed conditions more rapidly, achieve a significant competitive advantage.

In Chapter 4, the following possible climate change impacts in the 21st century are briefly approached: health and rescue capability; land use and planning; natural environment; bioeconomy; economy; society, awareness and cooperation; infrastructure and buildings; energy and security of supply.

In Estonia, climate change will cause the following problems:

- the spread of new pathogens and increasing health disorders;
- increasing flooding risk and the pressure for building relocation;
- changes in hydrological cycle and vegetation and the spread of alien species;
- unfrozen and waterlogged forest land in the winter and new plant pests;
- transient effects of global trends on the economy;
- immigration from global migration;
- additional requirements on infrastructure and building durability;
- changes in seasonal energy consumption.

In 2015, an overview report of the climatic changes in Estonia, which occurred in the course of the last century, as well as of the projections and assessments of the future climate in Estonia until 2100 was compiled. The overview formed the basis for the assessment of the sectors influenced by the atmospheric condition in drafting the national development plan for adaptation to the impacts of climate change. In the course, the sectoral impacts of climate change in Estonia and vulnerability were thoroughly assessed in the period of 2014–2016. Thereat, the natural and anthropogenic climate changes, regional differences, as well as socio-economic processes were observed. This enables planning and managing the area of adaptation to the impacts of climate change through a single strategy document both in the short (up to 2030) as well as in the long (up to 2100) perspective, with the overall aim to decrease vulnerability to climate change in Estonia and to achieve the preparedness and ability required to cope with the impacts of climate change at the local and national level with the help of the operational framework.

Adaptation to climate change and the respective measures are slowly, but surely becoming a horizontal topic in Estonia, which ensures the inclusion of all relevant sectors and administrative levels in the adaptation measures. For example, the preparation of local governments for climate change is supported by the continuous development of environmental and weather monitoring systems. Several local governments have taken the risks arising from climate change into consideration in drawing up their local development plans, as well as in the renovation of water and sewerage or other lines, and in drawing up detailed and general plans.

1.6. Financial resources and transfer of technology

Although Estonia is not one of the Parties listed in Annex II to the Climate Convention, and thus is not obliged to fulfil the commitments under Articles 4.3, 4.4 and 4.5 of the Convention, Estonia has contributed to climate finance voluntarily.

Estonia intends to continue to contribute to development cooperation according to its capabilities. The general goal of Estonia's development cooperation is to contribute to the eradication of world poverty and to attain the Sustainable Development Goals. As the sustainable use of the environment and natural resources is indispensable to achieve sustainable development goals, one of the goals of Estonian development cooperation is to contribute to finding environmentally sustainable solutions in partner countries as well as at the global level.

Estonia has been and will be supporting developing countries in the fight against climate change via bi- or multilateral channels under bi- or multilateral agreements. At COP21 United Nations Climate Change Conference, Estonia pledged to contribute 1 million euros annually until the year 2020 for financing international climate cooperation by supporting environmentally sustainable development in developing countries through contributing to bilateral projects, multilateral organisations and regional funds. The main focus is planned to be on climate change mitigation and adaption, for example by supporting renewable energy, energy efficiency, sustainable transport and industry efficiency projects, as well as by strengthening administrative capacity regarding climate action or supporting solutions for adapting to climate change. One of the measures in the State Budget Strategy 2017–2020 to be funded by the revenues from GHG emissions allowance trading system in 2013–2020 is Estonia's contribution to international climate change cooperation.

To date, funding from the private sector has been mobilised into domestic climate related activities rather than climate cooperation. In the future, Estonia is planning to involve the private sector in financing climate cooperation in developing countries.

Estonia has recently given assistance to Afghanistan and the Small Island Developing States as for developing country parties that are particularly vulnerable to climate change. The MoE of Estonia made a contribution of 1,605,008 euros to the United Nations Environment Programme (UNEP) for *Strengthening Climate Change Adaptation in Rural Communities, for Agriculture and Environmental Management in Afghanistan in 2012–2015*. The project was extended in 2014 with additional funding of 323,000 euros from Estonia and the activities were finished by the end of 2016. Estonia financed the Small Island Developing States by 100,000 euros via the project *Implementing the Climate Change Adaptation Component of the Satellite Communications Capacity, and Emergency Communications Solutions Project for the Small Island Developing States of the Pacific* carried out in 2014–2017 in cooperation with the International Telecommunication Union (ITU).

1.7. Research and systematic observation

Decisions related to Estonia's research and development policies are made by the Riigikogu on the basis of regulations and legal acts drafted by the Government of the Republic. The basis for the organisation of research and development (R&D) is established with the Organisation of Research and Development Act. The Ministry of Education and Research (MoER) is responsible for the planning, coordination, execution and monitoring of education and research policies; it also organises the evaluation of R&D institutions.

In 2014–2020, Estonia will base its R&D on the Research and Development and Innovation Strategy Knowledge-Based Estonia which sets an objective of applying the created potential for the benefit of Estonia's development and economic growth. More attention is paid on ensuring the progeny of researchers and internationalisation.

R&D is financed within the system of the MoER of the Republic of Estonia from the following resources: baseline funding, research funding, national research programmes, support for centres of excellence and doctoral studies, compensation of the expenses of R&D institutions. The competitiveness strategy Estonia 2020 sets a goal of increasing the funding of R&D activities to 3% of GDP by 2020. Such growth should mainly be supported by the private sector's increased financing of development activities.

The professionalism of Estonian researchers is acknowledged internationally. Although increasing foreign research funding is one of the objectives of Estonian research policy, it is not possible to achieve a significant growth, as Estonian researchers are already extensively included in international cooperation.

Estonian researchers study different aspects of climate, e.g. climate processes, climate system, paleoclimate, impacts of climate change, mitigation and adaptation technologies of climate change. They have been involved in modelling and predicting different future climate related aspects.

Research is also carried out to perform different parts of the national environmental monitoring programme. The national environmental monitoring programme is the responsibility of the ESTEA. The sub-programmes include climate-related fields, such as Meteorological and hydrological monitoring; Forest monitoring; Soil monitoring; Groundwater monitoring; Marine monitoring; Inland water bodies monitoring and Ambient air monitoring. In addition, research has done for improving the National Greenhouse Gas Inventory in Waste, LULUCF, Energy and Agriculture sectors. The main goal of the ESTEA's environmental monitoring is to forecast (through continuous monitoring and evaluation of environmental factors and environmental status) changes in environmental factors and statuses via a developed indicator system and forecasting models. In addition to the ESTEA, some other institutions also engage in environmental monitoring.

Estonia contributes to international cooperation in making systematic observations as well. Incl. others, Estonia is a member of the international Group on Earth Observations (GEO). The objective of the GEO is to create a Global Earth Observation System of System (GEOSS) for ensuring the sustainable development of humankind to improve the health and safety of humankind and to protect the global environment.

The weather service of the ESTEA fulfils the obligations of Estonian national meteorological service in accordance with its statutes and the recommendations of the World Meteorological Organisation (WMO). The ESTEA's weather service participates in WMO's climate programme, incl. the Global Climate Observing System (GCOS) as well as takes part in the work of many other international organisations.

1.8. Education, training and public awareness

The information about the public awareness of environment and climate change is available from *The survey of environmental awareness of Estonian citizens, The Eurobarometer survey on the attitudes of European citizens towards climate change and The survey on the values of the citizens of the Republic of Estonia*. Similarly to former years, Estonian citizens consider the problem of climate change smaller than other citizens of EU. About half of the population deems itself to be poorly informed about the influences of climate change. Still, the most people acknowledge the necessity of increasing the proportion of renewable energy. Moreover, Estonians have become more aware of environment and climate issues.

Estonian education system supports the teaching of sustainable development. Even the national curriculum of preschool institutions includes a field *The environment and I*. The national curriculum for basic schools and upper secondary schools includes the compulsory recurrent topic of Environment and sustainable development. The topic of climate is rare at the vocational educational institutions or at the institutions of applied higher education. At the level of higher education, one can study at different climate and climate change related courses. The MoE supports participation of schoolchildren in various extracurricular environmental programmes and environmental research work competitions, as well as various environmental education projects for schoolchildren by targeted financing.

In addition to formal education, several organisations all over Estonia are providing informal nature and environmental education. The problem here, however, is the lack of clearly established requirements for the study programmes provided in the field of environmental education and for the organisations providing the study programmes. The MoER and the MoE believe that the progress of rethinking both formal and informal education as education for sustainable development is not fast enough. The deficiencies concern the areas of teachers' training, low awareness of the heads of schools and lack of appropriate teaching aids. In the last few years, however, significant investments have been made in the environment and in education for sustainable development.

Official national climate information is shared on the website of the MoE at *http://www.envir.ee/et/kliima*. However, the wider public is mainly informed on climate-related issues through the media. Reporting of climate-related issues in the media has increased in connection with the Paris Agreement, thus the information about climate change is more easily available among society.

Different non-governmental organisations are important organisers of climate-related events and information sources. There are several climate-related environmental campaigns organised in Estonia, which are aimed at the public. The majority of the campaigns are directly focused on energy efficiency. The campaigns are often also related to healthy ways of mobility.

Every year, conferences and lecture series related to the environment are organised in various places all over Estonia, which are open for everyone interested. Several educational centres have been opened in Estonia where one can get information on climate change or take part in climate-related study programmes. More than 120 organisations in Estonia are providing informal environmental education study programmes for schoolchildren as well as others who are interested. Concluding from the numbers of climate related organisations or events one can say if people want to and know how to get information, then the accessibility to the environmental and climate educational programmes and its related activities is quite good among different age groups. Yet, the interest and awareness about these possibilities is quite low among Estonians.

Let's Do It Foundation has been active in international activities by organising cleanup actions. Now, the Foundation is organising the Let's Do It World Cleanup 2018. It has developed IT solutions for mapping the illegal dump sites. The European Parliament valued its activities by awarding Let's Do It Foundation with the European Citizen's Prize, in 2017. In addition, other organisations and schools that are participating at international educational cooperation projects are collaborating in international activities. Tallinn has been running for the title of the European Green Capital as it has tried to improve the sustainable development of the city.

II

National circumstances relevant to greenhouse gas emissions and removals

KEY DEVELOPMENTS

- **In Estonia, the average annual temperature has increased slightly faster compared to the world average, a clear winter warming trend can be observed, ice and snow cover period has shortened and the average annual precipitation amounts have increased.**
- **The population of Estonia is decreasing while urban expansion is continuing.**
- **The growth of the gross domestic product of Estonia has decelerated during the last years due to weak foreign demand.**
- **The volume of the industrial sector has increased by approximately 38% compared to 2010 and has almost doubled in current prices compared to 2005. The growth of processing industry has for many years mainly been led by the wood industry.**
- **The share of renewable energy in Estonia has gradually increased throughout the years, both in electricity generation and end consumption of energy. Nevertheless, the production volumes of shale oil have been growing steadily in recent years due to the construction of new factories.**
- **In transport sector, the number of passengers travelling by train and the usage of road transport has been growing in recent years, contrariwise, a steady decline in freight transport can be observed with the lowest level of the last fifteen years reached in 2016.**

2.1. Government structure

The institutional structure of the Estonian state is set out by the constitution, adopted in 1992. Estonia is a parliamentary democracy with the Riigikogu (the Estonian parliament) exercising supreme legislative power, the President of the Republic acting as the head of state and the Government of the Republic exercising executive power. The **Riigikogu** is the unicameral parliament of Estonia. Its main task is to fulfil the function of establishing normative acts. Members of the Riigikogu can submit inquiries to the Government of the Republic and its members, as well as several other high-ranking public officials.

The head of state of Estonia is the **President of the Republic** who is elected by the Riigikogu. If no candidate wins two thirds of the votes of the Riigikogu, the President is elected by an electoral college comprising members of the Riigikogu and representatives of local government councils. Estonia holds presidential elections every five years. The President proclaims the laws passed in the Riigikogu and signs instruments of ratification or denunciation of international agreements. The President represents Estonia in international relations, appoints Estonian diplomats, and receives the credentials of diplomats from other countries. Appointing the Prime Minister, other ministers, the president of the Bank of Estonia, and many other high-ranking public officials is also in their jurisdiction. Several advisory bodies operate under the President, incl. the Academic Advisory Board.

The **Government of the Republic** comprises the Prime Minister and the ministers. The government contains up to 15 members, incl. the Prime Minister. The Prime Minister determines the competency of the ministers in leading their ministries and their spheres of responsibility. Ministers who do not lead a ministry can also be appointed on the proposal of the Prime Minister. There are currently no such ministers.

The government has the executive power. The definition of executive power includes legislative drafting within a limited scope. In order to implement laws, regulations based on those laws from the Government of the Republic and from the ministers might be necessary.

Pursuant to the constitution, all local matters are administered by local authorities, who act autonomously in accordance with the law. The territory of Estonia is divided into counties; the counties in turn are divided into rural municipalities and cities. Rural municipalities and cities are local government units. Estonia has 15 counties and according to the new administrative reform that came into force on 15 October 2017, there are 79 local government units – 15 cities and 64 rural municipalities. In accordance with the law, the functions of all local authorities are the same: they are primarily responsible for education, public construction works, housing, maintenance of local roads, and primary level health care. Local authorities are largely economically dependent on the central government.

2.1.1. Implementation of climate policy within the government structure

In Estonia, there are two principal ministries responsible for the climate and energy policy: the Ministry of the Environment (MoE) and the Ministry of Economic Affairs and Communications (MoEAC). The Ministry of the Interior (MoI) is in charge of the risk analyses of emergency situations and relevant response plans.

The coordination lies with the **State Chancellery**, whose task is to support the Government of the Republic and the Prime Minister in policy drafting and implementation. There are two offices in the State Chancellery involved in the climate policy: the Strategy Office, which coordinates the drafting and implementation of the Government's action plans as well as strategic development plans to increase the country's competitiveness and promote sustainable development. The second office – the **European Union Secretariat** coordinates the development of Estonia's positions on issues relating to the EU and the transposition of EU legislation. European Union Secretariat also advises and supports the Prime Minister on issues relating to the EU and in the preparation of European Council summits.

The **MoE** is primarily responsible for the implementation of United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the Paris Agreement and relevant legal acts of the EU. The ministry also coordinates the preparation of annual greenhouse gas (GHG) inventories, National Communications, Biennal Reports, the implementation of joint implementation projects, International Emissions Trading and the EU emission allowance trading scheme (ETS). Another major institution in the climate context under the MoE is the Estonian Weather Service, which is a part of the Estonian Environment Agency (ESTEA) – a government service that performs meteorological and hydrological measurements, issues weather forecasts, prepares the climatological survey of Estonia, etc.

In order to assemble everything needed to organise the area of the environment and basic information that is of high quality at both the domestic and international level, the state system for the organisation of environmental monitoring has been restructured. In 2010 the Estonian Environment Information Centre (EEIC) was established when two environmental institutions were merged following reorganisation. The new agency consolidated the former EEIC and Centre of Forest Protection and Silviculture into a single organisation. As a result of the merger of the Estonian Meteorological and Hydrological Institute (EMHI) and the EEIC, the ESTEA was formed in 2013. This agency is the legal successor to its predecessors.

The **MoEAC** develops and implements the national economic policy and prepares economic development plans in the fields that have a direct impact on climate change: industry, trade, energy, housing, building, transport, and traffic management. (Examples include Estonia's Electric Energy Development Plan, Fuel and Energy Management Long-Term Development Plan, Energy Saving Programme, Estonian Renewable Energy Development Plan and Transport Development Plan.)

In summer 2009 the MoEAC was ordered by the Parliament of Estonia to establish a Climate and Energy Agency. The activities of the agency were to focus on two areas: analyzing trends in energy and the climate; and applying measures of sustainable development. The agency operated as part of the KredEx Credit and Export Guarantee Fund for just 18 months, when its functions were divided up between other agencies following internal restructuring in KredEx in 2010.

In addition to the abovementioned ministries, **the MoI, the Ministry of Rural Affairs, the MoER, the Ministry of Social Affairs** and **the Ministry of Foreign Affairs** are involved in different aspects of the climate issue at the state level. Regulation of crisis management and rescue work is, in principal, the task of the MoI, which is also responsible for risk analysis of emergency situations (incl. storms, floods and extreme weather conditions) and drafting relevant response plans.

If one ministry has a leading role in a certain climate-related strategy or development plan, the other ministries involved participate in working groups for the development of such strategies. In recent years local governments have also become more active in integrating climate aspects into spatial planning and transport management. Moreover, participation in different projects that have an impact on reducing GHG emissions has increased. Several local governments that are prone to flooding have developed detailed adaptation and action plans to deal with storms and floods.

2.2. Population profile

Being one of the smallest countries in the EU after Malta, Luxembourg, and Cyprus with its 1,315,635 residents (2017), Estonia is significantly more vulnerable to external effects compared to other EU countries. As at 1 January 2016, 68.5% of the population of Estonia lived in urban areas (cities, cities without municipal status, towns). Figure 2.1 shows the distribution of the Estonian population.

The early timing of demographic transitioning has had a long-term effect on demographic processes, meaning that as early as in the first decades of the 20th century, Estonia was characterised by a low birth rate and a relatively low mortality rate. This has been the primary reason for the low population growth rate in Estonia throughout the 20th century. In recent decades, Estonia has been characterised by a negative population growth rate, but in 2015, for the first time in more than two decades, the population growth rate was positive – 0.8 per 1,000 people.

From the perspective of fertility development, Estonia, much like most other Eastern[1] European countries, is still characterised by having the first child at a later age. In the past decade, the timing of births has moved by more than two years. In 2015, the age of a first-time mother was 27.2 years. In comparison with Northern and Western Europe, not to mention Southern Europe, our age of first-time births is more than two years lower, meaning that as the age of fertility increases, the periodic fertility indicators seem lower than they actually are (in 2015, the total fertility rate or the number of children per woman in fertile age was 1.58).

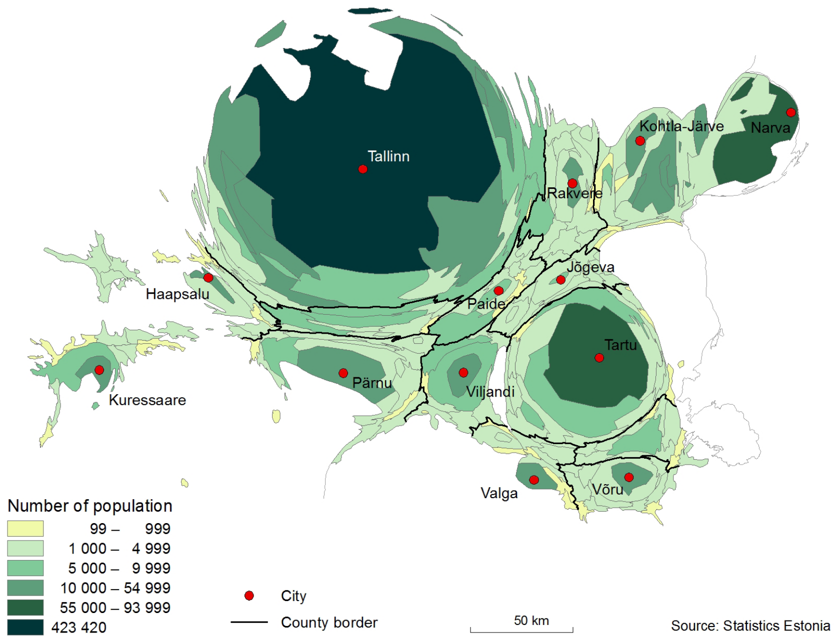

Figure 2.1. Distribution of the Estonian population on 1 January 2016, person (Statistics Estonia, 2017)

The primary factor affecting the population development of Estonia in the long term has been the geopolitical position of the country. Because of it, Estonia has had to experience numerous societal transformations, such as occupations before and after the Second World War, the dissolution of the Soviet Union, and the restoration of independence of Estonia in 1991. From the perspective of population development, the composition and structure of the Estonian population were changed by the immigration following the war and the subsequent return migration in the 1990s. Regardless of the latter, Estonia retained a foreign population of over 30%. The low birth rate already inherent in the first decades of the 20th century and the large waves of immigration after the war have been the basis for fast aging at the beginning of the 21st century. Now, Estonia is in the upper half of the EU with 19% of people aged 65 or above.

[1] Although since 2017 Estonia belongs to the Northern Europe according to the UN Geographic Region distribution, historically, surveys about Estonia have considered Estonia as an Eastern European country.

The post-war development has also affected the long-term mortality rate standstill until the mid-1990s and the subsequent fast increase in average life expectancy. Within the past ten years, the lifespan of men has increased by more than 5.5 years. In 2015, the average lifespan of men was 73.08 years. The lifespan of women increased by more than 3.5 years, making the average lifespan 81.85 years. Estonia has a very low number of healthy years of life and a high proportion of people with limitations on activity.

2.3. Geographic profile

Located on the eastern coast of the Baltic Sea, Estonia is the northernmost and also the smallest country in the Baltic States, in terms of both population and area (45,339 km^2). Along with the Western Estonian archipelago and the numerous islands in its coastal waters, Estonia can geographically be described as an extensive peninsula stretching between the Gulf of Finland and the Latvian capital Riga. The country has a variety of geographical features that form the basis of its climatic values: a long coastline; a high number of islets (ca 2,222); a large number of lakes and rivers; a very flat relief (with almost two-thirds of the country lying less than 50 metres above sea level. The highest point is Suur Munamägi at 317.2 metres above sea level, unique base rock openings – limestone cliffs – all along the northern coast of the mainland and the largest islands.

Estonia's neighbours are Russia to the east, Latvia to the south, Sweden to the west (across the Baltic Sea) and Finland to the north (across the Gulf of Finland). Its land border is 688.3 km long, of which 344.3 km is the length of land border between Estonia and Latvia and the border between Estonia and Russia is 344 km long. Located between latitudes 57°30' N and 59°49' N and longitudes 21°46' E and 28°13' E, Estonia is marked by conditions typical of the Boreal bio-geographic region. However, due to the strong influence of the Baltic Sea, half of the country can be considered to have boreo-nemoral and the other half more continental boreal conditions.

Almost half of the land surface is covered by forests (ca 51%). There are around 2,804 natural and man-made lakes in the country. The percentage of bogs is 5.5% (240,000 ha). Compared with other territories of a similar size situated north of the 57th parallel, Estonia's biological diversity is among the richest. This is due to the varied climatic conditions, the existence of island and continental sectors, the abundance of sea and inland waters and the variety of base rocks with correspondingly diverse soil conditions, all of which paved the way for the evolution and development of a wide diversity of ecosystems. 40,000 species are thought to exist in Estonia, currently about 30,000 of them (75%) have been identified.

Although Estonia is a relatively small country by area, it has a comparatively large proportion of unspoiled protected nature. This is mainly due to the low population density – 30.3 inhabitants per km^2. This figure itself is highly polarised, being almost two-thirds in urban and only one-third in rural areas. Very few countries in Europe can afford to have more than 15% of their land under nature protection. In total, 572 species are protected by law in Estonia, while 18% of land is under legal protection.

Sea-level rise due to thermal expansion and the melting of glaciers, ice caps and ice sheets may be one of the main impacts of climate change for Estonia. Accelerated sea-level rise could strongly affect the territory of the country because of its relatively long coastline and extensive low-lying coastal areas.

2.4. Climate profile

The main factor influencing Estonia's climate is the country's geographical position. Estonia belongs to the mixed forest sub-region of the Atlantic continental region of the temperate zone and lies in the transition zone between maritime and continental climates. According to the Köppen climate classification, the western part of Estonia belongs to the Cfb zone (a marine climate with mild winters) while the eastern part of the country belongs to the Dfb zone (a humid continental climate with severe winters).

Local climatic differences are due, above all, to the neighbouring Baltic Sea, which warms up the coastal zone in winter and later has a cooling effect, especially in spring. The topography, particularly the uplands in the southeastern part of Estonia, plays an important role in the distribution and duration of snow cover.

As a result of these factors, summers are moderately warm (the mean air temperature in July being 16-17 °C) and winters are moderately cold (the mean air temperature in February being between -2.5 and -7 °C). The highest daily temperature ever recorded is +35.6 °C (1992, Võru) and the lowest -43.5 °C (1940, Jõgeva).

The annual average temperature time series of Tartu-Tõravere Station illustrates Estonia's climate (Figure 2.2). The time series show a significant temperature increase starting from the end of the last century and a plateau formed during the last decade. It should be noted that current situation with fairly high average temperature has also occurred for a short period of time in the end of 1930s.

In Estonia the rise of annual average temperature has been slightly faster than in other parts of the world as a whole according to the report *Future climate change scenarios in Estonia until 2100*. The warming trend stands out monthly, also during the winter, especially in January.

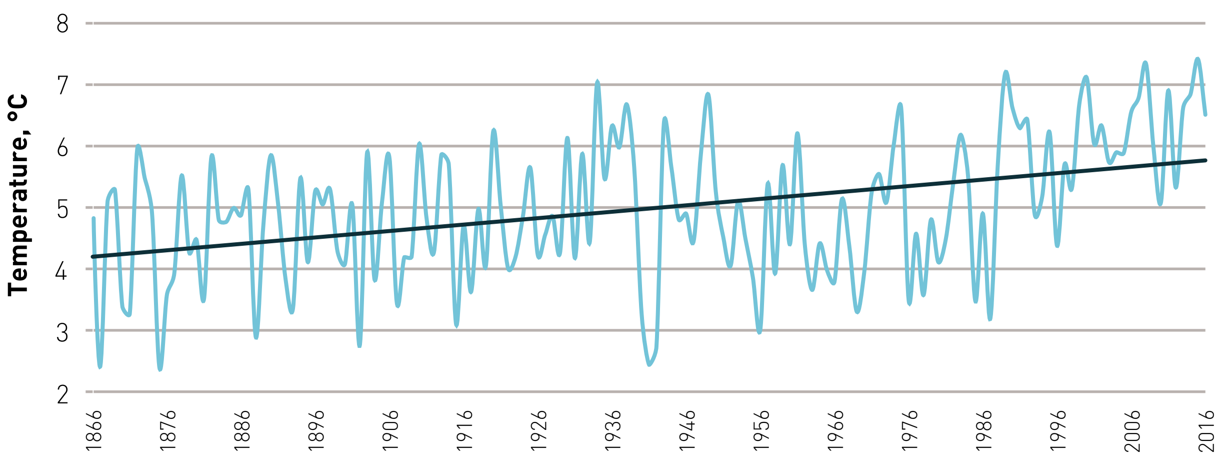

Figure 2.2. Annual average temperatures and their trendline measured in Tartu-Tõravere station 1866–2016, °C (Ain Kallis, 2017)

Since annual precipitation is approximately double that of evaporation, the climate is excessively damp. Mean annual precipitation is ca 550–700 mm, ranging from 520 mm on some islands to almost 740 mm in the uplands. Seasonal variation in precipitation is similar throughout the country, the driest months being February and March. From then on, precipitation gradually increases until July and August, after which it decreases towards winter and spring. The lowest annual precipitation can be less than 350 mm on the coast, but inland regions sometimes have more than 1,000 mm. The highest daily rainfall ever recorded is 148 mm (1972, Tooma) and the highest annual rainfall a total of 1,157 mm (1990, Nääri).

The snow cover duration, depth and water supply vary greatly between years. While in the middle of 1970s and in the end of 1980s there were mild winters practically without snow, then during 1920–1933 the winters lasted for longer periods of time with thick snow cover. On average there are approximately 109 days with snow cover per year, varying between 61 and 155 days. There has been a negative trend in duration of snow cover in the period of 1961–2002, in forty years the average snow cover has decreased by 25.9 days.

Snow cover becomes established earliest in the Haanja, Pandivere and Otepää uplands, usually in early December, and remains there until the end of March. On the islands of Saaremaa and Hiiumaa, permanent snow cover predominantly forms in mid-January. In some years, permanent snow cover does not form at all.

The prevailing winds are southwesterly, southerly and westerly. Winds from the north are more frequent in spring and early summer. Average wind velocity is 5–7 m/sec in coastal areas and 3–5 m/sec inland. The strongest winds occur in the autumn and winter months, especially in November, December and January (with an average velocity of 4.3 m/sec). The weakest winds are felt in summer (July/August, with an average velocity of 3.1 m/sec). The fastest wind speed ever recorded in Estonia, was on Ruhnu island in November 1969 when maximum wind gust of 48 m/sec was registered.

Mean annual total solar radiation in Estonia is 3,300–3,600 MJ/m^2, while sunshine duration varies from 1,650 hours inland to 1,950 hours on the islands. The sunniest months are June and July, the least sunny month is December. The annual average sunshine duration in the period from 1981 to 2010 is 1,766 hours.

2.5. Economic profile

Estonian economy is small, but open and flexible to changes in external environment. The domestic market of a country with 1.3 million residents is too small for many companies, thus, they set their sights abroad.

Great changes occurred in the general structure of the economy at the beginning of the 1990s, as many service industries had not existed yet and a large share of the factories had been manufacturing goods necessary for the military industry and Russia, which were no longer needed. In the last decade, however, the more general division of the service, industrial, and agricultural sectors has been relatively stable and changes have occurred within the sectors.

The economy of Estonia as an EU Member State is tightly connected to other EU Member States. The importance of the EU in the total export of Estonia has grown to 75%. From the perspective of economic development, however, Estonia has quite rapidly moved closer to the more developed EU countries, although the gap is still relatively large: according to Eurostat, the gross domestic product (GDP) per capita in Purchasing Power Standards (PPS) of Estonia was 47% of the EU average in 2001 and 73% in 2013. This also characterises the productivity of Estonia. The growth of Estonian GDP has been successful during the last 20 years despite the fact that the Estonian GHG emissions (without Land use, land use change and forestry sector) have remained at the level of approximately 20,000 kt of CO_2 equivalent in the last decade.

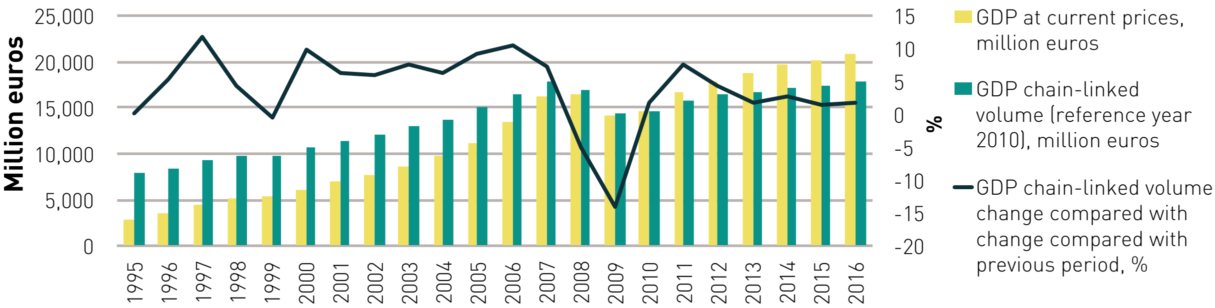

Figure 2.3. Growth in Estonian GDP 1995–2016, million euros (Statistics Estonia, 2017)

In 2016, the GDP of Estonia increased by 1.7%, which is among the lowest figures since 2010 (Figure 2.3). In 2017–2018 Estonian economic growth is expected to stabilise at around 3%. The growth decelerated due to weak foreign demand and its negative impact on the security and investments of the business sector. Employment continued to grow and unemployment continued to decline, prices dropped, the real growth of income from employment accelerated, and consumption activity remained at a relatively high level.

Due to the small size of Estonia, it is not possible to manufacture all products and offer all services required by the people and companies here domestically, for example transport fuels, household appliances, or metals. The volume of exported goods and services amounts to 90% of the Estonian GDP, with the export of services forming approximately one third of the total volume. The more important services successfully exported by Estonian companies include various transport services as well as tourism. More than three quarters of Estonian industrial production is exported; many companies sell their entire production outside of Estonia.

Estonian export is diverse – manufacturing of electrical appliances and devices, as well as mineral products and various wood and metal products are important. Export and import volumes are illustrated by Figure 2.4. Due to the available natural resources, all forest-related sectors are imperative for Estonian economy. The most important economic partners of Estonia are Finland, Sweden, Latvia, and Russia. However, the role of other European countries and countries from elsewhere in the world has also increased throughout the years. The volume of export has formed approximately 90% of the Estonian GDP in the last decade.

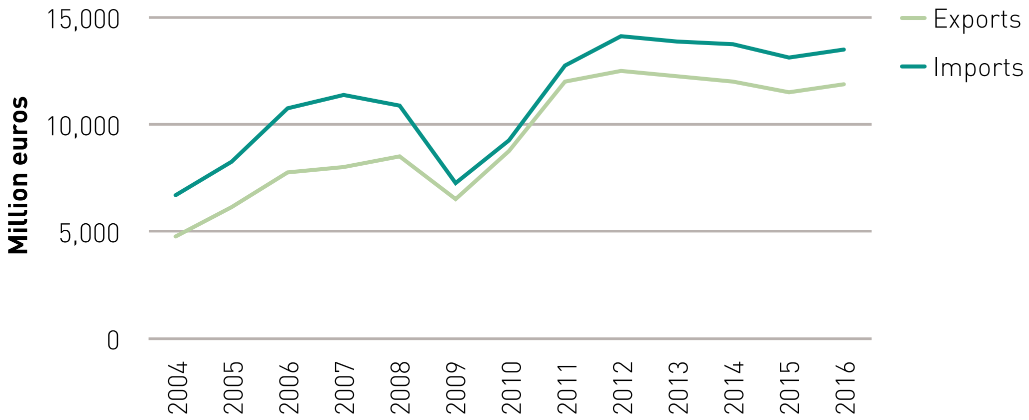

Figure 2.4. Foreign trade 2004–2016, million euros (Statistics Estonia, 2017)

The growth rate of wages was more than twice as fast as the growth in GDP in the period of 2013–2016. The share of wages in GDP or the real unit labour cost has been increasing for three years in the row at the expense of decreasing profitability. Even though the situation is somewhat similar to 2008 (beginning of the economic recession in Estonia), the situation is more bearable for undertakings due to the low level of investments, as a result of which the need to finance capital investments, incl. from profits, is lower. The indicators, which characterise the general balance of the economy, are also in a better state, as there is a slight surplus in the current account and the developments of domestic demand are not based on an excessive increase in credit. As unemployment has already dropped quite low and there is a labour force deficit due to the declining working age population and the close proximity of the Finnish labour market with higher wages, the pressure for an increase in wages can be expected to continue in the future.

2.6. Energy

The Estonian energy and fuel sector, which main purpose is to supply the country with high-quality fuel, electricity, and heat to ensure the optimal functioning and development of the sector, impacts the developments occurring in almost all fields of life. For instance, heating and housing influence Estonian regional development and public health. The choices related to the generation of biofuels have additionally an impact on the use of land and rural life, as well as on the external trade balance. The choices made in electricity generation impact the environmental condition of Estonia and the efficiency of commercial activities. For example, oil shale, the main source of energy in Estonia, ensures energy independence for the country and supports the economy, but has an adverse effect on the environment and public health.

Estonia ranks among the top EU Member States in terms of primary energy production per capita. Primary energy production in Estonia peaked in 2014 (Figure 2.5). In 2015, the amount of primary energy produced dropped below the level of 2013. Even though the majority of the primary energy produced in Estonia still comes from oil shale, the decline in primary energy production volumes in 2015 was above all caused by a drop in the production of oil shale. Nevertheless, the amount of oil shale produced in 2015 was still 20% higher than in 2007, before the economic downturn. In addition to electricity generation, oil shale is also used to produce shale oil, the production volumes of which have been growing steadily in recent years due to the construction of new factories. In 2015, the production of electricity in Estonia totalled 10,400 GWh – 16% less than in 2014. The decline in electricity generation was caused by a 46% increase in import compared to 2014. 15.6% of the electricity generated in 2015 came from renewable sources.

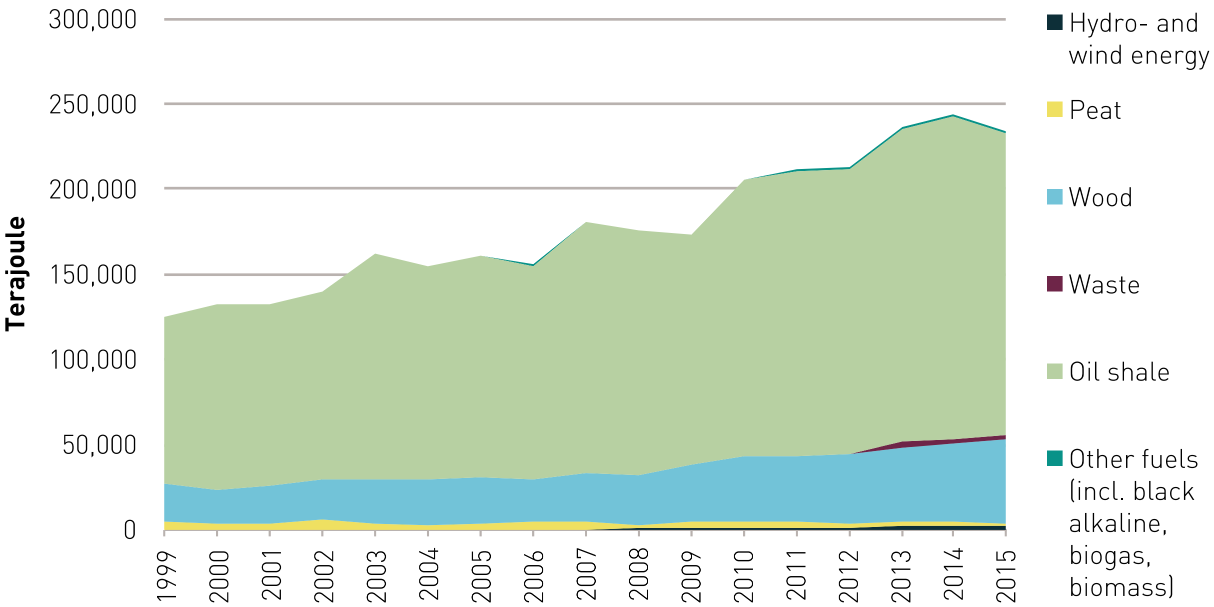

Figure 2.5. Production of primary energy 1999–2015, terajoule (Statistics Estonia, 2017)

Electricity and heat are mainly generated from oil shale, wood, and natural gas in Estonia, thereat, oil shale is used the most in electricity generation and various wood fuels in heat generation. Development of combined heat and power generation – the most efficient approach from the environmental perspective – continues. In 2015, there were 45 different cogeneration plants in Estonia, 13 of which were based on backpressure steam turbines, 14 on condensing turbines, and 18 on internal combustion engines.

2.6.1. Energy taxes and subsidies

Energy taxation provides significant revenues for the state, mainly from fuel excise and electricity excise, as well as from other taxes applicable to fuels, which generate about 10% of all budgetary tax revenues. In addition to being a source of revenue to the budget, the aforementioned taxes are aimed at reducing energy consumption and greenhouse gas emissions in Estonia.

Of the key excise rates in force, electricity excise amounted to 4.47 euros per MWh in 2017 and petrol and diesel fuel excises amounted to 512 and 493 euros per 1,000 litres, respectively. Estonia supports using renewable energy sources to generate electricity. Table 2.1 highlights the various support rates applied.

Table 2.1. Support rates applied to using renewable energy for electricity generation, euros/MWh (Elering, 2017)

Support rate, euros/MWh	Criteria for qualifying for the support
5.37	Energy generated from renewable energy other than biomass.
5.37	Energy generated from biomass in cogeneration regime.
3.2	Energy generated from waste, peat, or oil shale processing retort gas in efficient cogeneration regime.
3.2	Energy generated in efficient cogeneration regime, whereat the electrical capacity of the production equipment does not exceed 10 MW

2.6.2. Trade

Historically, Estonia has almost always been a net energy exporter. 6.37 TWh of electricity was exported in 2015. 61.3% of produced electricity was exported to Latvia and Finland in 2015. Estonia's main import partner is Finland, imports through which have increased more than ten times in 2015 compared to 2012. Energy is imported from Finland via EstLink 1 and EstLink 2 cables, the first of which was taken into use in 2006 and the other in 2014. The total transmission capacity of the two cables amounts to 1,000 MW. Electricity imports have increased, as the improved connection between Estonia and Finland allows for importing of cheap hydro energy from Scandinavia in certain periods.

The main fuels imported to Estonia include natural gas, liquid fuels, coal, and coke. Natural gas imports have gradually dropped, as the consumption has generally decreased (Table 2.2), for example, due to increased consumption of wood fuel. Of liquid fuels, the consumption of petrol has dropped by 6% compared to 2012, but has largely remained at the same level throughout the years. Due to more extensive use of diesel fuel in transportation, imports of light fuel oil and diesel fuel show a growing trend.

Table 2.2. Fuel consumption by fuel types (Statistics Estonia, 2017)

Type of fuel	2011	2012	2013	2014	2015	2016
Coal and coke, thousand tons	69	64	66	77	29	29
Oil shale, thousand tons	18,739	17,527	20,487	20,629	17,899	18,840
Peat, thousand tons	304	264	242	115	131	124
Peat briquette, thousand tons	12	13	12	12	9	2
Firewood, 1000 m^3 solid volume	4,348	4,495	4,295	4,283	4,509	4,647
Natural gas, million m^3	632	657	678	530	471	518
Liquefied gas, thousand tons	7	9	8	12	13	21
Heavy fuel oil, thousand tons	2	1	1	1	1	2
Shale oil, thousand tons	65	67	50	43	50	51
Light fuel oil, thousand tons	74	67	63	40	42	37
Gas/Diesel oil, thousand tons	646	668	658	677	704	684
Motor gasoline, thousand tons	261	252	234	237	236	252
Aviation fuels, thousand tons	34	37	28	41	24	21

2.6.3. Renewable energy

The share of renewable energy in Estonia has gradually increased throughout the years, both in electricity generation and end consumption of energy (Figure 2.6).

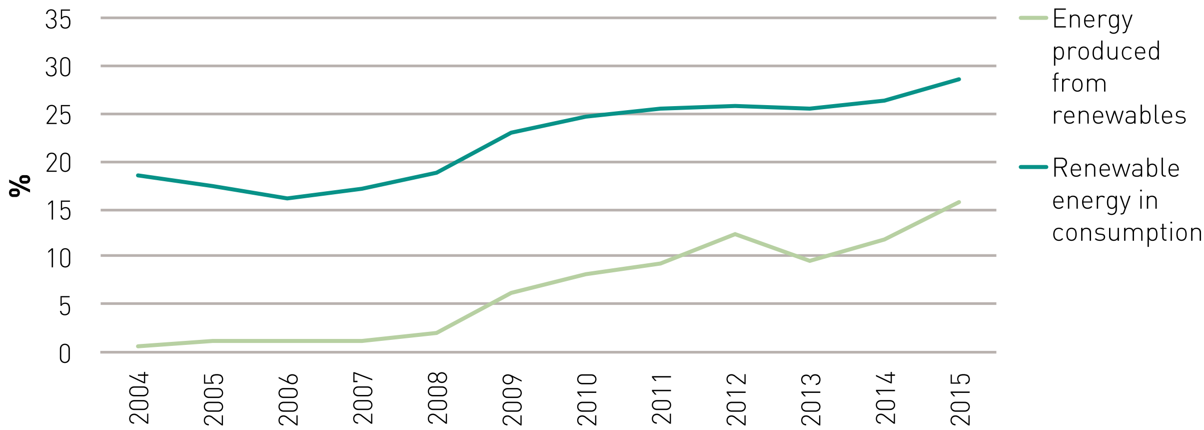

Figure 2.6. Use of renewable sources in energy generation, % (Statistics Estonia, 2017; Taastuvenergia aastaraamat 2015, 2017)

In 2015, electric energy produced from renewable resources formed 15.6% of total production, which marks a 3.3-percentage point increase in this area compared to 2012. Renewable energy formed 28.6% of total energy consumption in 2015, 2.8 percentage points more than in 2012.

2.7. Transport

Estonia's transport network consists of the infrastructure needed for road, rail, water and air traffic. The total length of national roads as at 1 January 2017 was 16,594 km, in addition to 87.6 km of temporary ice roads in the case of suitable weather conditions. Local roads cover 23,944 km and private and forest roads 18,398 km. 70.6% of national roads are sealed. In 2013, this figure was 65.9%. The density of the national road network is 366 km per 1,000 km^2, and the density of the entire road network is 1,300 km per 1,000 km^2.

The rail transport system in Estonia consists of 2,164 km of railway lines, of which 71.2% is in public use and 28.8% is not. 132 km of public tracks have been electrified. Most of the railway lines are owned by AS Eesti Raudtee and Edelaraudtee Infrastruktuuri AS. There are also certain private railway sections in Estonia in ports and the so-called Coal Railway. Development of the railway infrastructure, logistics, passenger and freight transport, as well as of rolling stock, and traffic and environmental safety in Estonia is coordinated by the MoEAC in cooperation with the agencies thereof.

Estonian coastline is 3,794 km long and there is a dense network of ports. Together with inland waterway ports, there are 211 ports registered in the State Port Register. The largest are of the depth of 17 metres. Taking into consideration both the number of passengers and the freight flows, the Port of Tallinn is the largest port complex in Estonia as well as of the Baltic Sea.

Estonia has 5 instrumental airports, 7 certified visual airports, and only one certified helicopter field. In 2016, Estonian airports served 2.3 million passengers, approximately the same number as in 2012. Tallinn Airport is the largest airport in Estonia, which served approximately 2.2 million passengers in 2016.

2.7.1. Passenger transport

Estonian transport enterprises served 208 million passengers in 2016. This figure has increased by 3.5% compared to 2012, when 201 million people were transported (Figure 2.7). In Estonia, the main form of public transport used by passengers is the bus, followed by the train. Compared to 2012, the number of passengers travelling by train has increased significantly – by 57.1%. This increase may be explained by the introduction of new, modern passenger trains in 2013, which made railway transport more comfortable for travellers.

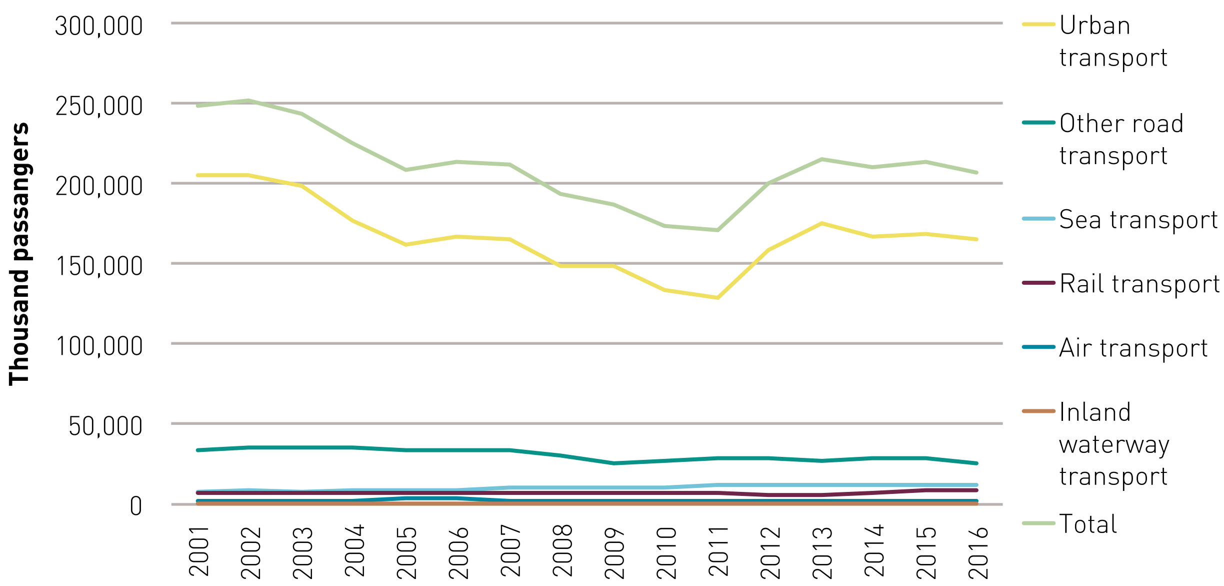

Figure 2.7. Passenger transport of transport enterprises, thousand passengers (Statistics Estonia, 2017)

2.7.2. Freight

Due to the economic decline, freight volumes dropped significantly in 2008 and 2009; in 2010, however, freight showed signs of recovering, achieving the highest post-crisis level in 2011 (Figure 2.8).

In the following years, however, a steady decline in freight transport can be observed, with the lowest level of the last fifteen years reached in 2016. This is due to the lower volume of goods being transported by railway, primarily due to the decreasing transit volumes between Estonia and Russia since 2011. Compared to 2012, the volume of freight decreased in 2016 by 16.4%. This is also one of the reasons why the Estonian GHG emissions in the subcategory of railway transport have decreased by 35.3% in the same period. Road transport has, however, been growing steadily after the end of the economic downturn and reached the pre-crisis level in 2016.

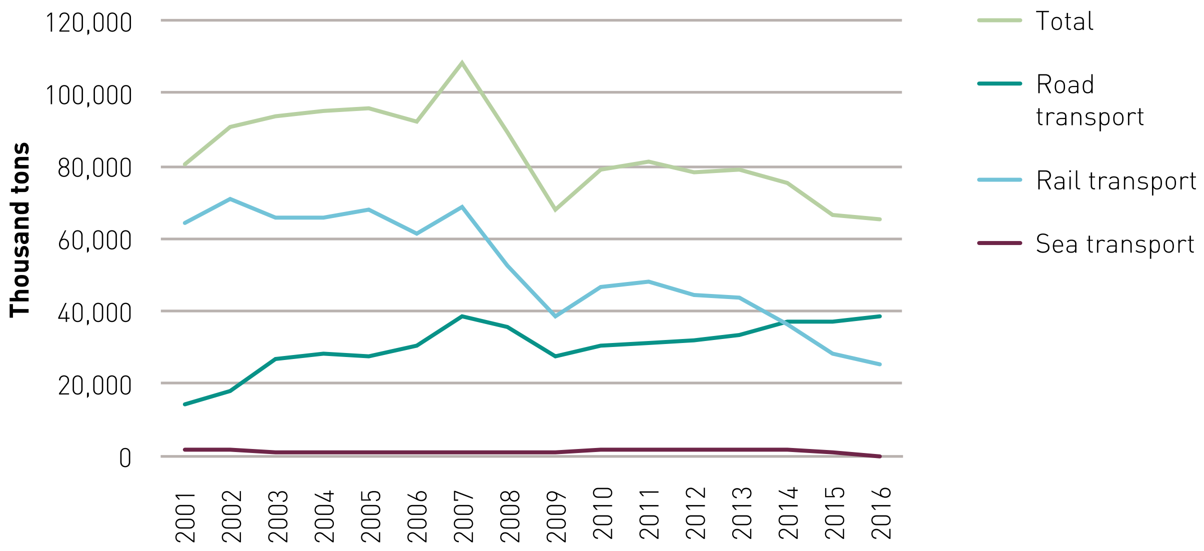

Figure 2.8. Freight transport of transport enterprises, thousand tons (Statistics Estonia, 2017)

2.8. Industry

In 2017, added value from the industrial sector formed 14.5% of Estonian economy, which is similar to the EU average. Compared to 2010, the volume of the industrial sector has increased by approximately 38% and compared to 2005, it has almost doubled in current prices (Figure 2.9.).

At the beginning on the 1990s, large-scale changes occurred in the general structure of the economy, as the service sector had not yet developed and the majority of the factories were focussed on the Soviet Union market. Smaller volumes of industrial output during the transfer from a planned economy to market economy also resulted in a significant decline in GHG emissions. In the 2000s, emissions fluctuated quite extensively and peaked in 2007 due to the rapid economic growth. In the last decade, the general distribution of the purchasing, processing, and servicing sectors has remained steady and GHG emissions have increased slowly. Changes have occurred within the sectors and the share of high-tech and knowledge-intensive industries is growing.

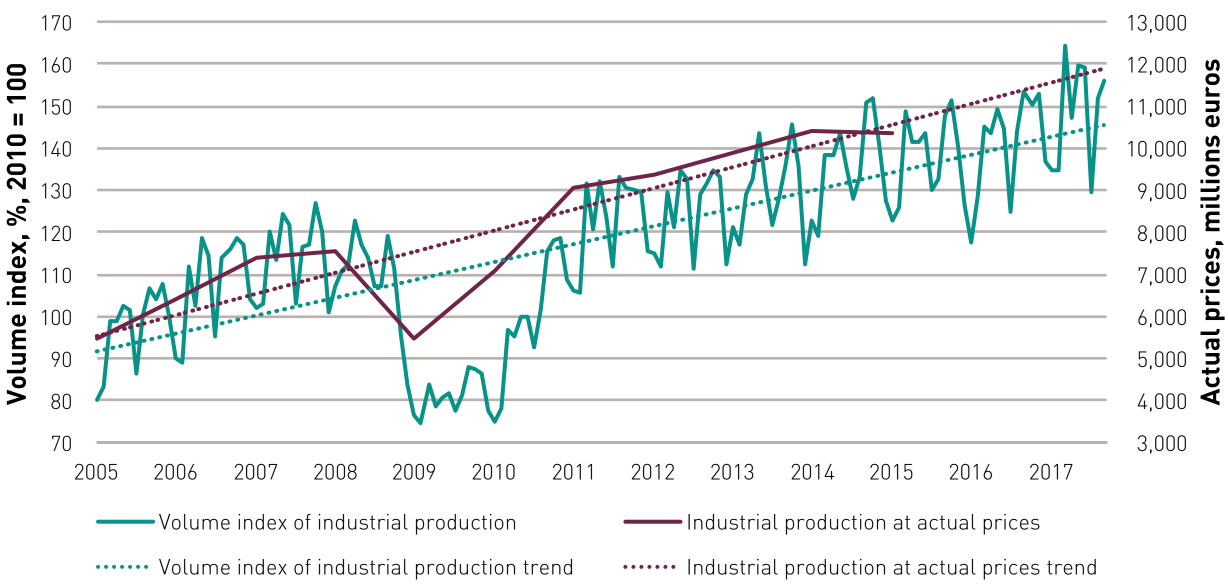

Figure 2.9. Estonian industrial production 2005–2017, million euros (Statistics Estonia, 2017)

The growth of processing industry has for many years mainly been led by the wood industry and higher added values are generated by the appliance and metal industries of increasing production volumes (Figure 2.10). Wood is one of the most important natural resources in Estonia and wood industry, in turn, is among the most important sectors of Estonian economy. The importance of the wood industry has been consistently growing and is close to reaching almost a fifth of the entire output of the processing industry and 2.5% of the entire GDP of Estonia. The wood industry is a net exporter also important from the perspective of levelling the external trade balance. Estonia has a competitive advantage in this sector thanks to the easily available, high-quality raw material and long-term experience. On the other hand, however, the pressure to limit felling volumes is growing.

Estonian economy is export-oriented and the share of export forms over 50% of the processing industry and has started to increase after 2013. Approximately 70% of the output of the processing industry was exported in 2017, most of which is sold in the EU market, mainly in the Nordic countries. Thus, a stronger growth of the European economy can greatly benefit the Estonian processing industry.

There are over 7,000 companies operating in the Estonian industrial sector, most of which are small or medium-sized companies. More than 200 companies employ at least 100 people, but half of the people working in the industrial sector are employed by these companies.

The largest companies include:

- Ericsson Eesti AS, the manufacturer of mobile network devices;
- ABB AS, the manufacturer of electrical appliances;
- PKC Eesti AS, the manufacturer of cables and wires;
- BLRT Grupp AS, the shipbuilding and metal processing group;
- Stora Enso Eesti AS, the wood processor;
- AS Norma, the manufacturer of automotive safety systems;
- HKScan Estonia AS, the meat product processor.

In 1991, 25% of the labour force was employed in the processing industry, in 2015, the same indicator was 19%, which is above the EU average. As the number of labour force in Estonia is bigger than in many other countries in the EU to produce the same value, the added value is respectively smaller in Estonia. The number of those employed in the processing industry is very likely to continue decreasing in the future, supported by increasing productivity and decreasing of the difference between the added value and the percentage of employment, especially in the labour-force-intensive sectors.

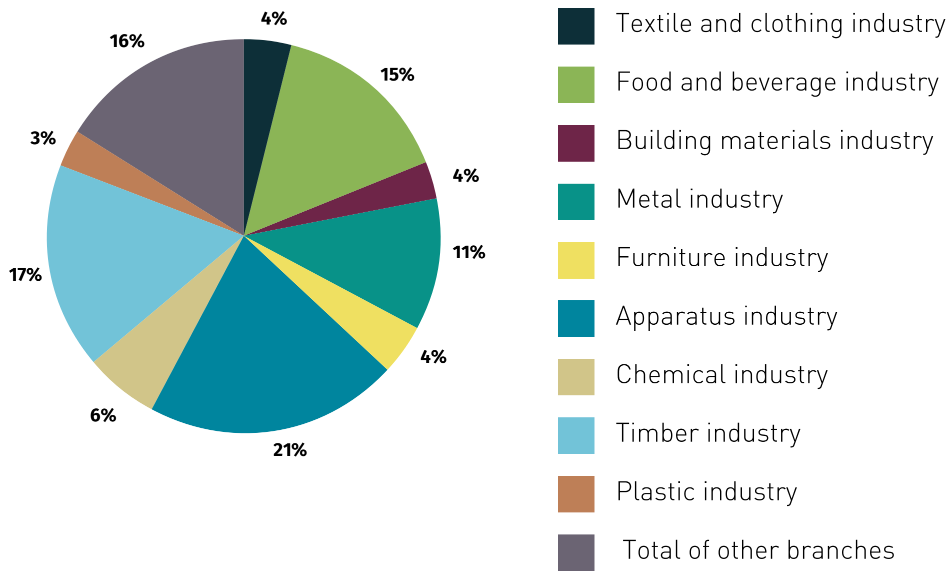

Figure 2.10. Structure of Estonian processing industry by added value 2015, % (Statistics Estonia, 2017)

2.9. Waste

The development and goals of waste management in Estonia are based on the EU and national legislation (Waste Act) and since 2014 on the National Waste Management Plan (NWMP) replacing the previous Waste Management Plan of 2009–2013. The current NWMP is in effect until 2020 and takes into account the 7th Environmental Action Programme which is set to guide European environmental policy until 2020 and beyond. The EU waste directive 2008/98/EC of the European Parliament and of the Council entered into force in 2008 setting concrete numerical targets for recycling and recovery of municipal solid waste (MSW), construction and demolition waste. These targets are also transposed in the Waste Act and in the NWMP.

According to the Estonian Waste Act, the content of biodegradable waste in disposed MSW must be less than 30% by weight starting from 2013 and less than 20% by 2020. At the same time, waste framework directive 2008/98/EU establishes a target of 50% by weight. Mixed MSW sorting studies in Estonia have shown that the share of biodegradable fraction in MSW is in decreasing trend and has declined to 52% by 2012. The share of bio-waste (kitchen, garden and park waste) in this was around 34%. From this, it can be concluded that Estonia is on track achieving this recycling goal if people continue collecting their waste separately. The NWMP foresees, among other things, wider implementation of technology for the composting and anaerobic digestion of biodegradable waste and the use of the materials produced which should contribute reaching the target. To promote the recycling of biodegradable waste, the MoE has developed special end-of-waste quality criteria according to which it is possible to:

- produce compost manufactured as a treatment product of biodegradable waste (excluding sewage sludge);
- produce compost or other products manufactured as a treatment product of sewage sludge;
- requirements for biodegradable waste from the production of biogas digestion residue.

In 2015, Estonia had 5 functioning MSW landfills (Tallinn Recycling Center, Uikala, Väätsa, Torma and Paikre) classified as managed solid waste disposal sites. These landfills are fully conformed to environmental and technical requirements and standards and are capable to serve more than one service area. The total waste generation in 2015 was about 24.7 million tons, in which MSW is 0.3 million tons. Over the last decade the total waste generation has steadily increased excluding some down-trend years due to economic crisis.

In 2015, the decreasing trend of waste produced by oil shale industry (wastes from mining and physical-chemical treatment, thermal processes, and other oil shale wastes) reached 47% of the total waste generation. MSW generation makes up just 1.2% of total waste generation summing up 234 kg per capita (Figure 2.11).

Separate collection of MSW is arranged by local authorities, which have continuously increased this form of collection and developed a network of waste amenity sites (waste stations). The deposition of mixed MSW in landfills has decreased steadily until 2015 (7% of generated municipal waste) due to the mechanical and biological treatment (MBT) of waste and Iru waste incineration plant (yearly incineration capacity of 250,000 waste tons).

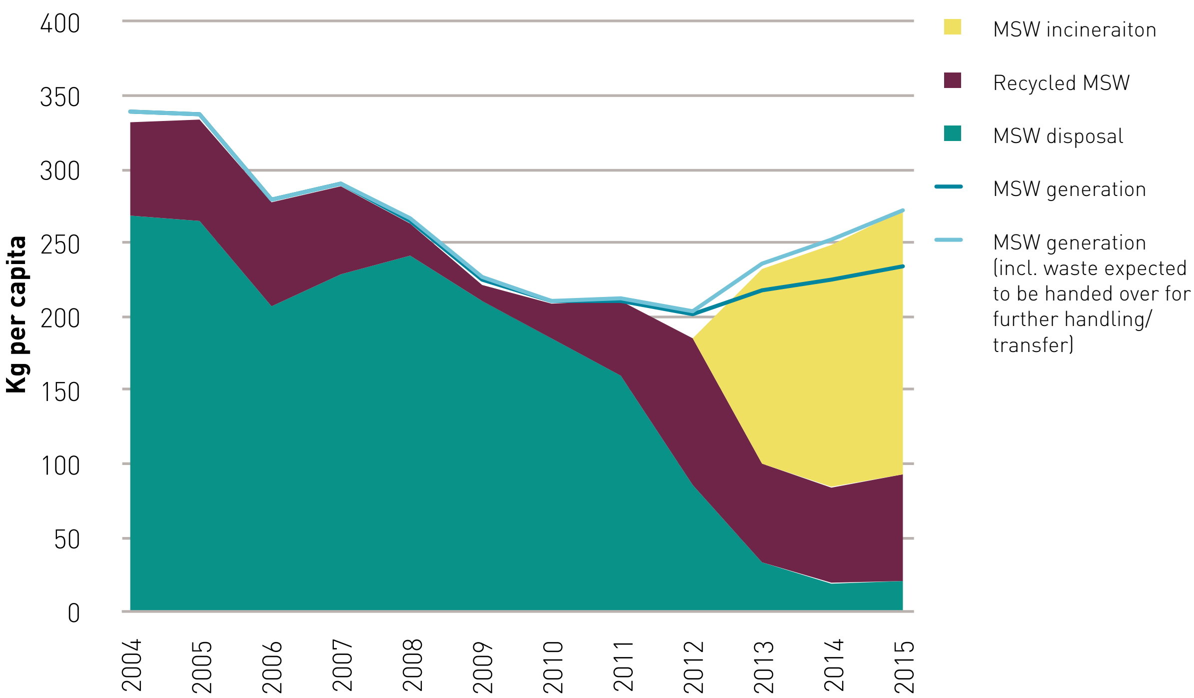

Figure 2.11. Municipal solid waste generation and treatment by type of treatment method, kg per capita (Estonian Environment Agency, 2017).

2.10. Building stock and urban structure

According to the Population and Housing Census, there were 657,791 dwellings in Estonia in 2011, 491 dwellings per person. The Estonian building stock included 23,616 apartment buildings, 178,069 single-family homes, and 13,146 semi-detached or terrace houses. Two thirds of the population (63%) lived in apartment buildings, 31% in single-family homes, and the remaining 5% in semi-detached or terrace houses. By the proportion of inhabitants living in apartments, Estonia ranks third in the EU. 82% of the population owns the homes they live in, approximately a fifth of the population lives in rented dwellings. Over a half of the building stock originates from the Soviet era residential dwelling mass construction period of 1961–1990. With respect to the activity of use of the building stock, the percentage of unpopulated dwellings is increasing (14%, 2011), especially in rural areas. The increasing simultaneous use of several homes is also causing underuse of the building stock and higher energy consumption. There is no shortage of thermal energy in Estonia, but more than a fifth of the population may experience problems related to an uncomfortable indoor temperature in summer due to the lack of air conditioning solutions.

In 2016, the number of new dwellings increased to 4,732 (464,500 m^2), i.e. by 16% compared to the year before, which is twice as high as in 2012. Irrespective of the remarkable growth in the construction of dwellings as well as in the new number of dwellings, the general aging of the housing stock continues with the renewal rate of the housing stock remaining modest (0.7%, 2016). Geographically, half of the construction of new dwellings occurs in the urban area of Tallinn, 15% in Tartu, and 4% in Pärnu.

The majority of the constructed dwellings are located in apartment buildings; thereat, half of the apartments are relatively small, consisting of two or three rooms. The average size of new dwellings is decreasing (98 m^2, a decrease of 16% in the last 5 years, 2016). Most of the new residential buildings are of energy class C according to Estonian Construction Register. The percentage of energy class B new residential buildings has grown in the last two years, but the class A residential buildings, which meet the nearly zero-energy standard, are still rare (224 class A buildings in total). Homebuyers and homeowners have increasingly begun to prioritise the energy-efficiency of residential buildings. The volume of renovation works has tripled in the last five years and increased by more than one million square metres per year to approximately 20,000 apartments (2016). Half of the renovations occur in Tallinn.

Household energy consumption was 41.9 PJ (2015), having dropped from 33% to 31% in the final energy consumption in the period of 2011–2015. The share of Estonian household energy consumption in final energy consumption was among the highest in the EU (the EU average is 25%), which arises from the high thermal energy consumption of residential buildings due to insufficient thermal refurbishment. By types of energy and fuel, the household energy consumption is distributed as follows: purchased heat 29%, transport fuels 27%, wood 24%, and electricity 15%. In the period of 2011–2015, the consumption of electricity of households has decreased significantly (- 206 GWh, - 12%), and the consumption of thermal energy even more (- 572 GWh, - 17%), which indicates improving energy efficiency. The use of wood is still relatively widespread in the case of private homes, although the burning of such fuel has decreased by 15% in the last five years. The transport energy consumption of households has also generally decreased.

The technological aging of the building stock and the accompanying infrastructure, such as district heating systems, calls for the implementation of additional energy and climate policy measures. On the background of the continuing concentration of the population to Tallinn, Tartu and their suburbs, the sustainability of district heating areas must be assessed critically in order to find optimum replacement technologies for ensuring the thermal energy supply in settlements. As 97% of the dwellings are privately owned, which is one of the highest percentages in the world, and the Estonian housing policy is among the most liberal in the world, it would be quite difficult to take a turn towards stricter regulation. In the areas of relatively low residential real estate prices, primarily the towns in Ida-Viru County and rural settlements, this has brought forth forced ownership and transfers of ownership as well as made both the development as well as renovation of housing uneconomical.

With regard to the developments of the urban system in the last decade, urban expansion is occurring in Estonia, which is resulting in the weakening of the position of most of the county towns and small towns in the settlement system. In the 2010s, inland peripheral areas have appeared in Central Estonia in addition to the thinning population in the peripheral regions of Estonia. 37 operational areas have been identified based on daily commuting, which are built on regional (Tallinn and Tartu), county (13), area (21), and local centres in the system of centres and hinterland. The growing model of urban areas, especially in Tallinn and Tartu, is characterised by suburbanisation, as well as remote urbanisation in the form of increasing commuting related to employment, education, and services from further-away areas.

County plans introduced the principle of development areas of settlements with the aim to increase the compactness of settlement, the densification of the urban space, and the placement of new settlements in locations, which are connected to existing settlements in order to create a higher-quality and more energy-efficient urban environment. In the case of low-density areas, the preservation of local centres and traditional rural settlements are prioritised. National regional policy measures have been implemented with co-funding from EU funds with the aim to strengthen the development of urban areas, county centres, as well as other local centres, but this has failed to decelerate urban expansion or the weakening of lower level settlements, small towns, and villages. A further concentration in the Estonia settlement system will be brought forth by the administrative reform, which reduced the number of local governments from 213 to 79.

2.11. Agriculture

The area of agricultural land in Estonia has dropped from 1,458,400 hectares in 1990 to 995,000 hectares in 2016. After Estonia joined the EU, the area of agricultural land has increased by 88,000 hectares in the past ten years. In 2016, the area of crops was 672,900 hectares, over a half of which (52.2%) was cereals. Forage crops made up 27.1%, industrial crops 11.2%, and potatoes, vegetables and legumes 9.6% of the area of crops. In 2016, 35% of used agricultural land was owned on average; 65% was rented or used under other conditions. The average Estonian agricultural producer had an average of 120 ha of agricultural land in 2015.

Since 1990, the number of farm animals has fallen by 69%. According to data from 2016, there were 248,500 heads of cattle (incl. 86,300 dairy cows), 265,400 pigs, 87,200 sheep and goats, and 1,985,300 poultry in Estonia. The main reason for the decline is the transition from a planned economy to a market economy in the early 1990s. In the past two years, the number of dairy cows has declined by 16,200 because of the complicated market situation caused by the low buying-in price of milk. The number of pigs has decreased by 92,000 in the past two years because of the African swine fever.

When appropriated land was returned to owners after the independence of Estonia was restored, the number of agricultural households increased from 7,400 to 55,700 between 1991 and 2001. After this, the number of agricultural households began to decline and in 2016, there were 16,700 agricultural households with at least one hectare of agricultural land or households producing primarily for sales, according to the farm structure survey. Farm animals, poultry, or beehives were kept in 6,970 of these households.

In 2016, the total output of the agriculture sector was 767 million euros. Out of that, 355.8 million euros (46%) was animal output and 309.2 million euros (40%) was crop output. The biggest production industries are dairy (23.2% of the total), cereal and oil-seed crop (14.5%), pig (8.4%), cattle (7%), vegetable (4%) and potato (4%) farming.

Organic production has spread quickly in Estonia – the area of organically farmed land has nearly tripled in the past decade. In 2016, 18% of the agricultural land of Estonia was organically farmed land (184,754 hectare), putting it in the top three in the EU. Compared to 2010, the area of organically farmed land has increased by 40%. The number of organic processors and distributors also increases every year and more organic food is being sold. There were 1,753 organic agricultural holdings in 2016, 1,205 of which also kept organic livestock. Mostly, they keep sheep (51,999 in 2016) and heads of cattle (44,675, out of which 1,881 as dairy cattle). Organic businesses are also increasing in size – their average area of organically farmed land was 105 hectares in 2016.

Subsidies are paid on the basis of the EU Common Agricultural Policy (CAP) Implementation Act to develop agriculture, food industry, and rural life. Since Estonia joined the EU, support measures have been funded from the budgets of three financial periods: 346 million euros in 2004–2006, 1,704 million euros in 2007–2013, and 720.3 million euros in 2014–2016.

2.12. Forest

More than half of Estonian land is covered in forests, with a total area of 2,312,500 hectares. According to the definition of forest in the Kyoto Protocol, forest area in Estonia is even larger – 2,419,035 hectares. Forest area was relatively stable in Estonia in the first half of the 20th century (1.4 million hectares or about 33%) and the significant variations in the percentage of forests in the literature of that time are caused by the differences in the definitions of forests.

The percentage of forest land has continuously increased since the late 1950s and has reached 51% of the total land area. The increase in the ratio of forest is mostly caused by the afforestation of former grasslands and wetlands. This was mostly done in the 1960s and 1970s and the ratio of forest increased by 10%. In the 1990s, the ratio of forest increased by 6% as agricultural activity lessened. Since Estonia joined the EU, the area of forest land has stabilised as EU agricultural subsidies were implemented in Estonia, therefore decreasing afforestation of agricultural land.

In recent years, unowned forest land that was largely not managed have been given to the use of the State Forest Management Centre (Riigimetsa Majandamise Keskus – RMK). As a result, the area of forest land of RMK has increased by 119,000 ha in the past five years (2012–2016). Thereby, the area of forests that are actually managed has also increased. At the same time, the area of forests under strict protection that are not managed has increased mostly because of the forests of RMK.

The total stock of trees growing in Estonian forests is 476 m^3, or 206 m^3 per one hectare of forest land on average. The annual increment of forests is 16 million m^3. 486 million m^3 of timber grows on the forest land as defined by the Kyoto Protocol. In addition to forest land, 2.2 million m^3 of timber grows on grasslands and in coppices. More standing and fallen deadwood, a total of 16 million and 23 million m^3, is left behind in order to increase biodiversity. There is an average of 16.8 m^3 of deadwood per hectare.

Estonia is near the northern border of hemiboreal climate. There is an equal area of forest stands with deciduous and coniferous trees (50% of each). The average hectare stock of coniferous forest stands is larger and therefore, they also have the majority in terms of volume, making up 56% of the stock. The three most widespread species are Scots pine, Norway spruce, and birch, making up 80% of the forest land area and 82% of the growing stock as predominant tree species. They are followed by grey alder, aspen, and black alder, which make up 19% of the forest land area and 17% of the stock. The rest of the tree species are less than 2% of both the forest land area and the stock.

The average age of forest stands is 55 years. The percentage of mature forest stands of the total forest land area is over a quarter – 27%. Forest stands that are over 100 years old take up over 6% of the forest land area. A little over 10% of forests are under strict protection – those areas are not considered in regular forest management.

The forest and timber industries contribute significantly to Estonian economy. The timber, paper, and furniture industries made up 20% of the total production of the processing industry in 2016. The forest and wood clusters made a significant contribution to Estonian foreign trade – their export was 13% in 2016 (over 1.5 billion euros).

In the past fifteen years, the annual felling volume has been relatively volatile. In the past four years, the intensity of felling has stabilised (Figure 2.12). In 2015, the total volume was 10.1 million m^3; 81% of this was regeneration felling and 17% was maintenance felling.

Forest areas and timber use make up 74.8% of Land use, land-use change and forestry (LULUCF) sector emissions/removals. In recent years, carbon sequestration has been steady in relation to the stabilisation of felling intensity.

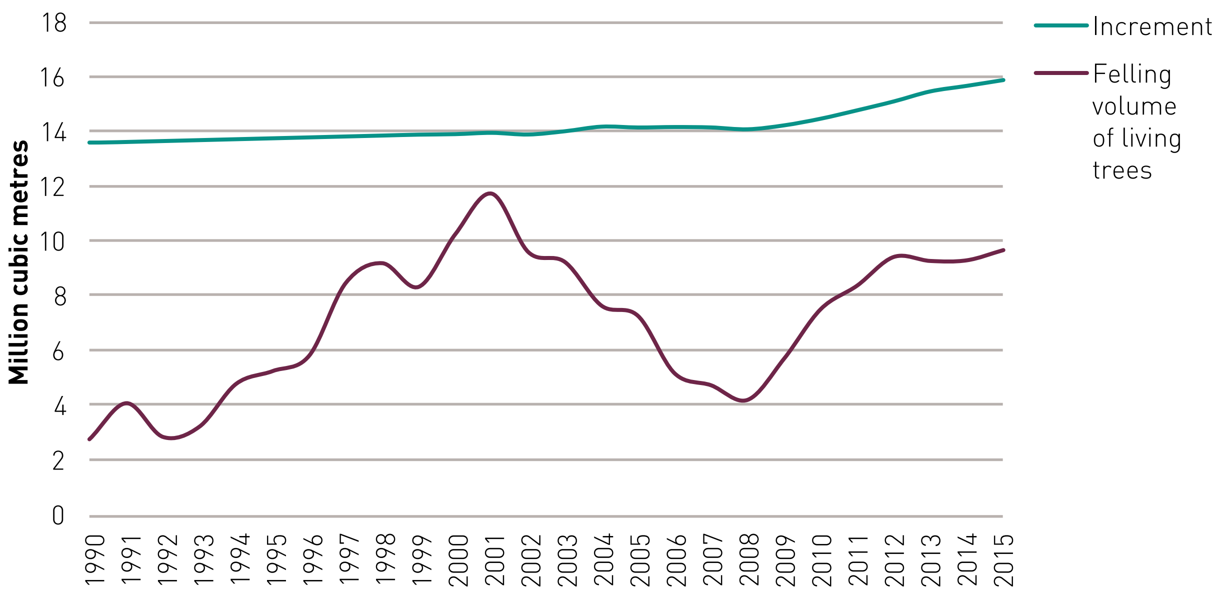

Figure 2.12. Felling volume and increment of living trees 2000–2015, million m^3 (Statistics Estonia, 2017)

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III

Greenhouse gas inventory information, including information on national systems and national registries

KEY DEVELOPMENTS

• Estonia's total greenhouse gas emissions in 2015 were 18,040.48 kt CO_2 equivalent (with indirect CO_2), excluding net emissions from Land use, land-use change and forestry. Emissions decreased by 55.3% in 1990–2015 due to transition from a planned economy to a market economy.

• Since the 6th National Communication on Climate Change Estonia has developed more accurate emissions estimates following the adoption of new data, methods and source/sink categories.

3.1. Introduction and summary tables

This chapter sets out Estonia's greenhouse gas (GHG) emissions and their trends for the period 1990-2015. It also provides information on Estonia's national system for GHG inventory and the national registry. The GHG data presented in the chapter is consistent with Estonia's 2017 submission to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat. Summary tables of GHG emissions in the common reporting format (CRF) are presented in Annex I. The chapter presents data on direct GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

3.2. Descriptive summary of emission trends

3.2.1. Overall greenhouse gas emission trends

Estonia's total GHG emissions in 2015 were 18,040.48 kt CO_2 equivalent (eq.) (with indirect CO_2), excluding net emissions from LULUCF (Land use, land-use change and forestry). Emissions decreased by 55.3% in 1990–2015 (see Table 3.1). This decrease was mainly caused by the transition from a planned economy to a market economy and the successful implementation of the necessary reforms.

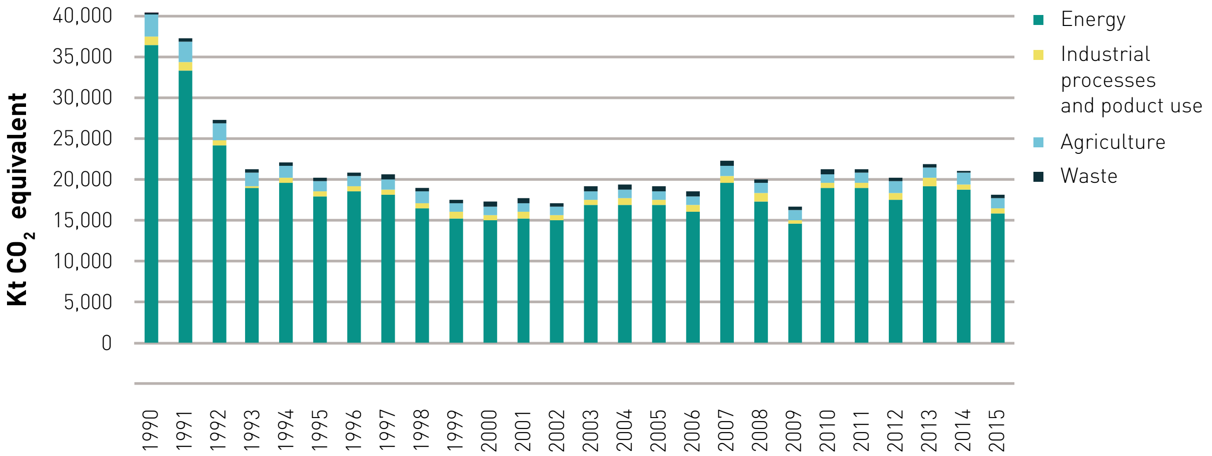

Figure 3.1. Estonia's GHG emissions by sector 1990–2015, excluding LULUCF, kt CO_2 eq.

Estonia's Kyoto Protocol (KP) target was to reduce GHG emissions by 8% during the period of 2008–2012 compared to the level of 1990. Estonia has met its commitments for the first commitment period (2008–2012) under the KP. Emission trends by sector are given in Figure 3.1.

The Energy sector is by far the largest producer of GHG emissions in Estonia. In 2015, the sector accounted for 87.9% of Estonia's total GHG emissions (Figure 3.2).

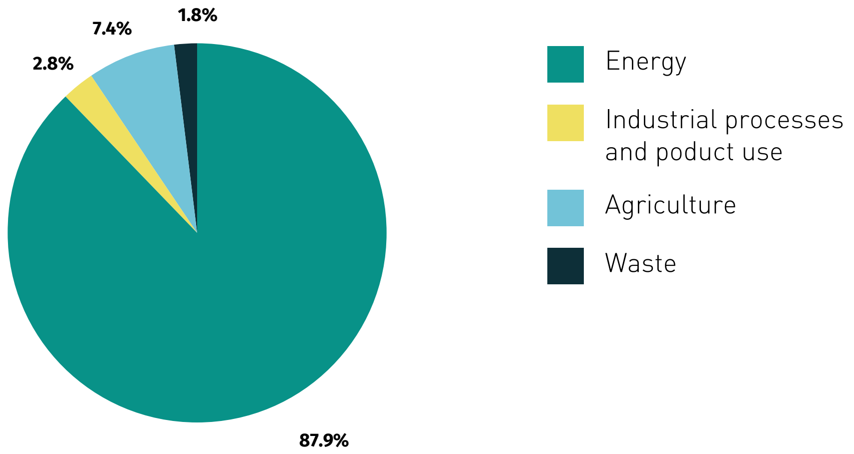

Figure 3.2. GHG emissions by sector in 2015, %

The second largest sector is Agriculture, which accounted for 7.4% of total emissions in 2015. Emissions from the Industrial processes and product use (IPPU) as well as Waste sector accounted for 2.9% and 1.8% of total emissions, respectively.

Table 3.1. GHG emissions and removals by sector in 1990, 1995, 2000, 2005 and 2010–2015, kt CO_2 eq.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
Energy	36,397.4	17,855.2	14,974.9	16,787.4	18,939.3	18,887.8	17,496.6	19,181.2	18,691.2	15,863.9
Industrial processes and product use (incl. indirect CO_2)	965.7	637.4	697.6	726.4	537.6	660.5	904.4	996.0	707.7	512.9
...Indirect CO_2 (from NMVOCs reported under IPPU 2.D.3 Solvent use and road paving with as-phalt)[1]	20.9	20.6	19.2	19.1	18.7	16.5	13.5	12.9	14.0	14.6
Agriculture	2,669.7	1,326.1	1,078.0	1,129.1	1,192.4	1,218.4	1,307.4	1,303.5	1,341.9	1,337.6
Waste	369.9	397.7	562.8	513.9	474.2	416.1	409.6	375.5	340.3	326.1
Total (excl. LULUCF incl. indirect CO_2)	40,402.7	20,216.4	17,313.3	19,156.6	21,143.5	21,182.7	20,118.1	21,856.3	21,081.1	18,040.5
Land use, land-use change and forestry	−1,734.7	−1,807.2	−3,396.7	−2,690.9	−1,924.4	−2,078.6	−2,083.6	−1,487.3	−17,54.9	−2,359.2
Total (incl. LULUCF and indirect CO_2)	38,668.0	18,409.2	13,916.6	16,465.9	19,219.1	19,104.1	18,034.4	20,369.0	19,326.2	15,681.3

[1] Indirect CO_2 emissions are calculated from NMVOCs reported under Industrial processes and product use (IPPU) 2.D.3 (CRF) Solvent use and road paving with asphalt.

The LULUCF sector, acting as the only possible sink of GHG emissions in Estonia, plays an important role in the national carbon cycle. In 2015, the LULUCF sector acted as a CO_2 sink, with a total uptake of 2,359.2 kt CO_2 eq. (Table 3.1). Uptake of CO_2 has increased by 36% compared to the base year (1990) and by 34% compared to the previous year (2014).

In 2015, the main GHG in Estonia was CO_2, accounting for 88.1% of the total GHG emissions (with indirect CO_2 and without LULUCF) expressed in CO_2 eq., followed by CH_4 with 5.9% and N_2O with 4.8%. Fluorinated gases (the so-called F-gases) collectively accounted for about 1.2% of overall GHG emissions (Figure 3.3).

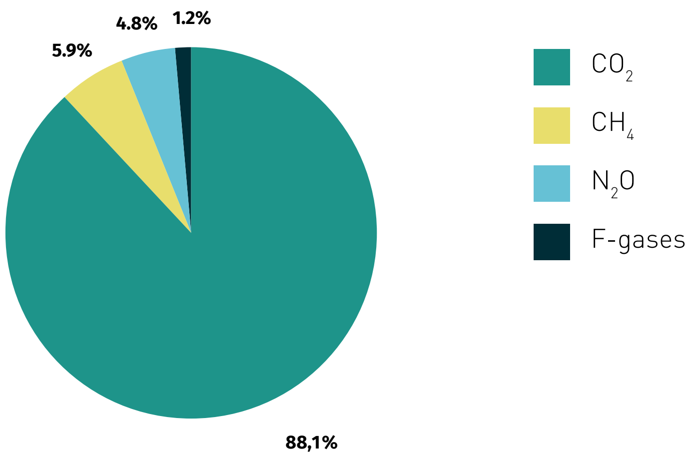

Figure 3.3. Greenhouse gas emissions by gas in 2015, %

Emissions of CO_2 (with indirect CO_2) decreased by 57.2% from 37,069.2 kt in 1990 to 15,885.4 kt in 2015 (Table 3.2), especially CO_2 emissions from the Energy subsector Public electricity and heat production, which is a major source of CO_2 in Estonia.

Methane is the second most significant contributor to GHG emissions in Estonia after CO_2. Emissions of CH_4 decreased by 44.5% from 1,909.6 kt CO_2 eq. in 1990 to 1,059.1 kt CO_2 eq. in 2015. The downturn was especially noticeable in the Agriculture sub-sector Enteric fermentation, which is a major source of CH_4 in Estonia.

Emissions of N_2O decreased by 38.3% from 1,423.9 kt CO_2 eq. in 1990 to 871.0 kt CO_2 eq. in 2015, especially N_2O emissions from the Agriculture sub-sector Agricultural soils, which is the main contributor of N_2O emissions in Estonia.

Emissions of F-gases (HFCs, PFCs and SF_6) increased from 0 kt CO_2 eq. in 1990 to 225.1 kt CO_2 eq. in 2015, especially HFC emissions from Refrigeration and air conditioning, which is a major source of halocarbons in Estonia. A key driver behind the growing emission trend in the Refrigeration and air conditioning sector has been the substitution of ozone-depleting substances (ODS) with HFCs.

Table 3.2. GHG emissions by gas in 1990, 1995, 2000, 2010 and 2010–2015, excluding LULUCF, kt CO_2 eq.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
CO_2 emissions incl. indirect CO_2 (excl. net CO_2 from LULUCF)	37,069.2	18,204.8	15,362.6	17,135.8	19,015.1	19,097.0	17,937.9	19,695.6	18,910.2	15,885.4
Indirect CO_2 (from NMVOCs reported under IPPU 2.D.3 Solvent use and road paving with asphalt)[1]	20.9	20.6	19.2	19.1	12.9	14.0	14.6	15.2	15.7	15.9
CH_4 emissions (excl. CH_4 from LULUCF)	1,909.6	1,263.8	1,238.8	1,208.3	1,196.2	1,127.0	1,146.2	1,138.1	1,106.4	1,059.1
N_2O emissions (excl. N_2O from LULUCF)	1,423.9	716.3	630.2	676.6	754.8	773.6	838.9	813.3	844.9	871.0
HFCs	NO	28.5	79.2	135.0	175.5	183.3	193.2	207.3	217.5	222.8
PFCs	NO	NO	NO	NA, NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	3.1	2.6	1.0	1.7	1.8	1.9	2.0	2.1	2.3
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (excl. LULUCF)	40,402.7	20,216.4	17,313.3	19,156.8	21,143.5	21,182.7	20,118.1	21,856.3	21,081.1	18,040.5
Total (incl. LULUCF)	38,668.0	18,409.2	13,916.6	16,465.8	19,219.1	19,104.1	18,034.4	20,369.0	19,326.2	15,681.3

3.2.2. Greenhouse gas emissions by sector

Energy

Estonia's emissions from the Energy sector are divided into the following categories: Fuel combustion, incl. Energy industries; Manufacturing industries and construction; Transport; Other sectors; Other; and Fugitive emissions from fuels. The share of emissions by category is presented in Figure 3.4.

The Energy sector is the main source of GHG emissions in Estonia. In 2015, the sector contributed 87.9% of all emissions, totalling 15,863.9 kt CO_2 eq. 99.9% of emissions in the sector originated from fuel combustion – only 0.1% were from fugitive emissions.

Energy-related CO_2 emissions varied mainly in relation to the economic trend, the energy supply structure and climate conditions. The decrease of GHG emissions between 1990 and 1993 is related to major structural changes in the economy after Estonia regained its independence from the Soviet Union. A small increase of emissions in 1994 is related to the growing energy demand in the transport sector. After that, the emissions from the Energy sector were rather steady (slight decrease until 2002). In 2003, the emissions increased mainly due to the export of electricity based on oil shale. The large increase of emissions between 2006 and 2007 is related to the overall economic upturn and the decrease of emissions between 2007 and 2009 to the overall economic downfall. Since 2009, the GHG emissions are strongly related to the volume of exported electricity that is mainly produced from oil shale.

Emissions from the Energy sector decreased by 56.4% compared to 1990 (incl. Energy industries – 58.2%; Manufacturing industries and construction – 80.1%; Transport – 6.2%; Other sectors – 62.6%; Other – 38.3%; and Fugitive emissions from fuels – 69.1%). This major decrease was caused by structural changes in the economy after 1991 when Estonia regained its independence. There has been a drastic decrease in the consumption of fuels and energy in energy industries (closing of factories), waste (reorganisation and dissolution of collective farms), transport (the proportion of new and environmentally friendly cars has increased and the number of agricultural machines has decreased), households (energy saving) etc. The overall progression of GHG emissions in the Energy sector in CO_2 eq. is presented in Figure 3.4.

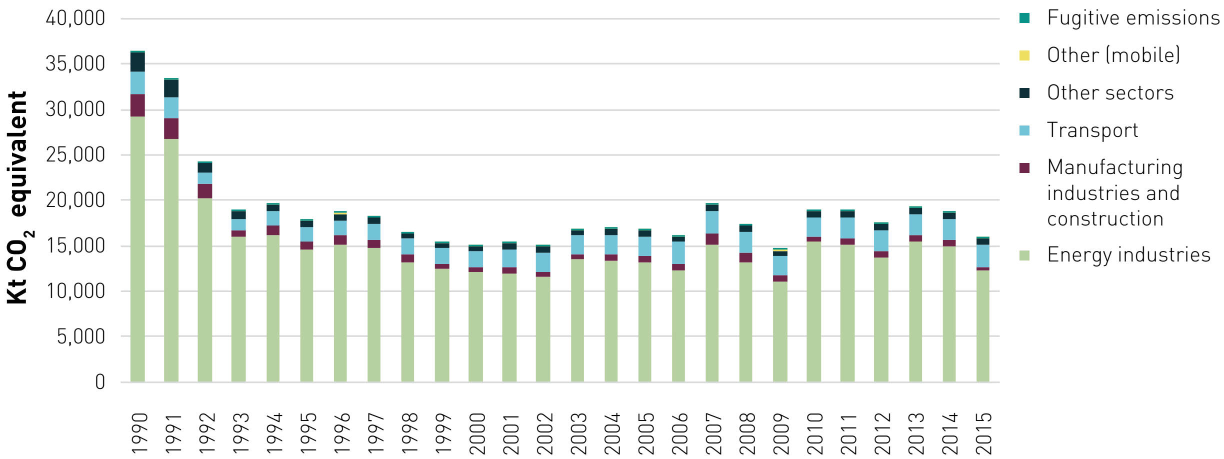

Figure 3.4. Trend in emissions from the Energy sector 1990–2015, kt CO_2 eq.

Industrial processes and product use

Estonia's GHG emissions from the IPPU sector are divided into the following categories:

- Mineral industry (emissions from cement, lime, glass production and other process uses of carbonates);
- Chemical industry (historically, ammonia and carbamide were produced);
- Non-energy products from fuels and solvent use (CO_2 emissions from lubricant and paraffin wax use and urea-based catalysts for motor vehicles, as well as non-methane volatile organic compounds (NMVOC) emissions from solvent use and road paving with asphalt);
- Product uses as substitutes for ODS (HFC emissions from refrigeration and air conditioning, foam blowing, fire protection and aerosols);
- Other product manufacture and use (SF_6 emissions from electrical equipment, SF_6 and PFC emissions from other product use and N_2O emissions from product use).

Additionally, Estonia reports indirect CO_2 emissions calculated from NMVOC emissions under CRF category 2.D.3.

In 2015, the IPPU sector contributed 2.84% of all GHG emissions in Estonia, totalling 512.9 kt CO_2 eq. with indirect CO_2 (and 497.0 kt CO_2 eq. without indirect CO_2). The most significant emission sources were CO_2 emissions from cement production at 40% and HFC emissions from refrigeration and air conditioning at 43% of total emissions of the sector (with indirect

CO_2). Compared to 2014, the emissions from IPPU (with indirect CO_2) decreased by 27.5% in 2015. This decrease in emissions is caused by the temporary lower output of the mineral industry because of economic slowdown.

Industrial CO_2 emissions have fluctuated strongly since 1990, reaching their lowest level in 1993. The decrease in emissions during the early 1990s was caused by the transition from a planned economy to a market economy after 1991 when Estonia regained its independence. This led to less extensive industrial production and to an overall decrease in emissions from industrial processes between 1991 and 1993. In 1994, the economy began to recover and production increased. The decrease in emissions in 2002 and 2003 was caused by the reduction in ammonia production, as the only ammonia factory in the country was being reconstructed. The sudden increase in emissions in 2007 was mainly caused by an increase in cement production, as the only cement factory had renovated its third kiln. In 2009, the industrial processes sector was affected by the recession. The decline in production was mainly due to insufficient demand on both the domestic and external markets. The increase in emissions in 2011 was caused by an increase in cement production. CO_2 emissions rose in 2012 and 2013, because a power plant temporarily used large amounts of limestone for flue gas desulphurisation.

The overall progression of GHG emissions in the IPPU sector in CO_2 eq. is presented in Figure 3.5.

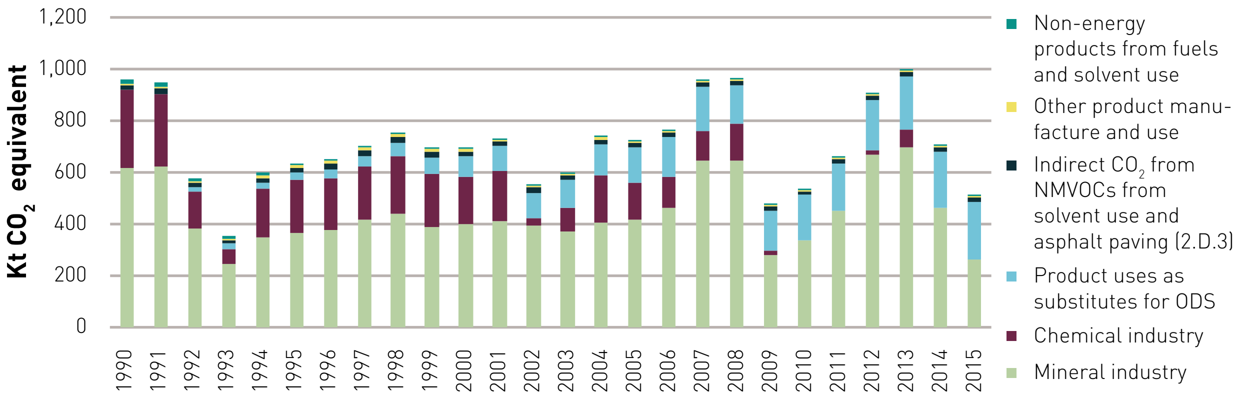

Figure 3.5. Trend in emissions from Industrial processes and product use sector 1990–2015, kt CO_2 eq.

Agriculture

Agricultural GHG emissions in Estonia consist of CH_4 emissions from Enteric fermentation of domestic livestock, N_2O emissions from Manure management systems, direct and indirect N_2O emissions from Agricultural soils, as well as CO_2 emissions from Liming and Urea application to agricultural soils. Direct N_2O emissions include emissions from synthetic fertilisers, emissions from animal waste, compost and sludge applied to agricultural soil, emissions from crop residues and cultivation of organic soils and emissions from urine and dung deposited by grazing animals. Indirect N_2O emissions include emissions due to atmospheric deposition, leaching and run-off.

The total GHG emissions reported in the Agricultural sector of Estonia were 1,337.6 kt CO_2 eq. in 2015. The sector contributed about 7.4%[2] to the total CO_2 eq. emissions in Estonia. In 2015, the emissions from enteric fermentation decreased by 3.5% and from manure management

[2] GHG emissions related to LULUCF sector are not included.

by 6.8% compared to the previous year due to a fall in the numbers of dairy cattle and swine. The dairy industry has suffered a decline in production due to economic sanctions imposed by Russia on EU starting from August 2014. Consequently, the number of dairy cattle in 2015 dropped by 5.2% in comparison with 2014. The number of swine has fallen 16% in Estonia as a result of the outbreak of African swine fever in the region in 2015.

Emissions from agricultural soils and enteric fermentation of livestock were the major contributors to the total emissions recorded in the sector – 48% and 40%, respectively.

As a result of the markets of the former Soviet Union collapsing in the early 1990s, Estonia was left with a large excess supply of agricultural produce. Western markets remained closed to Estonian agricultural products, mostly for two reasons – high customs barriers and non-compliance of our products with the requirements and practices abroad. Production prices in Estonia fell to a level of up to 50% lower than the prices on world markets and became insufficient for covering production costs. All of this led to a rapid decline of agricultural production in Estonia and explains why the emissions from the Agricultural sector declined by 49.9% by 2015 compared with the base year (1990). In 2002–2008, the most important driving force for Estonian agriculture was the accession to the EU and the implementation of the accompanying common agricultural policy of the EU, a significant effect of which appeared a few years before joining. The positive impact on the agricultural production manifested years preceding the accession to the EU and is reflected in the turnover of a downward GHG emissions trend that began in the 1990s.

The overall progression of GHG emissions in the Agriculture sector is presented in Figure 3.6.

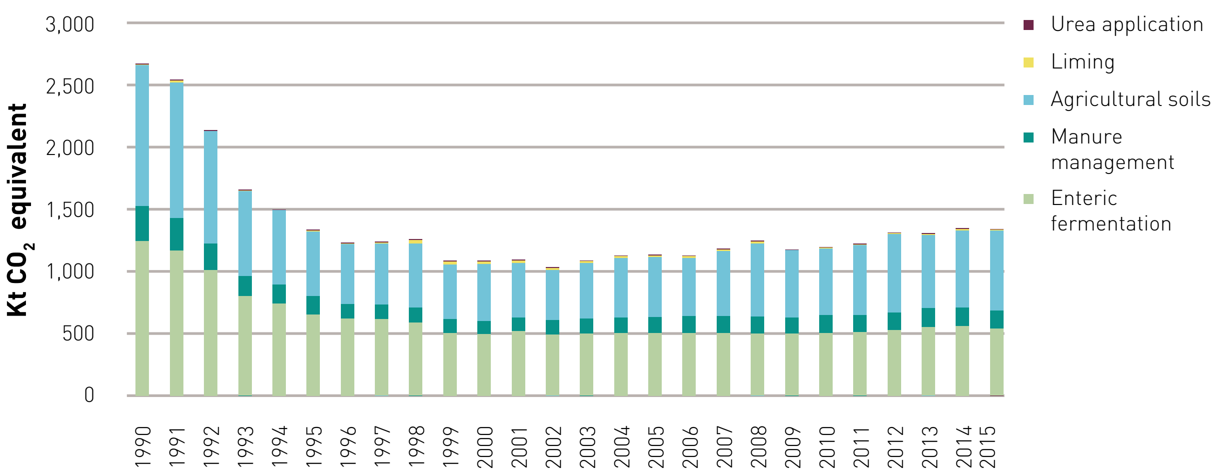

Figure 3.6. GHG emissions from Agriculture sector 1990–2015, kt CO_2 eq.

Land use, land-use change and forestry

The LULUCF sector, acting as the only possible sink of GHG emissions in Estonia, plays an important role in the national carbon cycle. Emissions and removals from the LULUCF sector are divided into the following categories: Forest land, Cropland, Grassland, Wetlands (peatland), Settlements, Other land, and Harvested wood products (HWP). Each category, except HWP, is further divided into subcategories *land remaining* and *land converted into*.

The share of LULUCF sector emissions and removals by each land use category during the period of 1990–2015 is presented in Figure 3.7. In 2015, the LULUCF sector acted as a CO_2 sink, the uptake totalling 2,359.2 kt CO_2 eq. Compared to the base year (1990), the uptake of CO_2 in LULUCF sector has increased by 36% and compared to the previous year (2014), 34.4%. The main driver behind the LULUCF sector sink is harvest rates, expanding settlements area, Harvested wood products and emissions from organic soils. A key driver behind the harvest trend has been the socio-economic situation in Estonia.

The majority of CO_2 removals in the LULUCF sector originates from the biomass increment in forest land remaining forest land and land converted into forest land subcategories. In 2015, forest land and HWP were the only net sink categories.

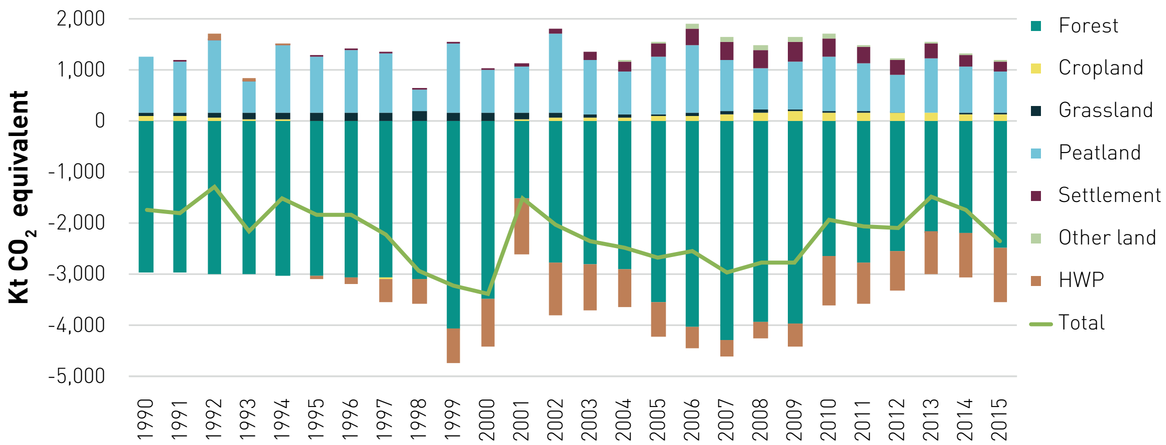

Figure 3.7. GHG emissions and removals from Land use, land-use change and forestry sector 1990–2015, kt CO_2 eq.

Waste

Estonia's GHG emissions from the Waste sector covers solid waste disposal sites which include solid municipal and industrial waste as well as domestic and industrial sludge. The Waste sector also covers GHG emissions which include both CH_4 and N_2O emissions from biogas burnt in flare waste incineration without energy recovery and open burning of waste, biological treatment of solid waste and wastewater treatment and discharge from the domestic and industrial sector. CO_2 emission is reported from non-biogenic incineration without energy recovery. The share of emissions by each category is presented in Figure 3.8.

Compared to the base year of 1990, the amount of CO_2 eq. emission in 2015 is 11.8% lower; compared to 2014, the CO_2 eq. decreased by about 4.2%. The total emission from the Waste sector has been in a decreasing trend in recent years.

In 2015, the Waste sector contributed 1.8% of all GHG emissions, totalling 326.1 kt CO_2 eq. Solid waste disposal is the highest contributor to total emissions in the waste sector in Estonia and is, compared to the base year of 1990, in a decreasing trend with 12.4%. CO_2 eq. emissions from incineration and open burning of waste has decreased by about 58.2% and Wastewater treatment and discharge decreased by 41.1%. On the other hand, emission from Biological treatment of solid waste has increased twice – 113.8%. Burning biogas in a flare has been taking place since 1999 and is connected to the number of active plants. The increase of burning biogas in a flare since 1999 is 1.5%.

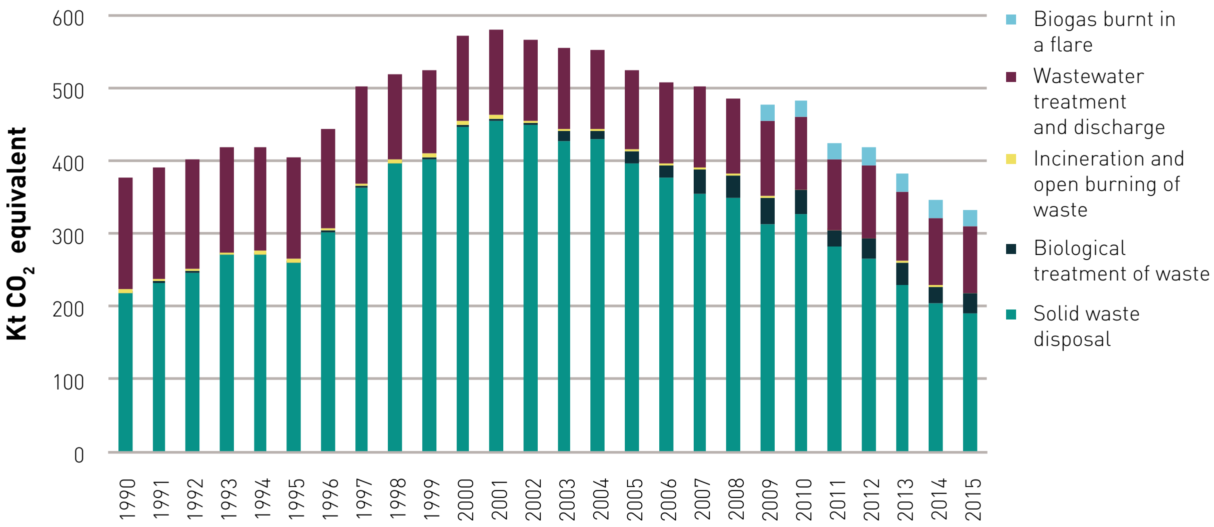

Figure 3.8. GHG emissions from the Waste sector 1990–2015, kt CO_2 eq.

Reporting under paragraphs 3 and 4 of Article 3 of the Kyoto Protocol

Estonia reports activities under paragraph 3 of Article 3 and Forest management under paragraph 4 of Article 3 of the KP. Estonia has chosen to account for KP-LULUCF activities at the end of the commitment period.

Under paragraph 3 of Article 3 of the KP, Estonia reports emissions and removals from afforestation (A), reforestation (R) and deforestation (D). Under paragraph 4 of Article 3, Forest management (FM) is reported.

Afforestation and reforestation activities incl. emissions from biomass burning were estimated to be –177.8 kt CO_2 eq., whereas Deforestation resulted in a net emission of 184.6 kt CO_2 eq. Areas subject to A, R and D were 59,382 ha and 19,589 ha, respectively, by the end of 2015. Annual rates of afforestation and deforestation have declined continuously from 1.78 kha to 0.04 kha per year for A and R and from 1.81 kha to 0.19 kha per year for D during the period of 2008–2015. In 2015, FM contributed to the total GHG balance with an uptake of –2,438.3 kt CO_2 eq. and with HWP –3,518.5 kt CO_2 eq. Total area of FM was 2,361 kha.

3.3. Greenhouse gas inventory system, under Article 5, paragraph 1, of the Kyoto Protocol

3.3.1. Institutional arrangements

The Ministry of the Environment (MoE) is the national entity with overall responsibility for organising and coordinating the compilation of GHG inventory reports and submitting them to the UNFCCC Secretariat and the European Commission. The inventory is produced in collaboration between the MoE, Estonian Environmental Research Centre (EERC) and Estonian Environment Agency (ESTEA).

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The MoE is responsible for:

- coordinating the inventory preparation process as a whole;
- approving the inventory before official submission to the UNFCCC;
- reporting the GHG inventory to the UNFCCC, incl. the National Inventory Report (NIR) and CRF tables;
- entering into formal agreements with inventory compilers;
- coordinating cooperation between the inventory compilers and the UNFCCC Secretariat;
- informing the inventory compilers of the requirements of the national system and ensuring that existing information in national institutions is considered and used in the inventory where appropriate;
- informing the inventory compilers of new or revised guidelines;
- coordinating the UNFCCC inventory reviews and communication with the expert review team, incl. responses to the review findings.

The EERC is responsible for preparing the estimates for the Energy, IPPU, Agriculture and Waste sectors. The Data Management Department of the ESTEA is responsible for LULUCF and KP LULUCF estimates. Sectoral experts collect activity data, estimate emissions and/or removals, implement quality control (QC) procedures and record the results, fill in sectoral data to the CRF Reporter and prepare the sectoral parts of the NIR. These experts are also responsible for archiving activity data, estimates and all other relevant information according to the archiving system.

The EERC, as the inventory coordinator, was responsible for:

- compiling the NIR according to the parts submitted by the inventory compilers;

- coordinating the implementation of the quality assurance and quality control (QA/QC) plan;
- coordinating the inventory process;
- the overall archiving system.

The three core institutions: MoE, EERC and ESTEA work together to fulfil the requirements for the national system. The overview of the allocation of responsibilities is shown in Figure 3.9.

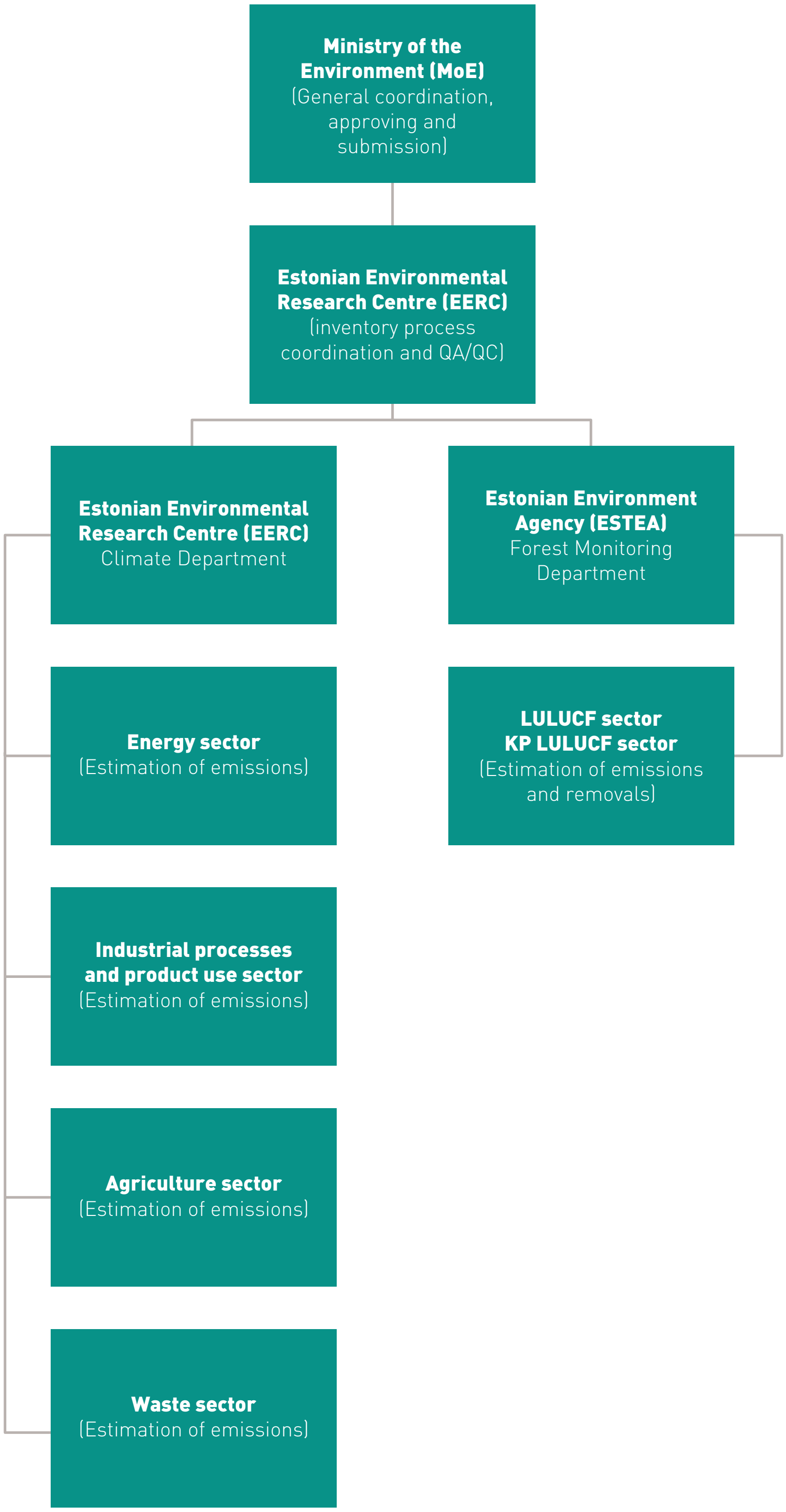

Figure 3.9. Overview of institutional arrangements for compilation of Estonia's 2017 GHG inventory

Legal arrangements

In accordance with §143 of the Atmospheric Air Protection Act (RT I, 05.07.2016, 1), activities for the reduction of climate change are organised by the MoE. The basis of the requirements for the restriction of GHG emissions' limit values are provided by the UNFCCC, the KP and the European Union legislation.

In accordance with §6 of the Statutes of the MoE (RT I 2009, 63, 412), the MoE is responsible for climate change related tasks and according to §23 section 8, the Climate and Radiation Department task is to organise, develop and implement climate change mitigation and adaptation policies. In accordance with the Statutes of the Climate and Radiation Department of the MoE, the department is responsible for organising and coordinating GHG emission reporting activities under the UNFCCC, the KP and the EU legislation.

The ESTEA is a state authority administered by MoE, which was formed as a result of the merger of the Estonian Meteorological and Hydrological Institute (EMHI) and the Estonian Environment Information Centre (EEIC) in 2013. In accordance with §9 section 5 of the Statute of the ESTEA, the tasks of the Data Management Department are to collect, process, analyse and publicise sectoral data, comply national and international reporting obligations.

The EERC is a joint stock company, all of the shares in which are held by the Republic of Estonia. The EERC belongs to the government area of the MoE. It compiles the GHG inventory on the basis of contract agreements with the MoE.

A three-year contract agreement (for the 2011, 2012 and 2013 submissions) was entered into with the EERC for inventory compilation in the IPPU and Waste sectors. A one-year contract agreement (for the 2013 submission) was entered into with the EERC for inventory preparation in the Energy and Agriculture sectors and for inventory coordination.

A new contract agreement with the EERC for inventory compilation in the Energy, IPPU, Agriculture and Waste sectors and for inventory coordination was entered into in 2013 for three years (for the 2014, 2015 and 2016 submissions). Again, a new contract agreement with the EERC for inventory compilation in the Energy, IPPU, Agriculture and Waste sectors and for inventory coordination was entered into in 2016 for three years (for the 2017, 2018 and 2019 submissions). The MoE plans to use the three-year contract approach in the coming years to ensure the continuity of inventory preparation.

The Statistics Estonia collects statistical data on the basis of the Official Statistics Act §3(2), taking into consideration the official statistical surveys approved by the Government of the Republic.

3.3.2. Inventory process

The UNFCCC, the KP and the EU greenhouse gas monitoring mechanism require Estonia to submit annually a NIR and CRF tables. The annual submission contains emission estimates for the years between 1990 and the year before last year.

Estonia's national GHG inventory system is designed and operated according to the guidelines for national systems under article 5, paragraph 1, of the KP to ensure the transparency, consistency, comparability, completeness and accuracy of inventories. Inventory activities include planning, preparation and management of the inventories.

The EERC and the MoE have developed an inventory production plan that sets out the schedule for inventory preparation. The schedule, which is annually reviewed, forms part of Estonia's QA/QC plan and must be followed by all core institutions.

Under the EU monitoring mechanism the annual inventory must be submitted to the Commission by 15 January. Member States may then complement and update their submissions by 15 March. The official GHG inventory is submitted to the UNFCCC Secretariat by 15 April.

The methodologies, activity data collection and emission factors are consistent with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006 GL).

The inventory process for the next inventory cycle starts with an examination of previous years and an analysis of the available datasets in order to improve the inventory through new knowledge and the activity data developed. Activity data is mainly based on official statistics and data from companies and the National Forest Inventory. The emission factors are national values, values recommended in the IPCC GL or values taken from other countries' GHG inventories.

Sectoral experts collect activity data, estimate emissions and/or removals, implement QC procedures and record the results, fill in sectoral data to the CRF Reporter and prepare the sectoral parts of the NIR. These experts are also responsible for archiving activity data, estimates and all other relevant information according to the archiving system. The EERC compiles the NIR according to the parts submitted by the inventory experts, evaluates the overall uncertainty of the inventory totals and performs key category analysis.

The uncertainty estimate of the 2017 inventory has been done according to the Tier 1 method presented by the IPCC 2006 GL. Tier 1 method combines the uncertainty in activity rates and emission factors, for each source category and GHG, and then aggregates these uncertainties, for all source categories and GHGs, to obtain the total uncertainty for the inventory. In many cases uncertainty values have been assigned based on default uncertainty estimates according to IPCC guidelines or expert judgement, because there is a lack of the information. For each source, uncertainties are quantified for emission factors and activity data.

Key categories are those of emissions/removals, which have a significant influence on the total inventory in terms of the absolute level of emissions or trends in emissions (or both). Estonia uses the Tier 2 method to identify key categories, and emission categories are sorted according to their contribution to emission levels or trends. The key categories are those that together represent 90% of the inventory level or trend.

The results of key category analysis are important because they guide decisions on methodological choice. The goal is to screen the long list of category-gas contributions and find those that are most important in terms of the emissions level or trend. The list of key categories forms the basis of discussions with the sectoral experts on the quality of the estimates and possible need for improvement.

Recalculations are made if errors, overlaps or inconsistencies in the time series are identified, when a new source or sink is considered or if more accurate knowledge becomes available. The driving forces in applying recalculations to Estonia's GHG inventory are the implementation of the guidance given in IPCC 2006 GL and the recommendations from the UNFCCC inventory reviews. In order to ensure the consistency of the emission inventory, recalculations are carried out on the whole time series, as far as possible.

All institutions involved in compiling the GHG inventory keep in close contact with one another. Several cooperation meetings are held annually to discuss and agree on methodological issues, problems that have arisen and improvements that need to be implemented.

Estonia has undertaken several projects to improve the quality of the country-specific emission factors and other parameters used in the GHG inventory (see Chapter 8).

3.3.3. Quality management

The starting point in accomplishing a high-quality GHG inventory is consideration of expectations and inventory requirements. The quality requirements set for annual inventories are continuous improvement, transparency, consistency, comparability, completeness, accuracy and timeliness. The setting of concrete annual quality objectives is based on these requirements. The next step is development of the QA/QC plan and implementing the appropriate quality control measures (e.g. routine checks and documentation) focused on meeting the quality objectives set and fulfilling the requirements. In addition, quality assurance (QA) procedures are planned and implemented. In the improvement phase of the inventory, conclusions are made on the basis of the realized QA/QC process and its results.

The MoE as the national entity has overall responsibility for the GHG inventory in Estonia, incl. responsibility for assuring that the appropriate QA/QC procedures are implemented annually. The EERC as the inventory coordinator is responsible for coordinating the implementation of the QA/QC plan.

Estonia's QA/QC plan consists of seven parts: (1) production plan; (2) annual meetings; (3) QA/QC checks; (4) QA results documentation form; (5) archiving structure; (6) response table to review process; and (7) list of planned activities and improvements.

The inventory meetings with participants from all institutes participating in the inventory preparation are held two times a year and the bilateral quality meetings between the quality coordinator (EERC) and the expert organisations are held whenever necessary.

QC procedures

The QC procedures used in Estonia's GHG inventory comply IPCC 2006 GL. General inventory QC checks include routine checks on the integrity, correctness and completeness of data, identification of errors and deficiencies, documentation and archiving of inventory data and quality control actions. Once the experts have implemented the QC procedures, they complete the QA/QC checklist for each source/sink category, which provides a record of the procedures performed. The QC checklist forms part of Estonia's QA/QC plan.

EERC checks the QC checklists completed by EERC and ESTEA. If it disagrees with a report, the errors are discussed and changes are made, where necessary. In addition to the general inventory QC procedures, Estonia applied category-specific QC procedures on some source/sink categories in the 2017 submission, focusing on key categories and on those categories in which significant methodological changes and/or data revisions occurred.

After the sectoral experts have completed entering data to the CRF Reporter, EERC carries out some general (incl. visual) checks on the data entered. When the CRF tables are finalized, the experts will start preparing the sectoral chapters of the NIR. These parts are sent to the compiler (EERC) who adds the introduction part and puts the draft NIR together. The compiler arranges the different chapters into one uniform document and makes sure that the structure of the report follows the UNFCCC guidelines. All figures on emissions and removals in tables and text are checked to make sure that they are consistent with those reported in the CRF. The sectoral experts and the inventory compiler also checks that all methodological changes, recalculations, trends in emission and removals are well explained.

In addition, the QA/QC of Member States' submissions conducted under the European Union GHG Monitoring Mechanism (e.g. completeness checks, consistency checks and comparison across Member States) produces valuable information on errors and deficiencies, and the information is taken into account before Estonia submits its final inventory to the UNFCCC.

When the draft NIR is completed it is sent to the MoE. The Climate and Radiation Department looks over the inventory report and makes sure that the submitted data is officially valid. Also, the structure of the report is assessed based on the established requirements. When there are no contradictions the report is introduced for coordination to the Forestry, Waste and Water Department and Deputy Secretary General on International Co-operation and afterwards to the Secretary General.

QA procedures

The objective of QA implementation is to involve reviewers that can conduct an unbiased review of the inventory and who may have a different technical perspective. It is important to use QA reviewers who have not been involved in preparing the inventory. These reviewers should preferably be independent experts from other agencies or national experts or groups not closely connected to national inventory compilation.

Estonia's GHG inventory is checked annually by one or more independent experts. From the 2009 submission to 2012 submission all data collected by institutions involved in the inventory process was checked by an independent expert from Tallinn University of Technology. In the 2013–2016 submission the inventory was reviewed in parts by the EERC, Tallinn University of Technology (TUT), University of Tartu (UT), Estonian University of Life Sciences (EULS) and other national experts. The 2017 submission was checked by experts from TUT, EULS and other national experts. The findings of the independent experts are looked through by experts (in collaboration with the EERC) and adjustments carried out as a result, if necessary.

UNFCCC reviews are part of QA. The reviews are performed by a team of experts from other countries. They examine the data and methods that Estonia is using and check the documentation, archiving system and national system. In conclusion, they report on whether Estonia's overall performance is in accordance with current guidelines. The review report indicates the specific areas in which the inventory is in need of improvement.

The draft NIR is uploaded to the MoE website *www.envir.ee* where all interested parties have the opportunity to comment on it. The inventory is also checked by different Ministries and institutions.

For a more detailed description of the QA/QC system, please see Estonia's National Inventory Report.

3.4. National registry

Directive 2009/29/EC, adopted in 2009, provides for the centralisation of the EU Emissions Trading System (ETS) operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the KP (26), plus Iceland, Liechtenstein and Norway, decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries – in particular Decision 13/CMP.1 and Decision 24/CP.8.

The consolidated platform which implements the national registries in a consolidated manner (incl. the registry of the EU) is called the Union registry and was developed together with the new EU registry on the basis the following modalities:

- Each Party retains its organisation designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
- Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
- Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
- Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
- The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
- The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public is fulfilled by each Party through a publicly available web page hosted by the Union registry;
- All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
    a. With regard to data exchange, each national registry connects to the ITL directly and establishes a secure communication link through a consolidated communication channel (VPN tunnel);

b. The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes in a way that those actions cannot be disputed or repudiated;

c. With regard to data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorised manipulation;

d. The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

e. In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the Union registry, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013. During the process of going live, all relevant transaction and holdings data were migrated to the Union registry platform and the individual connections to and from the ITL were re-established for each Party.

Information on registry administrator	Ms. Piret Väinsalu *khgregister@envir.ee* phone +372 6262 851
Cooperation with other countries concerning operation of the registry	EU Member States who are also Parties to the KP, plus Iceland, Liechtenstein and Norway, have decided to operate their registries in a consolidated manner. The Consolidated System of EU Registries (CSEUR) was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidating national registries. This description includes: • Readiness questionnaire • Application locking • Change management procedure • Disaster recovery • Manual intervention • Operational Plan

	• Roles and responsibilities • Security Plan • Time Validation Plan • Version change management A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as the second level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk notably with regard to connectivity or reconciliation issues.
Database structure and capacity of national registry	In 2012, the EU registry underwent a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the CSEUR. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidating national registries. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctiveness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and led to successful certification on 1 June 2012. In 2016, new tables were added to the database for the implementation of the CP2 functionality. Versions of the Union registry released after 6.1.6 (the production version at the time of the last National Communication submission) introduced other minor changes in the structure of the database. These changes were limited and only affected the functionality of EU ETS.
Conformity with DES	The overall change to the CSEUR triggered changes to the registry software and required new conformance testing. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidated national registries. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability

	testing, distinctiveness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and led to successful certification on 1 June 2012. Each release of the registry is subject to both regression testing and tests related to the new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to each release of a new version in Production. Annex H testing is carried out every year.
Procedures employed to minimise discrepancies in the issuance, transfer, acquisition, cancellation and retirement of registry units	The overall change to a CSEUR also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidated national registries.
Overview of security measures to prevent unauthorised manipulations and operator errors	The overall change to a CSEUR also triggered changes to security, as reflected in the updated security plan. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidated national registries. The mandatory use of hardware tokens for authentication and signature was introduced to registry administrators.
Information available to the public	Publicly available information is provided via the web page of the Union registry for each registry e.g. *https://ets-registry.webgate.ec.europa.eu/euregistry/EE/public/reports/publicReports.xhtml*. Following information is publicly accessible via the user interface of the MoE *http://www.envir.ee/et/kyoto-protokolli-alane-aruandlus*. Information regarding the National Registry is publicly available to users via the web page of MoE *http://www.envir.ee/et/eesmargid-tegevused/kliima/praktiline-info/kasvuhoonegaaside-heitkoguse-uhikutega-kauplemise*. Information referred to in Decision 13/CMP.1; II Registry requirements; E. Publicly accessible information in paragraphs 45–48 are as following: • account information (information on paragraph 45 of annex to the decision 13/CMP.1);

- joint implementation (JI) projects in Estonia (information on paragraph 46 of annex to the decision 13/CMP.1);
- information about unit holdings and transactions (information on paragraph 47 of annex to the decision 13/CMP.1);
- information about Entities Authorised to hold units (information on paragraph 48 of annex to the decision 13/CMP.1).

This information is currently available at:

1) Paragraph 45 of annex to the decision 13/CMP.1 (account information). This information is available to users via the user interface of the MoE *http://www.envir.ee/et/kyoto-protokolli-alane-aruandlus* and via European Union Transaction Log (EUTL) *http://ec.europa.eu/environment/ets/* (selecting from left hand menu: "ETS" – "Accounts" – "select Estonia" – "Search");

2) Paragraph 46 of annex to the decision 13/CMP.1 (information of JI projects in Estonia). This information is available to users via the user interface of the web page of the MoE *http://www.envir.ee/et/kyoto-protokolli-alane-aruandlus*;

3) Paragraph 47 of annex to the decision 13/CMP.1 (information about unit holdings and transactions). Following information is publicly accessible via the web page of the MoE *http://www.envir.ee/et/kyoto-protokolli-alane-aruandlus* and via the user interface of the EUTL *http://ec.europa.eu/environment/ets/* (selecting from left hand menu: "Transactions" – "Selecting Estonia and other relevant parameters displayed in the search field" – "Search"). In accordance with the annex XVI of the EC regulation (No. 2216/2004 of 21 December 2004), "the information for each completed transaction relevant for the registries system for year X shall be displayed from 15 January onwards of year X+5";

4) Paragraph 48 of annex to the decision 13/CMP.1 (information about Entities Authorised to hold units under its responsibility). Decision 280/2004/EC of the European Parliament and of the Council requires EU Member States to provide information on the legal entities authorised to participate in the mechanism under Articles 6, 12 and 17 of the KP in the NIR. Pursuant to Estonian legislation (§143 of the Atmospheric Air Protection Act), the Ministry of the Environment as a competent authority is authorised to trade with Assigned Amount Units (AAUs), Removal Units (RMUs), Emission Reduction Units (ERUs) and

Certified Emissions Reductions (CERs). Installations falling under the scope of the Directive 2003/87/EC are authorised to use ERUs and CERs for compliance according to the percentage set out in the National Allocation Plan for 2008–2020 and according to the Commission Regulation (EU) No. 1123/2013. This information is available to users via the user interface of the web page of the Ministry of the Environment: at *http://www.envir.ee/et/kyoto-protokolli-alane-aruandlus* and *http://www.envir.ee/et/eesmargid-tegevused/kliima/praktiline-info/eli-hksi-heitkoguste-aruandlus-juhendid-ja-vormid* (under "Rahvusvaheliste ühikute kasutusmäärad käitiste kaupa: Euroopa Komisjoni kinnitatud ICE tabel");

Public information required by Commission regulation (EC) No. 389/2013 (in addition to the above-mentioned public information):

1) Installation and permit details – information about installations and permit details is available to users via the user interface of the MoE *http://www.envir.ee/et/kyoto-protokolli-alane-aruandlus* (under "Käitajate arvelduskontod / Operator Holding Accounts") and via EUTL *http://ec.europa.eu/environment/ets/welcome.do?languageCode=en* selecting from left hand menu: "ETS" – "Operator Holding Accounts" – "Search" – "selecting Estonia";

2) Information about verified emissions, surrenders and compliance status of installations – information about verified emissions, surrenders and compliance status of installations is available to users via the user interface of the MoE web page at *http://www.envir.ee/et/eesmargid-tegevused/kliima/praktiline-info/eli-hksi-heitkoguste-aruandlus-juhendid-ja-vormid* (under "ELi HKSi käitiste nimekiri, heitkogused ja vastavusseisund") and from the interface of the EUTL *http://ec.europa.eu/environment/ets/*, selecting from left hand menu: "ETS" – "Allocation/Compliance" – "Search" – "selecting Estonia";

3) National allocation plan for Estonia (NAP) – information on national allocation plan for Estonia (NAP) is available via the user interface of the MoE web page at *http://www.envir.ee/et/eesmargid-tegevused/kliima/praktiline-info/eli-hksi-heitkoguste-aruandlus-juhendid-ja-vormid* and via the EUTL web page *http://ec.europa.eu/environment/ets/* selecting from left hand menu: "NAP-info" – "Search" – "selecting Estonia".

Internet address for the national registry	*https://ets-registry.webgate.ec.europa.eu/euregistry/EE/index.xhtml*
Measures taken to safeguard, maintain and recover data to ensure the integrity of data storage and recovery of registry services in the event of a disaster	The overall change to a CSEUR also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan**. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidated national registries.
Results of any test procedures that might be available or developed with the aim of testing the performance, procedures and security measures of national registry	On 2 October 2012, a new software release (called V4), incl. functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted. Prior to each release, security tests are carried out by the registry developer, the hosting organisation (DIGIT) and an independent security expert. Test reports for these tests are confidential, compliant with the standard security protocol, and may not be disclosed. The scope of the security tests includes source code analysis, vulnerability tests (OWASP) and penetration tests. Prior to specific release, load and stress tests are carried out by the hosting organisation (DIGIT). Both regression testing and testing of the new functionality are carried out prior to the release of the new versions in Production. The site acceptance tests are carried out by quality assurance consultants on the behalf of and assisted by the European Commission. - Annex H testing is carried out on an annual basis.

References

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IV

Policies and measures

KEY DEVELOPMENTS

- **The Parliament of Estonia has adopted the strategy for moving towards long-term emission reduction target which is set to reduce the emission of greenhouse gases by 80% by 2050 in comparison with the emission levels of 1990.**

- **Energy sector is the largest producer of greenhouse gas emissions and therefore the strategies regulating the sector are under closer attention. In accordance with Directive 2009/28/EC, Estonia must ensure that the share of energy from renewable sources amounts to 25% of the gross final consumption of energy by 2020. The share of renewable resources in final energy consumption was 28.6% on 2015, therefore Estonia has already reached its 2020 target and the share of renewable energy.**

- **The Government of Estonia approved the Estonian Energy Development Plan until 2030, which is aimed at ensuring an energy supply that is available to consumers at a reasonable price and effort and with an acceptable environmental condition, while observing the terms and conditions established in the long-term energy and climate policy of the European Union.**

4.1. Policy-making process

The major documents on environment-related issues are either passed by the Parliament (Riigikogu) or adopted by the Government. The relevant measures can be taken at the national and/or local level. The Parliament is the highest legislative body in Estonia. The Government of Estonia is the supreme executive body and the Ministry of the Environment (MoE) is the highest executive body responsible for carrying out national environmental policy.

The main mission of the Government Office is to support the Government and the Prime Minister in policy drafting and implementation. The Strategy Unit supports the planning of the work of the Government and coordinates the drawing up and carrying out of the Government's action plan, as well as strategic development plans to increase the country's competitiveness and for sustainable development. The Legal Department makes sure that the draft legislation of the Government complies with the Constitution and laws. The function of the EU Secretariat is to coordinate the development of Estonia's positions on issues relating to the EU and the transposition of EU legislation, as well as to advise and support the Prime Minister on issues relating to the EU and in the preparation of European Council summits.

The Constitution of the Republic of Estonia states that the natural wealth and resources of Estonia are national riches which shall be used economically. The function of the MoE is to establish prerequisites and conditions which ensure a natural environment rich in species and a clean living environment as well as guarantee the economical use of natural resources. Hence, the activities of the MoE focus on the utilisation of natural resources and environmental protection, balanced development of economic and social spheres, ensuring a well-functioning system necessary for the achievement thereof and the purposeful and well-considered use of resources allocated to environmental protection.

The MoE comprises seventeen departments, incl. the Climate and Radiation Department, the Forest Department, the Environmental Management Department, the Mineral Resources

Department and the Ambient Air Department. The jurisdictional structure of the MoE includes several subordinated entities:

- three state authorities (incl. the Estonian Environment Agency);
- six state-owned commercial enterprises and companies (incl. the Estonian Environmental Research Centre (EERC), the State Forest Management Centre and the Private Forest Centre);
- three governmental authorities: the Land Board, the Environmental Inspectorate and the Environmental Board.

The Environmental Inspectorate exercises supervision in all areas of environmental protection. It coordinates and executes supervision regarding the use of natural resources and the protection of the environment by applying the state's coercive measures on the basis and to the extent specified by law. Supervision activities have been classified into three main categories: environmental protection (which includes the integrated pollution prevention and control and protection of ambient air and ozone layer), nature protection and fisheries protection.

The Environmental Board was formed on 1 February 2009. It was established by merging the functions of three previous bodies: the State Nature Conservation Centre, the Radiation Centre and the departments of environmental services. Similarly, the Estonian Environment Agency was formed on 1 June 2013, by merging the functions of Estonian Environmental Information Centre and Estonian Meteorological and Hydrological Institute.

Some aspects having an impact on the environment and climate are in the scope of responsibilities of other ministries. The Ministry of Economic Affairs and Communications (MoEAC) is responsible for energy-related issues, incl. energy efficiency and conservation, transport and the use of renewable sources in the energy sector. The Ministry of Rural Affairs (MoRA) advises the Government in the field of agriculture and rural life. Some responsibilities of the Ministry of Finance include matters important to environmental management – taxation, use of state budget funds etc. All ministries are in charge of national development plans and programmes.

As a rule, new national environmental legislation is initiated by the Government or by the MoE. In some respects, the initiative can also come from the MoEAC or the MoRA.

The responsibilities of the Ministry of the Interior (MoI) include environment- and energy-related tasks concerning the handling and solving of crises. The functions of the Rescue and Crisis Management Department include developing and organising the implementation of a state crisis management policy based on the Emergency Act; organising the work of the Crisis Management Committee of the Government; coordinating nationwide training in the area of crisis management; and coordinating the crisis management-related activities of institutions in the MoI's area of government.

Coordination Council of EU issues ensures effective inter-ministerial cooperation. It is chaired by the director of EU affaires (in case of his/her absence by the head of EUs) and is comprised of representatives of all ministries and the Bank of Estonia.

In September 2009 the decision was taken to establish an energy and climate agency subordinated to the MoEAC. The main tasks of this institution were analysing and surveying energy- and climate-related activities and promoting sustainable development with relevant supporting investments. In summer 2011 the responsibilities of the agency were transferred to the financing institution KredEx, which belongs to the administrative area of the MoEAC.

The monitoring and regular evaluation of policies and measures (PaMs) adopted is usually performed by the institution that is implementing the relevant strategy document or action plan.

There has been an increase in the number of non-governmental organisations (NGOs) dealing with environmental problems and raising public awareness of matters related to the environment and sustainable development. Several NGOs have taken an active part in the preparation of environment-related development plans (e.g. Estonian Renewable Energy Association, Estonian Biogas Association).

During the period that has elapsed since Estonia regained its independence, great progress has been made in developing legislation. Estonian legal acts were amended in the process of integration with the EU, and today the country's legislation (incl. that on environmental management) is harmonised with the acquis communautaire of the EU.

According to §5 of the Constitution of the Republic of Estonia the natural wealth and resources of Estonia must be used economically, and §53 prescribes that everyone has a duty to preserve the human and natural environment and to compensate damage inflicted on the environment.

It is important to emphasise that §123 of the Constitution stipulates that if the laws or other legislation of Estonia are in conflict with international treaties ratified by the Parliament, the provisions of the international treaty shall prevail.

4.1.1. International agreements and conventions, EU legislation

Since regaining its independence in 1991, Estonia has entered into a number of bilateral or trilateral environmental agreements and has become a party to many environmental conventions and protocols. The conventions to which Estonia has acceded include New York (1992), Arhus (1998), Espoo (1991), Helsinki (1992), Geneva (1979), Rio de Janeiro (1992) and Vienna (1985).

The United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature on 9 May 1992, after an Intergovernmental Negotiating Committee produced the text of the Framework Convention as a report following its meeting in New York from 30 April to 9 May 1992. It entered into force on 21 March 1994. As of December 2015, UNFCCC has 197 parties. Estonia ratifed the Convention on 27 July 1994.

Estonia signed the Kyoto Protocol (KP) to the UNFCCC on 3 December 1998. The Protocol was ratified by the Estonian Parliament in September 2002. Estonia has fulfilled its emission reduction commitment under the KP which was set to reduce the emissions by 8% in the period of 2008–2012 compared to 1990.

Parties to the KP adopted an amendment to the KP by decision 1/CMP.8 in accordance with Articles 20 and 21 of the KP held in Doha, Qatar, in December 2012. A total of 144 instruments of acceptance are required for the entry into force of the Doha amendment establishing the second commitment period (2013–2020) of the KP. Doha amendment is not ratified yet. Estonia finished the national ratification process of the Doha Amendment in the first half of 2015. Estonia deposited the instruments of ratification on 21 December 2017 together with the EU. The second commitment period is consistent with the 2009 climate and energy package of legislation and reflects the package's reduction measures at EU and Member State level to gradually transform Europe into a low-carbon economy and to increase energy security. An agreement has been reached on legally binding targets which, by 2020, will:

- cut greenhouse gas (GHG) emissions by 20%;
- establish a 20% share for renewable energy in final consumption;
- improve energy efficiency by 20%.

Directive 2009/28/EC (amending and subsequently repealing Directives 2001/77/EC and 2003/30EC) on the promotion of the use of energy from renewable sources sets for Estonia a target (25%) for the share of energy from renewable sources in gross final consumption of energy by 2020.

Directive 2010/31/EC lays down requirements as regards:

- the common general framework for a methodology to calculate the integrated energy performance of buildings and building units;
- the application of minimum requirements for the energy performance of new buildings and new building units;
- national plans to increase the number of nearly zero-energy buildings;
- energy certification of buildings or building units;
- regular inspection of heating and air-conditioning systems in buildings;
- independent control systems for energy performance certificates and inspection reports.

In December 2015, the 2015 United Nations Climate Change Conference was held in Paris, during which 195 countries agreed to a legally binding treaty to combat global climate change. The agreement sets forth a global long term goal of holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels. The countries agreed to enforce measures to reduce GHG emissions substantially. Estonia deposited the instruments of ratification on the 31 October 2016. The agreement shall be implemented starting from 2020.

The Paris Agreement requires all Parties to contribute reaching the long term goals through nationally determined contributions (NDC). EUs NDC was set out in the conclusions by the European Council of October 2014 as an EU-wide binding target of at least 40% domestic reduction in GHG emissions by 2030 compared to 1990 incl. also Land use, land-use change and forestry (LULUCF) sector that needs to contribute to meeting the GHG reduction target of the EU. According to applied accounting rules, emissions may not exceed removals (so-called no-debit rule). In order to help Member States to meet the no-debit rule, certain flexibilities can be used if all preconditions are complied. For that purpose, the Commission introduced a proposal for a regulation on the 22 July 2016, which is currently under negotiation.

4.1.2. National GHG targets

The national reform programme Estonia 2020 was approved by the Government in April 2011 and is updated yearly. The last update was done in April 2017. The programme sets 3 main targets regarding GHG emissions and environmental economy and energy:

1. The GHG emissions covered by the Decision no 406/2009/EC (Effort Sharing Decision – ESD) should not exceed the GHG level of 11% growth by 2020 compared to 2005.
2. 25% share of renewable energy in final energy consumption by 2020.
3. Keep the final energy consumption on the 2010 level (about 118 PJ).

The target of reaching the 25% share of renewable energy in final energy consumption was already reached in 2011 (25.5%). The share of renewable energy in final energy consumption was 28.6% in 2015.

In 2011, the European Commission (EC) published A Roadmap for moving to a competitive low-carbon economy in 2050. Estonia finalised its report on Opportunities for a Low-Carbon Economy in Estonia in 2013. In the report it was concluded, that for Estonia the 75% decrease in GHG emissions by the year 2050 (compared to 1990) would be the most optimal amount. On the basis of the report, in the beginning of 2015 the MoE started to prepare Estonian low-carbon strategy General Principles of Climate Policy until 2050 (GPCP 2050), with the aim to decrease the GHG emissions 80% by 2050 compared to 1990. The roadmap was adopted by the Parliament on 5 April 2017 and includes sectoral policy guidelines for mitigation and political guidelines for adaptation to the effects of climate change. Please see additional information on GPCP 2050 under Chapter 4.2.3.

4.2. Domestic programmes and legislative arrangements as well as enforcement and administrative procedures

4.2.1. Strategy documents

The strategy documents and action plans are generally available at the websites of the responsible Ministries, that are also liable for the implementation procedures. During their compilation, the interested parties are able to input to the process. According to the Public Information Act (RT I 2000, 92, 597) holders of information are required to grant access to information in their possession pursuant to the procedure provided by law. Holders of information are also required to clearly explain the procedure for and the conditions and methods of access to information to persons making requests for information. The Constitution of the Republic of Estonia (RT T 1992, 26, 349) stipulates, that everyone have the right to address informational letters and petitions to government agencies, local authorities, and their officials.

GPCP 2050 is a vision document that sets a long term GHG emissions reduction target and policy guidelines for adapting to the impact of climate change or ensuring the preparedness and resilience to react to the impact of climate change.

Principles and guidelines in the document have to be taken into account when renewing and implementing the cross-sectoral and sectoral strategies and national development plans. Estonia will be transformed into an attractive environment mainly for the development of innovative technologies, products and services reducing the emission of GHG. In addition, the export and global implementation of such technologies, products and services shall be facilitated for the resolution of global problems. The general sectoral policy guidelines and principles of GPCP 2050 include:

- Efficient interaction of the system as a whole when planning energy consumption centres and new production capacities.
- Facilitating the implementation of technologies with a low emission factor of CO_2 and efficient use of resources in manufacturing processes.
- Considering economy and energy efficiency of the system as a whole when renovating the existing building stock and planning and constructing new buildings.
- Considering economy and energy efficiency when planning, building, managing and reconstructing grids within energy systems with the aim of achieving maximum energy and resource efficiency.
- Moving towards enhancing energetic value and the production of products with higher additional value to minimise the GHG emission in the oil shale treatment process in a way that does not entail an increase in other negative environmental impacts.
- Directing major participants in the energy and industry sectors towards a successful and cost-efficient reduction of GHG emissions while continuing the use of market based mechanisms.
- Ensuring energy security and security of supply with a gradual wider exploitation of domestic renewable energy sources in all sectors of final consumption with a view to increase the welfare of the society.
- Facilitating a well-functioning transportation system and reducing forced traffic through the integration of the planning of settlements and transportation and the design and implementation of mobility plans.
- Influencing the purchase of economical vehicles and sustainable alternative fuels through investments and tax policies of the public sector.
- Prioritising the development of public transportation, non-motorised traffic and energy efficient carriage of goods.
- Increasing and maintaining soil's carbon stock incl. developing and maintaining significant carbon stock of land areas.
- Encouraging efficient and ecological use of agricultural land while avoiding the falling out of agricultural use of such land.
- Enhancing the use of plant nutrients and replacement of mineral fertilisers with organic fertilisers and eco-friendly soil conditioners.
- Enhancing the production of bioenergy and using it in energy intensive manufacturing processes.

- Increasing the productivity of agriculture, with the focus on eco-friendlier manure management for limiting ammonia emissions.
- Increasing forest increment and ability to sequestrate carbon through timely regeneration of forests.
- Promoting the use of wooden products and increasing carbon storage in wooden products and buildings will help replace non-renewable natural resources and develop domestic wood production.
- Promoting the preservation of existing forest area and increasing carbon sequestration and emission reduction in other land-use categories.
- Preserving and increasing carbon stocks in wetlands. Avoiding further wetland drainage and already drained wetlands will be rewetted if possible to avoid further degradation.
- Preferring the development of research studies in Land use and forestry sector that will help to increase carbon sequestration and to find alternative uses for wood.
- Continuing the reduction of waste generation and making the separate collection of waste more efficient.
- Facilitating research, development and innovation that will help to increase the development of efficient energy technologies, renewable energy production technologies, sustainable transportation and mobility, sustainable agriculture, carbon sequestration in forestry and finding alternative uses for timber will be preferred.

The Estonian National Strategy on Sustainable Development – Sustainable Estonia 21 is the key overarching national strategy document aimed at developing the Estonian state and society up to 2030 ensuring that Estonia's policies meet sustainability criteria through integrating economic factors with principles of sustainable development. The strategy was compiled under the coordination of the MoE in close cooperation with experts and stakeholders from various institutions, and its approval was preceded by thorough public discussion. The strategy document was approved by the Parliament in 2005. Among the four main goals of the strategy there is one that requires the ecological balance to be sustained in all planned activities. The sub-goals that aim to achieve ecological balance are the following:

- the use of natural resources in a way and in amounts that ensure that ecological balance is maintained;
- reduction of pollution;
- preservation of biological diversity and natural areas.

The national strategy is based on the Sustainable Development Act, adopted by the Parliament in 1995, which establishes, first and foremost, principles for the sustainable use of the natural environment and natural resources. No separate plan has been compiled to implement the National Strategy on Sustainable Development. The strategy is being implemented through different sectoral strategies and development plans. More concrete long-term environmental development objectives are formulated in the National Environmental Strategy until 2030 endorsed by the Parliament in 2007. The aim of the Estonian Environmental Strategy 2030 is to specify long-term development trends to keep the good standing of the environment while taking into account relation of the field with economic and social issues and their effect on the natural environment and people. Since the strategy is long-term, it is possible to take into consideration the cause and effect relationships set in the strategy document when renewing development plans of other relevant fields.

The Action Plan for 2016–2019 of the Government, has set the following goals for 2019:

- the reuse amount of the total mass of municipal solid waste (MSW) is 48%;
- felling of timber does not exceed the yearly regrowth of wood;
- the share of renewables in final energy consumption is 27% (17% in final consumption of electricity and 53% in heat generation in district heating systems).

The Climate Change Adaptation Development Plan until 2030 (adopted by the Government on 2 March 2017) was prepared in cooperation between the MoE, EERC and other institutions with the support from the European Economic Association Financial Mechanism. The main objective of the Development Plan is to increase the readiness and capacity of the state, the regional and local level to adapt to the effects of climate change. The Development Plan is further described under Chapter 6 – Climate change impacts, vulnerability assessment and adaptation measures.

4.2.2. Legislation

Estonia is transposing the EU law (accessible in EUR-Lex, *http://eur-lex.europa.eu*) into several national legislative acts which can be accessed from a web-based outlet of Riigiteataja (*https://www.riigiteataja.ee/*) that also includes official announcements.

The Sustainable Development Act (RT I 1995, 31, 384), last amended on 1 January 2017, prescribes the principles of sustainable development, thus serving as a basis for all environment-related legislation and relevant national programmes. Therefore, the legal acts regulating the energy, industrial and transport sectors (i.e. the sectors that are the largest emitters of GHGs) usually take into account major environmental issues.

The Atmospheric Air Protection Act (RT I, 05.07.2016, 1), which replaced the Ambient Air protection Act since 1 January 2017 provides for:

- the requirements set for affecting ambient air by chemical and physical pollutants;
- the measures for maintaining and improving the quality of ambient air;
- the requirements for protection of ozone layer;
- the measures for mitigation of climate change and reduction of GHG emissions;
- the organisation of state supervision over compliance with the requirements provided for in this Act;
- the liability for failure to comply with the requirements provided for in this Act.

The Act stipulates that activities for a reduction in climate change must be organised by the MoE on the basis of the requirements for limitation of GHG emissions arising from the UNFCCC, KP and the EU legislation. The Act also provides that the possessors of pollution sources must take additional measures to reduce the emission levels of CO_2 and other GHGs. Number of secondary level legal acts have been issued on the basis of this Act.

The Environmental Monitoring Act (RT I, 18.05.2016, 1) establishes the organisation of national, local government and voluntary environmental monitoring, the completion of national environmental monitoring programme and its sub-programmes, the establishment, use, protection and liquidation of national environmental monitoring stations and areas, the procedure for the storage, use and dissemination of data obtained during the course of environmental monitoring, and the organisation of state supervision and the responsibility for failure to meet the requirements provided in the Act.

Environmental Register Act (RT I 2002, 58, 361) provides the grounds for the entry of data regarding natural resources, natural heritage, the status of the environment and environmental factors in the environmental register, for the retention of data in the register and for the processing and release of data.

Environmental Impact Assessment and Environmental Management System Act (RT I 2005, 15, 87) provides legal grounds and procedure for the assessment of likely environmental impact, organisation of the environmental management and audit scheme and legal grounds for awarding the eco-label in order to prevent environmental damage and establishes liability for violation of the requirements of the Act.

The Law Enforcement Act (RT I, 22.03.2011, 4) defines the nature of environmental supervision, establishes the rights and obligations of persons and agencies that exercise environmental supervision, the rights and obligations of persons and agencies which are subject to environmental supervision and the procedures for supervisory operations.

General Part of the Environmental Code Act (RT I, 28.02.2011, 1) aims to ensure the reduction of environmental nuisances to the maximum extent possible in order to protect the environment, human health, well-being, property and cultural heritage. It also stipulates the promotion of sustainable development in order to secure an environment that meets the human health and well-being needs of the present generation and future generations incl. the prevention of damage to the environment and the remedying of damage caused to the environment.

The Environmental Liability Act (RT I 2007, 62, 396) is targeted at the more effective implementation of the polluter pays principle and more efficient reaction to environmental damage. The act specifies the procedures for the prevention and rectification of environmental damage, which ensures the restoration of the environment by those who cause the damage.

The purpose of the Industrial Emissions Act (RT I, 16.05.2013, 1) is to achieve a high level of protection of the environment taken as a whole by minimising emissions into air, water and soil and the generation of waste in order to prevent adverse environmental impacts. In addition, the Act determines the industrial activities of high environmental hazard, provides the requirements for operation therein and liability for failure to comply with the requirements, and the organisation of state supervision.

The Electricity Market Act (RT I 2003, 25, 153) governs the generation, transmission, sale, export, import and transit of electricity and the economic and technical management of the power system. This Act prescribes the principles of the operation of the electricity market, based on the need to ensure an effective supply of electricity which is provided at a reasonable price and which meets environmental requirements and the needs of consumers, and the utilisation of energy sources in a balanced manner, in an environmentally clean way and with a long-term perspective. It states that electricity undertakings shall always facilitate activities performed by consumers for the purpose of conserving electricity.

The Liquid Fuel Act (RT I 2003, 21, 127) provides the bases and procedure for handling liquid fuel, the liability for violations of this Act and the arrangements for exercising state supervision, with a view to ensuring the payment of taxes and guaranteeing the quality of the more widely used motor fuels.

The District Heating Act (RT I 2003, 25, 154) governs activities related to the production, distribution and sale of heat by way of district heating networks and connection to district heating networks.

The Product Conformity Act (RT I 2010, 31, 157) sets out the competence of authorities participating in market surveillance and stipulates that the Technical Surveillance Authority must exercise state surveillance over compliance of household appliances, heating appliances and devices with energy efficiency, energy performance labels and ecological design requirements.

Due to the large share of buildings in total energy use the improvement of energy efficiency in the residential and tertiary sectors also has an important role from the emissions reduction aspect. Here the impact of EU Directive 2002/91/EC and its recast 2010/31/EU on the energy performance of buildings (EPBD) should be highlighted. In Estonia, the implementation of the EPBD is the responsibility of the MoEAC. The provisions of the EPBD have been transposed into the Building Code. Several detailed requirements were enforced using secondary legislation. The most important secondary level act is the regulation (No 55 of 3 June 2015) of the Government on the Minimum Requirements for Energy Performance of Buildings. The regulation applies to new as well as existing ones undergoing major renovations.

As to impact on the environment, the Organic Farming Act (RT I 2006, 43, 327) is important among legislation regulating the agricultural sector, as it provides for the requirements for operating in the area of organic farming to the extent not regulated by the regulations of the EU, as well as for the grounds and extent of supervision exercised over persons operating in the area of organic farming, and for the liability for violation of the requirements established by such legislation. In addition, a number of secondary legislative acts have been issued on the basis of this act to regulate aspects of organic farming.

The Forest Act (RT I 2006, 30, 232) regulates the directing of forestry, forest survey and management and compensating the damage caused to the environment within the meaning of the Act, and provides for liability for violation of the Act. It also regulates the sustainable management of forests as a renewable natural resource.

Waste Act (RT I 2004, 9, 52) provides waste management requirements to prevent waste generation and health and environmental hazards arising therefrom. The act also includes measures to improve the usage efficiency of natural resources and reducing the adverse impacts of such use.

4.2.3. Information on activities under Kyoto Protocol Articles 3.3 and 3.4

Articles 3.3 and 3.4 of the KP concern emissions and removals from LULUCF activities. Under KP Article 3, paragraph 3, of the KP, Estonia reports emissions and removals from afforestation, reforestation and deforestation, and under Article 3, paragraph 4, emissions and removals from Forest management. Estonia has decided not to elect any of the activities under Article 3.4 of the KP. For the second commitment period of 2013–2020, Estonia accounts Forest management as it became mandatory activity under Article 3.4 of the KP. At the moment, land reform in Estonia is coming to an end and no special measures regarding afforestation, reforestation and deforestations are foreseen. Therefore, current trends are expected to continue and activities under Article 3.3 are expected to be a source of GHG emissions during the second commitment period.

Estonia started to make efforts to monitor, estimate and report carbon flows related to Afforestation, Reforestation and Deforestation activities for the first time in 2009, when the National Forest Inventory (NFI) started to report land-use changes. Now, NFI field data about land-use changes are used, assuming that cropland, wetlands and settlement conversion to forest land reported under the Convention is directly human-induced land conversion. Conversion of the Grassland and Other land into forest land is considered as not directly human induced. Grassland conversion to forest land occurs mainly due to natural succession after land abandonment, therefore these areas are not taken into account for Afforestation reporting (AR). With the new approach, all AR areas are identified and georeferenced – detailed information about growing stock, mineral and organic soil distribution is obtained from the NFI and consistency between UNFCCC and KP-LULUCF reporting is assured. Data about Deforestation is also acquired from the NFI.

4.2.4. Mechanisms under Article 6, 12 and 17 of the Kyoto Protocol

Estonia has used two of the three Kyoto flexible mechanisms – Article 6 Joint Implementation (JI) and Article 17 International Emissions Trading (IET). The Clean Development Mechanism set out in Article 12 of the KP is not used, as Estonia is not a developing country.

According to the National GHG Inventories, Estonia's emissions decreased significantly between 1990 and 1993 due to the restructuration of the economy after the collapse of the Soviet Union. Since then, annual emissions have remained approximately 50% below the 1990 level. This is a clear indication that Estonia does not have problems meeting its Kyoto target. As a consequence, Estonia is acting as a seller within both of the used mechanisms and was able to participate in JI projects under the KP.

JI and the Kyoto flexible mechanism, and their relation to the EU Trading Scheme and the national registry are regulated by the Atmospheric Air Protection Act.

Joint implementation

During the JI commitment period 2008–2012 there were altogether 12 JI projects (incl. the seven early mover projects) implemented in Estonia which all have been registered in UNFCCC as Track 1 projects. During the commitment period Emission Reduction Units (ERUs, each equal to 1 tonne of CO_2 equivalent (eq.)) were transferred to investor countries for the generated emission reductions.

By 31 December 2012, the 12 JI projects, incl. 2 district heating projects and 7 wind power projects among others, resulted in a total emission reduction of around 1.34 million tons CO_2 eq.

International Emissions Trading

A complete restructuration of the economy after the Soviet Union together with the implementation of energy efficiency measures, increase in the use of renewable energy and modern technologies, a significant emission reduction (about 50%) of GHG has taken place since 1990. Therefore Estonia had a surplus of Assigned Amount Units (AAU), which could be used for trading under the Article 17 of the KP.

All revenue from sales of surplus AAUs was invested in environmentally friendly projects and programmes via the Green Investment Scheme (GIS). An inter-ministerial working group was formed with the aim to coordinate the preparation of the legal framework and to prepare projects and programs for the use of the revenues.

The GIS provides that the money received must be directed to environmentally friendly projects aimed at reducing CO_2 and other GHG emissions. The main projects and programmes invested via the GIS are the following:

- energy efficiency (incl. thermal refurbishment) of buildings and district heating sector;
- efficient and environmentally benign transport (e.g. electromobility programme);
- development of wind energy farms;
- use of renewable energy (e.g. wind parks).

4.2.5. Emissions trading under the EU Emissions Trading System

The EU Emissions Trading System (EU ETS) is one of the key policy instruments implemented in the EU to achieve its climate policy objectives. The EU ETS is a cornerstone of the EU's policy to combat climate change and its key tool for reducing GHG emissions cost-effectively. It was established by Directive 2003/87/EC (the Emissions Trading Directive) and entered into force on 1 January 2005.

Estonia's first National Allocation Plan (NAP) for the EU ETS for 2005–2007 included 43 installations. The first NAP for GHG emission allowances provided the right to emit 56.7 million tons of CO_2 from 2005–2007. The NAP2 for the period 2008–2012 provided the right to emit 66.51 million tons of CO_2 eq. (13.3 Mt/a). This quantity included a reserve of 3.47 million tons of CO_2 eq. for new entrants and a JI reserve of 0.99 million tons of CO_2 eq.

The EU ETS is now in its third phase of 2013–2020. Compared to the previous phase, the main changes include:

- A single, EU-wide cap on emissions (previous system included national caps).
- Covering more sectors and gases: CO_2 from power and heat generation, energy-intensive industry sectors and commercial aviation; N_2O production of nitric, adipic and glyoxylic acids and glyoxal and PFC (perfluorocarbonal) aluminium production.

- Auctioning method for allocating allowances (instead of free allocation), and harmonised allocation rules apply to the allowances still given away for free. The amount of free allowances is reduced and decreases by 1.74% every year.
- 300 million allowances has been set aside in the New Entrants Reserve to fund the deployment of innovative renewable energy technologies and carbon capture and storage through the NER 300 programme.

The share of Estonia's EU ETS emissions from all sectors is very high, comprising about 66% from total emission in 2015. As of year 2017 Estonia had 46 installations and one aircraft operator in the EU ETS.

Articles 10a and 10c of the EU Emissions Trading Directive (Directive 2003/87/EC as amended by Directive 2009/29/EC) allow several Member States (incl. Estonia) to allocate limited number of emission allowances free of charge. These Articles are covering district heating and high efficiency cogeneration for economically justifiable demand in respect of the production of heating or cooling and existing power plants, provided that the funds are used to modernise the energy system. In June 2012 the EC concluded that provisions of Estonia's development plan for the electricity sector allocating free allowances are in line with EU state aid rules. During the transition period (2013–2019) Estonia is permitted to allocate 18 million of free allowances to electricity producers included in the EU ETS.

4.2.6. Effort Sharing Decision

The Effort Sharing Decision (Decision No 406/2009/EC – ESD) establishes GHG emission limits for Member States to be achieved by 2020 through binding annual targets between 2013 and 2020 (Annual Emission Allocations – AEA). The ESD only refers to GHG emissions that are not included within the scope of the EU ETS (e.g. transport (except aviation), buildings, agriculture (excluding LULUCF) and waste). According to the ESD, each Member State must define and implement national PaMs to limit the GHG emissions covered by the ESD. The inclusion of the ESD within the EU's climate and energy package ensures that the abatement potential from non-ETS sectors contribute to the delivery of the EU-wide target of reducing GHG emissions by 20% below 1990 levels by 2020. For Estonia, the GHG emissions from non-ETS sectors have to be limited at least by 11% by the end of the period of 2013–2020 compared to 2005 (see Chapter 4.1.2).

For the period up to 2030, the European Council set out in its October 2014 conclusions an EU-wide binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990. The non-ETS sectors will need to reduce emissions by 30% by 2030 compared to 2005, continuing the methodology and elements of the ESD, incl. a linear trajectory of annual targets (AEA) and flexibility instruments to help achieve them. For that purpose, the Commission introduced a proposal for a regulation on the 20 July 2016, which is currently under negotiation. According to the proposal, Estonia would have a target of -13% compared to 2005.

4.3. Policies and measures and their effects

4.3.1. Cross-cutting measures

National programmes and EU assistance

The National Reform Programme Estonia 2020 (approved by the Government in 2011, updated in April 2017) established two major priorities of the Government in moving towards an environmentally sustainable economy and energy sector:

- implementing long-term structural changes in the energy sector in accordance with Estonia's energy security and energy efficiency objectives;
- reducing general resource and energy intensity of the economy.

In the Programme, the Government has set an ambitious goal for making final energy consumption more efficient in Estonia – to keep final energy consumption in 2020 at the same level as 2010. The relevant values are presented on Table 4.1.

Table 4.1. Final consumption of energy, PJ

Actual		Target
2010	**2015**	**2020**
118	116	118

Regarding GHG emissions, the National Reform Programme Estonia 2020 provides that according to EU goals, Estonia's emissions from non-ETS sectors should not increase by more than 11% by 2020 compared to the 2005 level.

The level of GHG emissions is related to the plans set in the Programme for the wider utilization of renewable energy sources (RES) developing relevant solutions in all sectors (see Table 4.2).

Table 4.2. Share of renewable resources in final energy consumption, %

Actual		Target
2009	**2015**	**2020**
19.5	28.6	25

The total target is in accordance with Directive 2009/28/EC – Estonia must ensure that the share of energy from renewable sources amounts to 25% of the gross final consumption of energy by 2020. The same directive also provides that each member state shall adopt a National Renewable Energy Action Plan. In Estonia, the National Renewable Energy Action Plan up to 2020 (NREAP) was approved by the Government in November 2010 (Order No 452, 26.11.2010). The national goals for Estonia in the EU 20-20-20 package require a 25% share of energy from renewable sources in gross final energy consumption by 2020 and allow for an 11% increase in GHG emissions outside the emissions trading directive scope by 2020, compared to the 2005 level. The 10% share of renewable energy sources in road transport fuels by 2020 is an EU-wide goal. The NREAP presents estimations and planned PaMs to achieve the national targets. As the share of renewable resources in final energy consumption was already 28.6% on 2015, it means that Estonia has already reached its 2020 target and the share of renewable energy only has to be held on the same level.

An improvement in energy efficiency can be considered a goal of increasing priority for the Government. A National Energy Efficiency Programme for 2007–2013 was prepared, through which investments have been made in energy efficiency, relevant information has been made more widely available and consumers have been informed about ways of conserving energy. The Programme is one of the documents prepared for the implementation of the National Long-term Development Plan for the Fuel and Energy Sector Until 2015, which was approved by the Government of the Republic in December 2004. It took into account the task of achieving the indicative energy conservation objective set by Directive 2006/32/EC, i.e. a saving of 9% of final energy consumption during the period 2008–2016.

In September 2011, the MoEAC presented a mid-term overview of the implementation of the Energy Efficiency Plan 2007–2013 and the further implementation plan that was presented to the EC as the Second Energy Efficiency Action Plan of Estonia (NEEAP2). Since then two new NEEAPs have been compiled, of which the latest was presented to the EC in May 2017, which presents a forecast of the final energy consumption in Estonia by 2020 (see Table 4.3).

Table 4.3. Final consumption of energy by sector, PJ

Sector	2020 (forecast)
Industry and agriculture	27.4
Transport	38.4
Households	39.5
Services	13.8
Total	119.1

In Estonia, oil shale is the main domestic fuel, therefore to ensure the long-term balanced use of it, the National Development Plan for the Use of Oil Shale 2016–2030 was prepared to specify the plans for use of oil shale as a nationally strategic indigenous energy resource. These plans include an assessment of the use of shale fuel oil and oil shale gas taking into account economic, social, security and environmental issues. The Plan was endorsed by the Parliament in March 2016.

The objective of the preparation and implementation of the Estonian Rural Development Plan (ERDP) for 2014–2020 is to support Estonian rural development in a manner that is complementary to other measures of the EU Common Agricultural Policy (e.g. direct supports and market organisation measures), cohesion policy and the European Common Fisheries Policy. The main environmental issues covered are improving the sustainable management of natural resources and improving climate action.

To administer environment-related financial support measures, the Environmental Fund was established in 1993. In 2000 the Fund was reorganised as the Environmental Investments Centre (EIC). The main goals of the EIC are to channel the proceeds from the exploitation of the environment into environmental projects; to act as the implementing agency for the environmental projects funded by the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF); and to lend money for the implementation of environmental projects. Since 2010 the EIC has also acted as the implementing agency for the GIS, i.e. selling the surplus AAUs and supervising the relevant investments. In 2011, the EIC distributed foreign aid (ERDF and CF and other smaller EU grant funds), incl. co-financing, to a total value of 149.0 million euros, which was twice as much as in 2010, when foreign aid and co-financing amounted to 74.0 million euros. From 2012 to 2016 EIC has distributed funds in the amount of 505.0 million euros incl. 5,091 different projects, incl., among others, 2,287 environmental education, 718 environmental projection, 504 water, 386 waste and 232 energy sector projects.

Excise duties

Excise duties (Table 4.4) are one of the fiscal measures in Estonia with an impact on GHG emissions. As a Member State, Estonia must comply with EU requirements (Directive 2003/96/EC) for the taxation of fuels and energy. Nevertheless, Estonia has been granted a transitional period for the introduction of relevant taxes.

Regarding oil shale, Directive 2004/74/EC stipulates that until 1 January 2013 Estonia was allowed to apply a reduced level of taxation for oil shale, provided that it does not result in taxation falling below 50% of the relevant Community minimum rate as of 1 January 2011. Regarding shale oil (oil produced from oil shale), Estonia was eligible to apply a transitional period until 1 January 2010 to adjust the national level of taxation on shale oil used for district heating purposes to the EU minimum level of taxation. Nevertheless, Estonia had already introduced the tax on shale oil by that date.

Table 4.4. Excise tax on fuels and energy (as of 1 July 2017)

Fuel/energy type	Unit	EUR/unit
Unleaded petrol	1,000 l	512
Aviation spirit	1,000 l	512
Kerosene	1,000 l	330.1
Diesel oil	1,000 l	493
Diesel oil for specific purposes	1,000 l	133
Light heating oil	t	493
Heavy fuel oil	t	559
Heavy fuel oil[1]	t	58
Shale-derived fuel oil	t	548
Shale-derived fuel oil[2]	t	57
LPG (used as heating fuel)	t	55.15
LPG (used as motor fuel)	t	193
Natural gas (used as heating fuel)	1,000 m^3	40.52
Natural gas (used as motor fuel)	1,000 m^3	47.32
Natural gas (liquefied, motor fuel)	t	66
Solid fuels (coal, brown coal, coke, oil shale); heat production	GJ (GCV)	0.93
Electricity	MWh	4.47

[1] Heavy fuel oil, which density is >900 kg/m^3 at 15 °C, viscosity is >5 mm^2/s at 40 °C, contains >0.5% sulphur.

[2] Shale-derived fuel oil, which density is >900 kg/m^3 at 15 °C, viscosity is >5 mm^2/s at 40 °C, contains >0.5% sulphur.

The tax exemption for natural gas (CH_4) is permitted by Directive 2003/96/EC, which allows an exemption on natural gas in Member States where the share of natural gas in energy end-use was less than 15% in 2000. The exemption applies for a maximum of ten years after the directive's entry into force or until the national share of natural gas in energy end-use reaches 25%, whichever comes first. In fact, Estonia has imposed an excise duty on natural gas since 1 January 2008.

Directive 2004/74/EC allowed Estonia to apply a transitional period until the 1 January 2010 to introduce output taxation on electricity. Despite this exemption, Estonia introduced an excise duty on electricity on 1 January 2008.

Pollution charges

Pollution charges are a second fiscal measure in Estonia with an impact on GHG emissions.The Government's tax policy is based on objectives aimed at reducing environmental impact by increasing the rates of charges on pollution and resource use. The Environmental Charges Act provides the grounds for determining the natural resource charges, the rates of the pollution charge, the procedure for calculation and payment thereof, and the grounds and specific purposes for using state budget revenue obtained from environmental use. Environmental charges are established and imposed based on the need for environmental protection, the economic and social situation of the state and, in the events specified in the Act, also based on the value created by natural resources subject to the charge. A mineral resource extraction charge that exceeds the minimum rates provided for in the Act is established based on the state's goal of earning revenue. In the case of an energy mineral resource, the added value generated by the energy mineral resource is relied upon in addition to the goal of earning revenue.

In Estonia a pollution charge for releasing CO_2 into the ambient air was introduced in 2000. Currently, the Environmental Charges Act (enforced in 2006) obliges the owners of combustion equipment to pay pollution charges for several pollutants emitted into the air. The pollution charge in the case of emissions into ambient air must be paid by all enterprises that are required to have an air pollution permit. According to the regulation of the Minister of the Environment the air pollution permit is obligatory for all enterprises which own and operate combustion equipment (utilizing solid, liquid or gas fuel) with a rated capacity equal to or higher than 50 MW in one location. As an exception, the CO_2 charge must only be paid by enterprises producing heat. Since 2009 the rate of the CO_2 charge has been 2 EUR/t. In the case of CO_2 emissions in quantities larger than those provided in the emission permit, higher charge rates apply: since 1 January 2008 the penalty rate has been 100 EUR/t. Installations that emit nitrous oxide into the ambient air also pay a pollution charge. CH_4 and fluorinated gases (HFC – hydrofluorocarbons, PFC and SF_6) are not subject to pollution charges.

As an exception, the Environmental Charges Act provides the option of replacing the pollution charge (incl. the CO_2 charge) with environmental investment by enterprises. The financing replaces the pollution charge if the polluter implements, at its own expense, environmental protection measures that reduce pollutants or waste by 15% from their initial value.

Cross-cutting measures with potential for GHG reduction

1) **Facilitating the supply and use of renewable sources of energy**, of by-products, wastes, residues and other non-food raw material for purposes of the bio-economy. The main requirement underlined within the Priority 5C of the Priority 5C of the ERDP 2014–2020 is supporting the production of heat and electricity from biogas. The objectives under Priority 5C are furthered by activities of article 17 in the ERDP which include investments to improve the productivity of agricultural enterprises within the framework of which investments are endorsed to produce electricity, heat, liquid fuels or gas out of biomass. Despite of the vast potential, the use of manure as raw material for biogas plants is not a common practice in Estonia. Planned investments: 18 million euros by 2020. This measure affects Agriculture and Energy sector.

2) **EU CAP Greening measure** – under the EU Common Agricultural Policy (CAP) the Greening measure aims to limit and reduce GHG emissions and to enhance carbon sequestration on croplands with a cost of measure: 900 million euros. The objective of the measure is to make farms with monocultures more environmentally friendly and sustainable. This measure has an effect in the Agriculture and LULUCF sectors.

3) **Fostering carbon conservation and sequestration in agriculture and forestry** – ERDP also highlights supporting to include 14.8% of the agricultural and forest land currently in use under economising agreements to further carbon sequestration by 2020 to reduce the tillage of histosols and contribute into counselling and training activities to promote sustainable agricultural management. There are no separate measures or types of activities programmed under Priority 5E and the needs ascertained in the framework of this priority will be met by an activity type of agricultural environment grant *Regional Soil Protection Grant*. This measure also affects Agriculture and LULUCF sector.

4.3.2. Energy supply

General development plans

Estonia's second National Long-term Development Plan for the Fuel and Energy Sector until 2015 (approved by the Parliament in 2004) was replaced in 2009 with the National Development Plan of the Energy Sector until 2020.

The National Development Plan for Energy Sector until 2020 was passed by the Parliament in June 2009. The plan defines the mission of Estonia's energy sector: to ensure a steady, efficient, environmentally benign energy supply with reasonable prices, whilst ensuring the sustainable use of energy. In the plan, three groups of major goals are set, all accompanied by relevant sets of specified measures:

- a continuous energy supply is ensured for the Estonian population (five measures);
- energy supply and consumption is more sustainable in Estonia (six measures);
- energy supply at a justified price has been ensured for consumers (five measures).

The Government of Estonia approved the *Estonian Energy Development Plan until 2030 (EEDP 2030+)* on 19 October 2017. The development plan is aimed at ensuring an energy supply that is available to consumers at a reasonable price and effort and with an acceptable environmental condition, while observing the terms and conditions established in the long-term energy and climate policy of the EU. The most beneficial economic competitiveness aspects must be observed for the purposes of the implementation of EEDP 2030+. The new plan also drafts the benchmarks for renewable energy and energy efficiency operational programmes and the vision for the renovation of buildings.

Expected outcomes of the EEDP 2030+ include:

- reduction of GHG emission by 70%, (Energy sector);
- renewable energy sources account 50% of final energy consumption (and 28% of domestic primary energy consumption);
- final energy consumption in 2020 and 2030 at the same level as in 2010 (in accordance with the programme *Estonia 2020*);
- primary energy supply: 57.7 TWh.

The EEDP 2030+ also includes plans for regional cooperation, particularly with Latvia and Lithuania in terms of security of Energy supply.

Regarding pollution, the most important part of the energy sector is the combustion of oil shale, as the majority of emissions are discharged by the oil shale-based power industry. Introduction of new combustion technology has enabled a reduction in emissions from oil shale-firing power plants, which produce more than 80% of electricity in Estonia. At the same time, the wider use of renewable energy sources in electricity production enables GHG emissions from the power sector to be significantly reduced.

Electricity supply

The major national-level document aimed at the electricity sector is the National Development Plan for Electricity Sector until 2018 approved by the Government in February 2009. The plan foresees a significant decrease in electricity production from oil shale and an increase in proportion of other sources of energy.

The plan emphasises that Estonia's electricity sector requires fundamental changes as the impact of electricity generation on the environment must be reduced. This process is also affected by the need to use the resources of oil shale in a more sustainable way. Therefore, the plan provides scenarios for the restructuring of electricity production in Estonia. Also, the capacity of wind turbines (mainly wind farms) could be increased significantly (up to 900 MW), compared to when the development plant came into effect, together with the required capacity reserves.

The plan stipulated the construction of a second submarine cable (EstLink 2) to Finland. The construction of EstLink 2 was finished in the beginning of 2014 and increased Estonia's transfer capacity with Finland from 350 MW to 1000 MW. Due to increased transfer capacity and affordable electricity generated in Nordic countries, for example in 2015, Estonia was able to import 5277 GWh electricity from Finland.

Regarding options for electricity generation, the plan considers four main development scenarios. The projected annual increase rate of the peak load is 1.6–3.8%, the average taken as 2.3% per annum. As for consumption, the target is set to keep the domestic final consumption of electricity at 2007 level or lower (7,180 GWh in 2007). The main precondition is that total electricity must be covered by domestic generation.

All scenarios include the following common elements for generation:

- the currently used oil shale-based units with fluidised bed boilers are still in operation;
- at least 200 MW of cogeneration units firing various fuels;
- some old units of oil shale pulverised combustion with desulphurisation equipment.

According to the EEDP 2030+ new electricity production units have to be competitive in open electricity market without any subsidies. The support schemes for new production units are set in Electricity Market Act and are primarily aimed at renewable energy, combined heat and power (CHP) production and complying to the criteria of local production units.

The measures of electricity supply sector used in With Measures (WM) emission calculations are based on known investments. The measures are the following (additional information presented in Table 4.6):

1) **Improvement of the efficiency of the use of oil shale** – two oil shale pulverised combustion units were replaced in Narva Power Plants in 2004 with fluidised bed block combustion units (both with capacity of 215 MW). The cost of investment was 245 million euros.

2) **Improvement of the efficiency of the use of oil shale** – in 2011, the construction of one more fluidised bed block combustion unit started (with capacity of 300 MW) – Auvere oil shale power plant. The cost of investment was about 640 million euros. The plant started working in 2015. The new plant has been designed in a way that it enables to use biomass as 50% of the fuel input.

3) **Support for renewable and efficient CHP based electricity production** – the support rates are presented in Table 4.5.

4) **Investments through GIS for construction of wind parks** – the transaction was made in 2010. It included 3 projects with the cost of 23 million euros.

PaMs affecting electricity generation along with their effect on GHG emissions are also presented in Table 4.6.

Table 4.5. Support for renewable and efficient CHP based electricity production

Level of subsidy	Conditions for receiving the subsidy
	Subsidies are paid for electricity that is produced:
0.0537 €/kWh	From renewable energy sources which do not exceed 100 MW
0.0537 €/kWh	From biomass in CHP mode. From 31 December 2010, producers who have started generating electricity from biomass can only get the subsidy for electricity generated in efficient CHP mode
0.032 €/kWh	In efficient CHP mode from waste as defined in the Waste Act, peat or oil shale retort gas
0.032 €/kWh	In efficient CHP mode using generating equipment with a capacity of not more than 10 MW

Table 4.6. Policies and measures on the electricity supply

Name of policy or measure[1]	GHG affected	Objective and/ or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2]			
						2020	2025	2030	2035
Improvement of the efficiency of the use of oil shale (2x215MW)*	CO_2 N_2O	Efficiency improvement in the Energy and Transformation sector	Regulatory	Expired	Government	366.3	368.6	0.0	0.0
Improvement of the efficiency of the use of oil shale (300 MW)*	CO_2 N_2O	Efficiency improvement in the Energy and Transformation sector	Regulatory	Expired	Government	515.1	428.3	155.6	108.5
Support for renewable and efficient CHP based electricity production*	CO_2 CH_4 N_2O	Increase in renewable energy	Economic	Implemented	Government	1,309.9	1,554.5	1,570.6	1,730.0
Investment support for wind parks*	CO_2 CH_4 N_2O	Increase in renewable energy	Fiscal; economic; regulatory	Implemented	EIC	66.0	66.0	66.0	66.0

[1] All PaMs marked with an asterix (*) are included in the WM scenario

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

Heat supply

Heat supply, particularly district heating, is a sector with quite a large potential for increasing energy efficiency, which in turn will result in lower GHG emissions. The goals set in EEDP 2030+ are to use the full potential of CHP plants, promote the use of local fuels and to reduce the share of imported fuels in heat supply. It is expected, that the share of renewable energy in heat supply will be more than 60%, the share of imported fuels less than 30% and the use of primary energy less than 19 TWh per year by 2030.

Regarding biomass, a large amount of the primary energy arising from fuel wood (logs, chips, pellets and wood waste) is used in heat production. However, development is hindered by the large-scale exporting of biomass, due to which local energy producers in some cases do not have enough biomass resources. Exports result in elevated prices for some biomass products, especially wood pellets. The deployment of smaller-scale cogeneration CHP's as an element of decentralised energy production strategy would increase the security of energy supply in Estonia. A small heat load and the fact that new equipment producing only heat alone has already been installed in many areas with a favourable heat load can be indicated as hindrances to the development of combined heat and power production based on biomass.

As a rule, district heating is more environmentally benign as a heat supply option than local heating. Therefore, it is important that the District Heating Act enables the zoning of district heating as an element of regional heat supply planning. The Act gives local governments the power to introduce the zoning of heat supply based on analyses, carried out for alternative heat supply options during the planning phase. The zoning of heat supply as an instrument of regulation of the energy sector gives municipalities the authority to avoid chaotic disconnection from district heating (DH) systems. The latter process had been taking place in some towns and cities for many years.

The main measures that have an effect on GHG emissions in Heat supply sector are the following:

1) **Renovation of boilerhouses** – this measure includes fuel switch from oil fuels to renewable and/or local energy sources like biomass, peat, etc. The expected cost is projected to be about 37.5 million euros annually.

2) **Renovation of heat networks** – the aim of this measure is to reduce the losses in district heating networks. The expected cost is projected to be about 3.8 million euros annually.

3) **Transition of consumers to local and place heating** – district heat networks that are operating inefficiently (the amount of MWh sold per meter of heat pipes is less than 1.2) will be restructured to local and place heating. The expected cost is projected to be about 1 million euros annually.

4) **Investments through GIS for reconstruction of boilerhouses and heat networks.**

5) **Investments through the European Regional Development Fund for reconstruction of boilerhouses and heat networks** – total of 21 projects were financed with the total cost of 8.7 million euros.

PaMs affecting heat supply along with their effect on GHG emissions are presented in Table 4.7, which also contains measures that are in a planned state and not yet implemented. These measures show an estimated GHG mitigation impact, should additional funding appear for the renovation of boiler houses and heat networks as well as transitioning consumers to local and place heating.

Table 4.7. Policies and measures on the heat supply

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2]			
						2020	2025	2030	2035
Renovation of boilerhouses*	CO_2 CH_4 N_2O	Increase in renewable energy; switch to less carbon-intensive fuels; efficiency improvement in the Energy and Transformation sector	Economic	Implemented	MoEAC	65.2	76.4	140.6	224.4
Renovation of heat networks*	CO_2	Reduction of losses	Economic	Implemented	MoEAC	48.2	56.6	104.2	205.4
Transition of consumers to local and place heating*	CO_2	Efficiency improvement in the Energy and Transformation sector	Economic	Implemented	MoEAC	19.7	23.3	42.9	54.7
Investments through GIS for reconstruction of boilerhouses and heat networks*	CO_2	Reduction of losses; efficiency improvement in the Energy and Transformation sector	Economic	Implemented	EIC	96.5	96.5	96.5	96.5
Investments through the European Regional Development Fund for reconstruction of boilerhouses and heat networks*	CO_2	Reduction of losses; efficiency improvement in the Energy and Transformation sector	Economic	Implemented	EIC	60.0	60.0	60.0	60.0
Additional renovation of boilerhouses	CO_2	Efficiency improvement in the Energy and Transformation sector; switch to less carbon-intensive fuels (energy supply); increase in renewable energy	Economic	Planned	MoEAC	61.9	73.0	134.1	212.9
Additional renovation of heat networks	CO_2	Reduction of losses	Economic	Planned	MoEAC	168.9	198.1	365.0	440.6
Additional transition of consumers to local and place heating	CO_2	Efficiency improvement in the Energy and Transformation sector	Economic	Planned	MoEAC	45.4	53.2	98.1	137.6

[1] All PaMs marked with an asterix (*) are included in the WM scenario

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

4.3.3. Energy consumption – Manufacturing industries and construction

The NEEAP2 declares that increasing the energy efficiency in Manufacturing industries is in Estonia mainly ensured by increasing environmental awareness and measures that are related to the wider energy policy, such as the opening up of the electricity market, the renewable energy charge, fuel and electricity excise duties and reduced differences in excise duty rates. For example, in the beginning of 2017 MoE opened a measure for increasing industrial resource efficiency, of which the main objectives are gaining energy savings in small and medium sized companies. The actions supported are raising awareness, educating experts, conducting audits and making investments. Investment support is provided to five most important sectors: mining, food processing, wood, pulp, paper and non-metallic minerals industries. In 2017, a study is planned to be conducted to open investment to other sectors of manufacturing industries. According to the Energy Sector Organization Act, large companies are mandated to have regular energy audits.

4.3.4. Energy consumption – Other sectors (Commercial/Institutional and Residential sectors)

Measures taken into account in the Residential and Commercial/Institutional sector are mainly related to energy conservation through reconstruction of buildings. In Other sectors, the main measures having an effect on GHG emissions, that are already in place, include:

1) **Reconstruction of public and commercial buildings** – reconstruction of 10% of the existing buildings in the 20 year period to at least energy efficiency class D.

2) **Reconstruction of private houses and apartment buildings** – reconstruction of 10% of existing private houses to at least energy efficiency class E and 15% of existing apartment buildings in the 20 year period to at least energy efficiency class E. The expected cost of the measure is about 3.5 million euros annually.

3) **Implementation of the minimum requirements for nearly zero energy buildings** – the requirements will be implemented as required by the Energy Efficiency Directive and in the regulation The minimum requirements of the energy efficiency of buildings.

4) **Promotion of use of energy efficient electrical appliances in residential sector** – the increased use of energy efficient electrical appliances in households is expected to lead to annual savings of 0.5 PJ of electricity.

5) **Investments through GIS to the improvement of energy efficiency in public buildings** – between 2010 and 2013, a total of 540 public buildings were reconstructed with a total cost of the measure is 165.6 million euros.

6) **Investments through GIS to the improvement of energy efficiency in residential buildings** – grants of 15% to 35% of the total cost of renovation were supported from this measure. The total cost of the measure is 28 million euros.

7) **Investments through GIS to street lighting reconstruction programme** – according to the programme, 7 Estonian cities (with population between 8,000 and 15,000 inhabitants) had their street lighting replaced with energy-efficient lighting. The total cost of the programme was 14.55 million euros.

Table 4.8. Energy consumption policies and measures in the Residential, Commercial and Other sectors

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2]			
						2020	2025	2030	2035
Reconstruction of public and commercial buildings*	CO_2	Efficiency improvements of buildings; efficiency improvement in Services/Tertiary sector; demand management/reduction	Economic	Implemented	Government	1.1	1.7	2.3	2.6
Reconstruction of private houses and apartment buildings*	CO_2	Efficiency improvements of buildings; demand management/reduction	Economic	Implemented	MoEAC	1.7	2.6	3.4	4.2
Implementation of the minimum requirements for nearly zero energy buildings*	CO_2	Efficiency improvements of buildings; demand management/reduction	Regulatory	Implemented	MoEAC	5.4	8.1	10.8	13.2
Promotion of the use of energy efficient electrical appliances in the residential sector*	CO_2	Efficiency improvement of appliances	Information; regulatory	Implemented	Government	43.2	38.0	33.7	33.8
Energy efficiency improvement in public buildings*	CO_2	Efficiency improvements of buildings; demand management/reduction	Economic	Expired	Government	27.8	27.8	27.8	27.8
Energy efficiency improvement in residential buildings*	CO_2	Efficiency improvements of buildings; demand management/reduction	Economic	Expired	Government	28.0	28.0	28.0	28.0
Street lighting reconstruction programme*	CO_2	Demand management/reduction	Economic	Implemented	EIC	1.4	1.2	1.1	1.1
Additional reconstruction of public and commercial buildings	CO_2	Efficiency improvements of buildings; efficiency improvement in Services/Tertiary sector; demand management/reduction	Economic	Planned	MoEAC	3.4	5.2	7.1	8.3
Additional reconstruction of private houses and apartment buildings	CO_2	Efficiency improvements of buildings; demand management/reduction	Economic	Planned	MoEAC	37.7	56.6	75.4	92.5
Accelerated implementation of the minimum requirements for nearly zero buildings	CO_2	Efficiency improvements of buildings; demand management/reduction	Regulatory	Planned	MoEAC	8.1	12.1	16.2	19.9

[1] All PaMs marked with an asterix (*) are included in the WM scenario

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

A few additional measures are still under discussion or waiting additional funds and henceforth are reported as planned in the Seventh National Communication (NC7). These measures include:

1) **Additional reconstruction of public and commercial buildings** – reconstruction of 20% of the existing buildings in the 20 year period to at least energy efficiency class C.

2) **Reconstruction of private houses and apartment buildings** – reconstruction of 40% of existing private houses (energy efficiency classes C and D) and 50% of existing apartment buildings in the 20 year period to at least energy efficiency class C.

3) **Accelerated implementation of the minimum requirements for nearly zero energy buildings.**

PaMs affecting energy consumption in Commercial/Institutional and Residential sectors along with their effect on GHG emissions are also presented in Table 4.8.

4.3.5. Energy consumption – Transport

The Estonian Parliament approved the Transport Development Plan 2014–2020 in February 2014. The development plan sets forth the following relating to climate policy:

- Decreasing the use of vehicles in towns by improving the conditions for walking, cycling and using public transport and use smart solutions to offer various new services, particularly short-term bicycle and car rent.
- Increasing the number of departures and speed of connection for train traffic for trains to become the most favoured means of transport that connects Tallinn and other towns; improving the train connection with Latvia (on Tartu–Riga line, Rail Baltic) and Russia (the trip to St Petersburg should be shorter than 5 hours).
- Increasing the share of more economic vehicles that run on renewable energy so that biomethane or compressed gas generated from domestic biomass and waste would become the main alternative type of fuel in Estonia.

Reducing GHG emissions in the Transport sector is one of the key questions for Estonia in meeting the ESD targets in the future as the energy consumption has been growing in the same trend as the gross domestic product (GDP). The main goals for the measures implemented or planned in the Transport sector are directed at increasing the efficiency of vehicles and reducing the demand in domestic transport.

In the transport sector, the main measures having an effect on GHG emissions, that are already in place, include:

1) **Increasing the share of biofuels in transport sector** – the main target of this measure is to achieve the 10% share of biofuels in transport sector by 2020. This is achieved through stipulating a mixed fuel requirement on liquid fuels and increasing the use of biogas in transport.

2) **Increasing fuel economy in transport** – includes developing a support system for energy efficient cars, hybrid buses, hybrid trolleys, electrical buses etc. The expected cost is at least 6 million euros annually.

3) **Promoting economical driving** – includes promoting eco-driving and also developing light traffic systems. The expected cost of this measure is 14 million euros annually.

4) **Reducing forced movements with personal vehicles in transport** – includes developing telecommunication and also developing short-term rental cars systems. This measure aims to mitigate the transport load during rush hours. The expected cost is about 0.5 million euros annually.

5) **Improvement of the traffic system** – includes updating parking policies in cities, planning land use to reduce the use of private cars, restructuring the streets in cities, etc. The expected cost is about 16.7 million euros annually.

6) **Development of convenient and modern public transport** – includes improving the availability of public transport, developing ticket systems and new services. The expected cost is about 17 million euros annually.

Following measures are still in discussion and henceforth are reported as planned in the NC7:

1) **Road usage fees for cars and heavy duty vehicles** – based on mileage, location, environmental aspects, etc. The expected cost is about 62 million euros annually. This measure is reported as planned, however in June 2017, the Parliament approved road usage fees for vehicles with a maximum mass over 3500 kg (heavy duty vehicles). Because GHG estimations are currently not available for road usage fees that are only applied to these vehicles, this measure is still reported as planned.

2) **Developing and implementing a congestion charge system in Tallinn (the capital of Estonia)** – the expected cost is about 13 million euros annually.

3) **Developing the railroad infrastructure (includes the building of Rail Baltic)** – the expected cost of Rail Baltic is 30 million euros annually (during the period of 40 years). This measure also includes raising the speed limit to 160 km/h in Tallinn–Narva and Tapa–Tartu directions. The expected cost is about 5 million euros.

In addition to these planned, but not implemented PaMs, Table 4.9 also contains additional measures, which are in a planned state and not yet implemented. These measures show an estimated GHG mitigation impact, should additional funding be available for increasing fuel economy in transport, promoting economical driving, reduction of forced movements with private vehicles, improvement of the traffic system, and development of convenient and modern public transport.

International bunkers

CO_2 emissions from aviation have been included in the EU ETS since 2012. Under the EU ETS, all airlines operating in Europe, European and non-European alike, are required to monitor, report and verify their emissions, and to surrender allowances against those emissions. They receive tradeable allowances covering a certain level of emissions from their flights per year. In October 2016, the International Civil Aviation Organization (ICAO) agreed on a Resolution for a global market-based measure to address CO_2 emissions from international aviation as of 2021. The agreed Resolution sets out the objective and key design elements of the global scheme, as well as a roadmap for the completion of the work on implementing modalities.

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) aims to stabilise CO_2 emissions at 2020 levels by requiring airlines to offset the growth of their emissions after 2020. Airlines will be required to monitor emissions on all international routes, offset emissions from routes included in the scheme by purchasing eligible emission units generated by projects that reduce emissions in other sectors (e.g. renewable energy). A regular review of the scheme is required under the terms of the agreement. This should allow for continuous improvement, incl. in how the scheme contributes to the goals of the Paris Agreement. Work is ongoing at ICAO to develop the necessary implementation rules and tools to make the scheme operational. Effective and concrete implementation and operationalization of CORSIA will ultimately depend on national measures to be developed and enforced at domestic level. Estonia, as all other EU Member States, will participate in the voluntary Phase I (2021–2026). Participation of states in the will become mandatory in Phase II (as of 2027) and exemptions will then apply for some states.

International Maritime Organization's (IMO) Marine Environment Protection Committee (MEPC) continues to address GHG emissions from international shipping, with work on track for the adoption of an initial IMO strategy on the reduction of GHG emissions from ships in 2018. Considerable efforts to agree such an approach have been made over recent years within both the IMO and the UNFCCC also with a view to ensure a fair contribution of the sector to the objective of the Paris agreement to limit the average increase of the temperatures to +1.5 °C. In 2016 the IMO in its MEPC 70 meeting reached an agreement on a global data collection system as the next step in their action to tackle CO_2 emissions. Also MEPC 70 agreed to develop a Roadmap for addressing CO_2 emissions from international shipping, with initial CO_2 reduction commitments to be agreed in MEPC 72 by April 2018. In 2017 MEPC 71 adopted guidelines for administration verification of ship fuel oil consumption data (Resolution MEPC.292(71)) and guidelines for the development and management of the IMO ship fuel oil consumption database (Resolution MEPC.293(71)).

In June 2013, the EC set out a strategy to progressively integrate maritime emissions into the EU's policy for reducing its domestic GHG emissions consisting 3 consecutive steps:

1. monitoring, reporting and verification of CO_2 emissions from large ships using EU ports;
2. GHG reduction targets for the maritime transport sector;
3. further measures, incl. market-based measures, in the medium to long term.

EU has already taken the first step: monitoring, reporting and verification of CO_2 emissions from large ships using EU ports. Large ships over 5000 gross tonnes loading/unloading cargo/

Table 4.9. Policies and measures in Transport sector

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2]			
						2020	2025	2030	2035
Increasing the share of biofuels in transport*	CO_2	Low carbon fuels/electric cars	Economic	Implemented	MoEAC	251.8	294.3	329.6	319.6

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2]			
						2020	2025	2030	2035
Increase of fuel economy in transport*	CO_2	Efficiency improvements of vehicles	Economic	Implemented	MoEAC	40.7	69.8	98.8	98.8
Promotion of economical driving*	CO_2	Modal shift to public transport or non-motorised transport; demand management/reduction; improved behaviour	Economic; information	Implemented	MoEAC	36.3	62.3	88.2	88.2
Reduction of forced movements with personal vehicles in transport*	CO_2	Demand management/ reduction	Economic; planning	Implemented	MoEAC	15.4	26.3	37.4	37.4
Improvement of the traffic system*	CO_2	Modal shift to public transport or non-motorised transport; demand management/reduction; improved transport infrastructure	Economic; information; regulatory; planning	Implemented	MoEAC	39.4	67.5	95.7	95.7
Development of convenient and modern public transport*	CO_2	Improved behaviour; improved transport infrastructure	Economic; information	Implemented	MoEAC	22.1	37.9	53.6	53.6
Additional increase of fuel economy in transport*	CO_2	Efficiency improvements of vehicles	Economic	Planned	MoEAC	16.2	45.1	75.2	83.6
Additional promotion of economical driving	CO_2; CH_4; N_2O	Modal shift to public transport or non-motorised transport; demand management/reduction; improved behaviour	Economic; information	Planned	MoEAC	23.1	64.5	107.5	119.5
Additional reduction of forced movements with private vehicles in transport	CO_2; CH_4; N_2O	Demand management/ reduction	Economic; planning	Planned	MoEAC	13.7	38.2	63.7	70.8
Additional improvement of the traffic system	CO_2; CH_4; N_2O	Modal shift to public transport or non-motorised transport; demand management/reduction; improved transport infrastructure	Economic; regulatory; information; planning	Planned	MoEAC	68.3	190.6	317.8	353.3
Additional development of convenient and modern public transport	CO_2; CH_4; N_2O	Improved behaviour; improved transport infrastructure	Economic; information	Planned	MoEAC	27.6	77.0	128.4	142.8
Road usage fees for cars and heavy duty vehicles	CO_2	Demand management/ reduction; improved behaviour	Fiscal	Planned	MoEAC	69.9	194.5	324.3	360.7
Congestion charge	CO_2	Demand management/ reduction; improved transport infrastructure; improved behaviour	Fiscal	Planned	MoEAC	17.0	47.7	79.6	88.5
Development of the railroad infrastructure	CO_2; CH_4; N_2O	Modal shift to public transport or non-motorised transport; demand management/reduction	Economic	Planned	MoEAC	8.1	22.7	38.0	42.2

[1] All PaMs marked with an asterix (*) are included in the WM scenario

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

passengers from 1 January 2018 at EU maritime ports are to monitor and later report their related CO_2 emissions and other relevant information in accordance with their monitoring plan. Monitoring, reporting and verification of information shall be done in conformity with Regulation 2015/757 (as amended by Delegated Regulation 2016/2071).

According to the EU's Marine Strategy Framework Directive (MSFD, 2008/56/EC), all Member States have to establish and implement the programme of measures to achieve or maintain good environmental status of the marine areas by 2020. One of the measures under the Programme of measures of the Estonian marine strategy 2016-2020 includes creating the readiness to use liquefied natural gas (LNG) as ship fuel that helps to maintain good environmental status of the marine areas.

PaMs affecting Transport sector along with their effect on GHG emissions are also presented in Table 4.9.

4.3.6. Industrial processes and product use

Previously Estonia reported as an emission curbing measure the Industrial Emissions Act of the Estonian Parliament that is implemented by means of duty for manufacturing industries to use best available technologies (BATs), integrated environmental permits and domestic reporting of emissions. The Industrial Emissions Act is implemented on the base of the Industrial Emissions Directive (Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)).

The effect of the Industrial Emissions Act on CO_2 emissions is shown on the aggregated emissions from the industries that are belonging to EU ETS. According to the integrated environmental permits all Estonian mineral and chemical production plants under Industrial processes and product use (IPPU) sector already and currently comply with BATs and the future effect of this measure would be zero.

In January 2017, Ambient Air Protection Act was repealed and amended with the Atmospheric Air Protection Act, which now entails all relevant legislation regarding F-gases, incl. Regulation (EU) No 517/2014 on fluorinated GHGs.

Therefore Estonia is reporting only one measure for IPPU sector – bans and duties stipulated in the Regulation (EU) No 517/2014 on fluorinated GHGs and Directive 2006/40/EC related to emissions from mobile air conditioners (MACs). The aforementioned and their effect are handled as one measure (named as bans and duties from the Regulation (EU) No 517/2014), since it would be difficult to model the effect of each of the aforementioned measure separately. The projected effects of the measure used for projecting GHG emissions in the IPPU sector is presented in Table 4.10.

The Regulation (EU) No 517/2014 on fluorinated GHGs (entry into force 1 January 2015) strictly imposes a schedule for phase-down of F-gases by 2030, which is implemented by means of the quota system and bans/restrictions.

The most important measures in the Regulation (EU) No 517/2014 (Table 4.10) that reduce fluorinated GHGs include:

- bans on bringing certain new equipment to the market;
- the service ban for F-gases with global warming potential (GWP) equal or over 2,500;
- duty of collecting the gases from decommissioned equipment;
- certification duties for entrepreneurs who are handling the gases.

Directive 2006/40/EC prohibits since 1 January 2017 the sale of new passenger cars, pick-up trucks and vans with EU type approval which have refrigerant with GWP over 150 in air conditioners. Estonia has not imposed significantly stricter requirements than in Regulation 517/2014 and in Directive 2006/40/EC.

Table 4.10. Projected effects of the IPPU sector policy

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2]			
						2020	2025	2030	2035
Regulation (EU) No 517/2014*	HFC	Reduction of emissions of fluorinated gases; replacement of fluorinated gases by other substances	Regulatory	Implemented	MoE	22.8	67.6	108.8	134.0

[1] All PaMs marked with an asterix (*) are included in the WM scenario

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

4.3.7. Agriculture

Climate change mitigation and adaptation have been considered in the development of different measures, and directly or indirectly the majority of environmental and investment grants along with different environmental awareness raising activities contribute to these efforts in the ERDP 2014-2020. Under ERDP the following priorities and measures, which are also referred in the Climate Change Mitigation and Adaptation Action Plan in Agriculture sector 2012–2020 and in the Estonian Organic Farming Development Plan 2014–2020, strive to limit and reduce GHG emissions in the agricultural sector:

1) The objectives of the **support for organic farming** are the following: supporting and improving the competitiveness of organic farming; increasing biological and landscape diversity and maintaining and improving soil fertility and water quality. Organic farm land constituted 15.3% of the total agricultural land in Estonia in 2012. 75% of organic farm land was grassland. Cost of measure will be approximately 92.2 million euros.

2) **Support for environmentally friendly management**. The objectives are the following: to promote the introduction and continual use of environmentally friendly management methods in agriculture, in order to protect and increase biological and landscape diversity and to protect the status of water and soil; to expand environmentally

friendly planning in agriculture and to increase the awareness of agricultural producers of the environment. Cost of measure is expected to be around 170 million euros.

3) **To reduce GHG and ammonia emissions from agriculture it has been** stipulated in the ERDP to include 49.6% of the agricultural land currently in use under economising agreements by 2020. The objectives include promoting use of biomass, producing renewable energy, investing in livestock buildings (incl. manure storage) and increasing the technological capacity of agricultural enterprises. Besides the horizontal measures Transferring of Knowledge and Information and Advisory, Agricultural Enterprises Management and Substitute Services there are no particular measures or activities programmed to achieve these objectives. The intervention is planned to take place through supporting activities (investments in bioenergy, investments in manure storage facilities) of activity type *Investments to improve the productivity of agricultural enterprises* under the measure *Investments in tangibles*.

The objective of the Estonian Dairy Strategy to increase the volume of milk production by a third compared to 2011 is not a mitigation measure by nature and will affect the GHG emission balance by increasing CH_4 and N_2O emissions from animal husbandry. For this reason the Estonian Dairy Strategy has been shown in as an informative item.

EEDP 2030+ describes the objectives of Estonia's energy policy until 2030 and the vision of energy management until 2050, objectives and sub goals of EEDP 2030+ and measures of the implementation of the development plan. The production of biomethane and bioethanol would enable Estonia to reach the mandatory national target set by the EU for renewable energy shares of final energy consumption in 2020, which also includes 10% of renewables in transport sector.

Measures to reduce nitrogen leakage from agriculture

The Accession Treaty for the new members of the EU specified that the measures of the Nitrates Directive had to be implemented in Estonia by the end of 2008. Therefore a Code of Good Agricultural Practices were agreed upon between MoRA and the MoE in 2001 and an Action programme for establishment of Nitrate Vulnerable Zone (NVZ) was defined with the aim of being implemented by the end of 2008.

Actions to reduce nitrogen losses from agriculture, for example based on the requirements of the Nitrates Directive, have led to reduced nitrogen emissions to the aquatic environment with indirect positive effects for the mitigation of climate gas emissions. The legislation which is relevant for the implementation of the Nitrates Directive is the Water Act, which was enacted in 1994 and has been revised since, especially in connection with the accession into the EU. In 2001 the Code of Good Agricultural Practices and a Government decree on water protection requirements for fertiliser, manure and silage were introduced and both of these are relevant to Annex II and III in the Nitrates Directive. The Water Act is one of the principal legal acts that the prime measures in Estonian Water Management Plan measure programme 2015–2021 are grounded upon.

Measures in the Estonian Water Management Plan measure programme 2015–2021 striving to limit nitrogen exposure from agriculture to the environment are:

1) **Introduction of effective fertilisation technologies.** Expected cost of measure: 7.8 million euros.

2) **Reducing pollution caused by nutrients from agriculture** (repair manure and silage storage facilities, support the promotion of environmentally friendly fertiliser spreading technologies, support the promotion of good agricultural practice. Expected cost of measure is 0.9 million euros.

3) **Reconstruction or construction of new livestock facilities** (incl. manure and silage storage facilities) in order to prevent the environmental risks arising from production. Expected cost of measure is 20.9 million euros.

A summary of all Agriculture sector PaMs are presented in Table 4.11 GHG estimates under mitigation impact are not available for all PaMs due to lack of quantifiable activity data under each measure.

Table 4.11. Policies and measures in Agriculture sector

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2,3]			
						2020	2025	2030	2035
Organic farming*	N_2O CO_2	Reduction of fertiliser/manure use on cropland; improved livestock management; activities improving grazing land or grassland management	Regulatory	Implemented	MoRA	NE	NE	NE	NE
Support for environmentally friendly management*	CH_4 CO_2 N_2O	Promote the introduction and continual use of environmentally friendly management methods in agriculture.	Information; regulatory	Implemented	MoRA	NE	NE	NE	NE
Reducing GHG and ammonia emissions from agricultural sector*	CH_4 N_2O	Include 49.6% of the agricultural land currently in use under economising agreements to reduce N_2O and CH_4 emissions by 2020.	Economic	Implemented	MoRA	NE	NE	NE	NE
Introduction of effective fertilisation technologies*	N_2O CO_2	Preventing and reducing nitrogen leaching and runoff	Economic; information; research	Implemented	MoE	NE	NE	NE	NE
Reducing pollution caused by nutrients from agriculture*	N_2O	Preventing and reducing water nitrogen pollution resulting from agricultural production	Economic; information; research	Implemented	MoE	NE	NE	NE	NE
Reconstruction or construction of new livestock facilities (incl. manure and silage storage facilities) in order to prevent the environmental risks arising from production*	N_2O	Preventing and reducing water nitrogen pollution resulting from agricultural production	Economic; information; research	Implemented	MoE	NE	NE	NE	NE

[1] All PaMs marked with an asterix (*) are included in the WM scenario

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

[3] NE – not estimated: GHG estimates of mitigation impact is not available due to lack of quantifiable activity data under reported measures.

4.3.8. Land use, land-use change and forestry

The Forest Act provides the legal framework for the management of forests in Estonia. The main objective of the act is to ensure the protection and sustainable management of forests as an ecosystem. The Forest Act includes Reforestation measure that aims to support regeneration of forest after felling or natural disturbances. According to Forest Act, the forest owner is obliged to assure regeneration of forest no later than 5 years after felling or natural disturbances. Supporting fast reforestation after felling is beneficial to achieving continuous carbon sequestration on forest land and therefore maintaining the level of GHG removals by forests in Estonia.

The Estonian Forestry Development Programme until 2020 (EFDP 2020), approved by the Parliament in 2011, is the official sustainable development strategy for the Estonian forest sector. The programme determines objectives and describes measures and tools for achieving them for the period 2011–2020. The main objective of the development plan is to ensure productivity and viability as well as to assure multiple and efficient use of forests. One of the aims is to increase the annual increment along with carbon sequestration in forests by implementing appropriate forest management activities like regeneration, cleanings and thinnings. In Table 4.12 the main indicators and target levels are presented for the current situation and for 2020.

Table 4.12. Indicators and target levels set in EFDP 2020

Indicator	Baseline level	Target level
Growing stock	442 million m^3 (NFI 2008)	450 million m^3
Increment	12.1 million m^3/yr (NFI 2008)	12.5 million m^3/yr
Annual volume and area of regeneration fellings	5.85 million m^3 22,400 ha/yr (NFI 2000–2008)	10.1 million m^3 34,500 ha/yr (2011–2020)
Annual area of cleanings	22,200 ha/yr (STAT 2009)	32,400 ha/yr
Annual area of thinnings	14,200 ha/yr (NFI 2007)	34,500 ha/yr
Woody biomass used in energy production	22 PJ/yr (2009)	30 PJ/yr

According to the EFDP 2020 the state has set a goal to enhance the use of wood because the age structure of Estonian forests supports more cutting (12–15 million m^3 per year), and not using forest resources would be an unreasonable waste of renewables.

Achieving the objectives of the EFDP 2020 is supported by the ERDP, through which most of the private forestry support measures are co-financed. The objective of the ERDP is to support Estonian rural development in a manner that is complementary to other measures of the EU Common Agricultural Policy, Cohesion Policy and the European Common Fisheries Policy. Additionally, Estonian MoRA wants to help raise the competitiveness of agriculture, improve the sustainable management of natural resources and improve the climate action through the implementation of the development plan. ERDP is implemented through measures, which are based on the needs and objectives identified during the preparation of the development plan. In total, it is intended to implement over 20 (sub) measures within the framework of the development plan.

The LULUCF sector's role as a sink or source of GHGs in the future will mainly be determined by forest management practices – the intensity of forest fellings, also usage of peat soils and practices applied in cropland and grassland.

Measures related to forest management

EFDP 2020 (renewed in January 2016) and the ERDP comprise the following measures that target sustainable use of forest, inter alia increase of forest carbon pools:

1) **Increasing forest increment and ability to sequestrate carbon through timely regeneration of forests for climate change mitigation** – the overall objective of the measure is to support activities related to timely regeneration of forests in order to mitigate climate change. Cost of the measure is expected to be about 5.5 million euros in the period 2016–2020.

2) **Promotion of regeneration of forests in managed private forests with the tree species suitable for the habitat type** – the measure grants the supply of tree species suitable for the habitat type to promote efficient and fast regeneration of private forests. Cost of the measure is expected to be about 7.5 million euros in the period 2016–2020.

3) **Improving forest health condition and preventing the spreading of dangerous forest detractors** – the measure provides support for monitoring and restoration of forests in order to improve forest health condition and prevent damage caused by fire, pests and storms. Cost of the measure is expected to be about 0.4 million euros in the period 2016–2020.

4) **Reducing the environmental impact related to the use of fossil fuels and non-renewable natural resources by increasing timber production and use in Estonia** – the objective of the measure is to encourage timber production and use in Estonia through supported activities. Cost of the measure is expected to be about 0.3 million euros in 2016–2020.

5) **Natura 2000 support for private forest land** – protected areas, special conservation areas and species protection sites on forest land will help to preserve forest carbon stock from those areas. The measure aims to maintain biological and landscape diversity in Natura 2000 areas covered with forests, which means support for private forest areas.

6) **Maintaining biological processes and preserving population of species that are common to Estonia.** Cost of the measure is expected to be about 1 million euros in 2016–2020.

7) **Improvement of forest economic and ecological vitality** – the overall objective of supporting forestry as an integral part of rural life, is sustainable and effective forest management which promotes raising vitality of forests by improving its species composition or implementing other silvicultural techniques, maintaining and renewing forest biological diversity, integral ecosystem and protection function by helping to preserve forest's multifunctional role and its spiritual and cultural heritage. Cost of the measure is expected to be about 13.8 million euros in 2016–2020.

Measures related to Cropland management

ERDP's following measures pursue to limit and reduce GHG emissions and enhance carbon sequestration:

1) **Support for growing plants of local varieties** – the measure helps to preserve crop varieties more suitable for local conditions (more resistant to locally spread diseases and climate conditions) and therefore gives a good basis for developing new breeds and supports organic farming. Cost of the measure is expected to be about 0.6 million euros.

2) **Regional support for soil protection** – the aims of the measure are to: limit GHG emissions, limit soil erosion, reduce nutrient leaching and maintain and raise the content of soil organic matter. Cost of the measure is expected to be about 2.45 million euros.

3) **Crop diversification (CAP measure)** – the Crop diversification measure is one of the Greening measures under CAP. The objective of the measure is to make farms with monocultures more environmentally friendly and sustainable. Cost of the measure is expected to be about 900 million euros.

4) **Support for the establishment of protection forest on agricultural land** – with the establishment of protected forests, the share of agricultural lands sensitive to the environment will be reduced and the need to establish protection forests on the account of commercial forests will be decreased. With the establishment of small groves forest, the biodiversity will be increased in particular areas as well. The measure supports the permanent conversion of vulnerable agricultural lands to protected forest lands.

Measures related to Grassland, Wetland and Grazing land management

Measures related to Grassland, Wetland and Grazing land management that have a GHG mititgation impact are:

1) **Support for the maintenance of semi-natural habitats** – the overall objectives of this measure are: to improve the quality of maintenance of semi-natural habitats whereas increasing the share of semi-natural habitats maintained by farm animals, to preserve and increase biological and landscape diversity; to increase the area of land under maintenance; to improve the condition of species related to semi-natural habitats. Cost of the measure is expected to be about 40 million euros.

2) **Ensuring the favourable conservation status of habitats** – the measure aims to improve the conservation status of at least 14 habitat types in Estonia due to the applied protection measures. The immediate outcome of the activity of the measure is 10,000 hectares of fen and transition mire habitats and raised bog margins (lag-zones, mixotrophic and ombrotrophic forests, degraded raised bogs still capable of natural regeneration) in protected areas. Cost of the measure is expected to be about 2.7 million euros in 2017.

3) **Preservation of permanent grassland** – the Preservation of permanent grassland is one of the Greening measures under CAP. The objective of the measure is to avoid massive conversion of grassland to arable land. The member state is obliged to maintain the total area of permanent grassland. Estonia has to maintain the area of permanent grassland at least on the level of the year 2005.

Table 4.13. Policies and measures in LULUCF sector

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2,3]			
						2020	2025	2030	2035
Increasing forest increment and ability to sequestrate carbon through timely regeneration of forests for climate change mitigation*	CO_2	Conservation of carbon in existing forests; enhancing production in existing forests	Economic	Implemented	MoE	NE[1]	NE	NE	NE
Promotion of regeneration of forests in managed private forests with the tree species suitable for the habitat type*	CO_2	Conservation of carbon in existing forests; enhancing production in existing forests; enhanced forest management	Economic	Implemented	MoE	NE	NE	NE	NE
Improving forest health condition and preventing the spreading of dangerous forest detractors*	CO_2	Strengthening protection against natural disturbances; conservation of carbon in existing forests	Economic	Implemented	MoE	NE	NE	NE	NE
Reducing the environmental impact related to the use of fossil fuels and non-renewable natural resources by increasing timber production and use in Estonia*	CO_2	Increasing the harvested wood products pool; substitution of GHG-intensive feedstocks and materials with harvested wood products	Economic; regulatory	Implemented	MoE	NE	NE	NE	NE
Natura 2000 support for private forest land*	CO_2	Conservation of carbon in existing forests	Economic	Adopted	MoRA	NE	NE	NE	NE
Improvement of forest economic and ecological vitality*	CO_2	Conservation of carbon in existing forests	Economic	Adopted	MoRA	NE	NE	NE	NE
Support for growing plants of local varieties*	CO_2 N_2O	Carbon sequestration; GHG emissions reduction	Economic	Adopted	MoRA	NE	NE	NE	NE
Regional support for soil protection*	CO_2	GHG emissions reduction; carbon conservation on agricultural land	Economic	Adopted	MoRA	NE	NE	NE	NE
Crop diversification measure*	CO_2	GHG emissions reduction; carbon conservation on cropland	Regulatory	Adopted	MoRA	NE	NE	NE	NE
Support for the maintenance of semi-natural habitats*	CO_2	GHG emissions reduction; carbon conservation on grassland	Economic	Adopted	MoRA	NE	NE	NE	NE
Ensuring the favourable conservation status of habitats*	CO_2 CH_4	GHG emissions reduction; carbon sequestration	Economic	Implemented	MoE	NE	NE	NE	NE

[1] All PaMs marked with an asterix (*) are included in the WM scenario

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

[3] NE – not estimated: GHG estimates of mitigation impact is not available due to lack of quantifiable activity data under reported measures.

A summary of LULUCF sector PaMs are presented in Table 4.13. GHG estimates under mitigation impact are not available for all PaMs due to lack of quantifiable activity data under each measure.

4.3.9. Waste

General waste related requirements and rules are stipulated under Waste Act according to which all landfills had to meet the EU established requirements by 16 July 2009 and had to be conditioned in accordance with the requirements no later than 31 December 2015.

The Estonian Waste Act includes following measures to limit and reduce GHG emissions:

1) **Prohibition concerning percentage of biodegradable waste deposited** – the percentage of biodegradable waste in the total amount by weight of municipal waste deposited in landfills in Estonia shall not exceed: 45% by 16 July 2010; 30% by 16 July 2013 and 20% by July 2020. Reducing the amount of biodegradable waste deposited is also included in the Estonian Waste Management Plan 2014–2020 (NWMP). The amount of biodegradable waste in the total amount by weight of municipal waste deposited in landfills was 57% in 2011 and decreased to 48% by 2014.

2) **Increasing reusing and recycling of waste materials** – to meet the requirements of the directive 2009/98/EC, the Waste Act stipulates that by 1 January 2020, reuse and the recycling of waste materials such as paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased at least to the extent of 50% of the total weight of such waste per calendar year. The same target is also included in the NWMP. The level of reusing and recycling of waste materials was 27% in 2011, which increased to 35% by 2014.

Establishment of waste management rules incl. adoption and updating the waste management plan is stipulated under The Local Government Organization Act and is the responsibility of the local government. Most of local government waste management plans also stipulate prohibition of open burning of MSW.

The National Environmental Strategy until 2030 includes following policy:

1) **Reducing landfilling waste** – by 2030, landfilling waste is reduced by 30% and the hazard of waste is reduced significantly. Reaching the target is supported by measures that are included in the NWMP.

The objective of the NWMP is to introduce sustainable waste management that follows waste hierarchy principle, mainly focusing on modern product design, clean resource saving productions and recycling of already produced materials. Also, the reduction of hazardous substances in materials and products. NWMP has set following target levels for 2020 (Table 4.14).

Table 4.14. Target levels in NWMP

NWMP	Target level 2020
Recycling percentage of biodegradable waste in the total amount by weight of municipal waste.	13%
The share of biodegradable waste in total landfilled MSW.	20%
Recycling percentage of municipal solid waste in the total amount by weight of municipal waste.	50%

The NWMP comprises following measures to limit and reduce GHG emissions:

1) **Promoting the prevention and reduction of waste generated, incl. reducing the hazard of waste** – the overall objective of the measure is to improve the resource efficiency of Estonia's economy and promoting waste prevention to reduce the negative impact on environment and human health. The state is supporting the prevention of waste by dissemination of information. A variety of initiatives, implementation of environmental management tools, additional research projects and investment and completion of the necessary legal regulations will help to implement this measure. Measure helps to reduce GHG emissions in solid waste disposal subsection. Expected cost of implementing the measure is 3.73 million euros.

2) **Recycling or reusing waste at the maximum level** – this strategic objective is set to increase recycling of municipal waste and biodegradable waste in the total amount of MSW and developing a nationwide waste collection network with intensified waste reporting system. Consistent waste reuse and recycling guidance and simple expanding system for waste handling will thereby increase the amount of waste separately collected and decrease the amount of waste landfilled. Establishing the state-wide biodegradable waste collection and treatment network is especially important when reducing the GHG emission from solid waste disposal. Expected cost of implementing the measure is 32.46 million euros.

3) **Reducing environmental risks arising from waste, improvement of monitoring and supervision** – the overall objective of the measure is to improve hazardous waste treatment options and reducing environmental risks arising from waste disposal. Landfills closed for waste deposit have to be conditioned in accordance with the requirements. Strengthening the supervision of waste management will help to reduce illegal waste disposal. In 2013 there were 5 operating mixed municipal waste landfills. Measure is supporting the previously mentioned measures. Expected cost of implementing the measure is about 27.77 million euros.

The summary of the PaMs with expected mitigated GHG emissions, where available, are presented in Table 4.15. GHG mitigation estimates of mitigation impact are not available for all PaMs due to lack of quantifiable activity data under each measure.

Table 4.15. Policies and measures in Waste sector

Name of policy or measure[1]	GHG affected	Objective and/or activity affected	Type of instrument	Status	Implementing entity	Total GHG estimate of mitigation impact, kt CO_2 eq.[2,3]			
						2020	2025	2030	2035
Reducing landfilling waste*	CH_4	Enhanced recycling; improved landfill management; reduced landfilling	Planning	Implemented	MoE	NE	NE	NE	NE
Promoting the prevention and reduction of waste generated, incl. reducing the hazard of waste*	CH_4 N_2O	Enhanced recycling; improved landfill management; reduced landfilling	Regulatory	Implemented	MoE	NE	NE	NE	NE
Reducing environmental risks arising from waste, improvement of monitoring and supervision*	CH_4	Improved landfill management; improved treatment technologies; improvement of monitoring and supervision	Planning	Implemented	MoE	NE	NE	NE	NE
Increasing reusing and recycling of waste materials*	CH_4	Reduced landfilling; enhanced recycling; improved landfill management	Regulatory	Implemented	MoE	NE	NE	NE	NE
Prohibition concerning percentage of biodegradable waste deposited and Increasing reusing and recycling of waste materials*	CH_4 N_2O	Reduced landfilling; enhanced recycling	Regulatory; planning	Implemented	MoE	11.9	34.6	50.6	62.2

[1] All PaMs marked with an asterix (*) are included in the WM scenario.

[2] Effects of PaMs for the years 2020, 2025, 2030 and 2035 are not estimated by gas, only the total estimate of mitigation impact kt CO_2 eq. is available. Mitigation impact of PaMs for the years 1990, 1995, 2000, 2005, 2010 and 2015 are not estimated and therefore not presented in table.

[3] NE – not estimated: GHG estimates of mitigation impact is not available due to lack of quantifiable activity data under reported measures.

In 2013, Eesti Energia finished building the modern and efficient waste-to-energy power unit at the Iru power plant to generate heat and electricity from mixed municipal waste. With the completion of the Iru waste-to-energy unit, the large-scale depositing of mixed municipal waste in landfills is decreasing. In Iru's Air pollutants emissions reduction action plan 2013–2030 it is estimated that the total amount of mixed municipal waste used for energy production is 250 kt per year. Iru CHP plant is mostly burning Estonia's mixed municipal waste that is supported by imported waste to keep up the yearly capacity target of 250 kt.

4.3.10. Effect of policies and measures on the modification of long-term GHG trends

Estonia reached its Kyoto target already in the beginnings of 1990, after major restructuration of economy. In the National Inventory Report 2013 of Estonia, the GHG emissions had decreased about 48% by 2011, compared to 1990. Therefore Estonia had no specific need for PaMs reducing GHG emissions to reach its Kyoto target. However, after joining EU in 2004, significant efforts have been made GHG mitigation PaMs.

The share of renewable energy resources in final consumption of energy has increased from 18.4% in 2004 to 25.9% in 2012. The CO_2 intensity of GDP has decreased from 2.30 tCO_2 million euros in 1998 to 1.56 tCO_2 million euros in 2013. This indicates, that PaMs have had a sizeable impact on GHG trends.

As the share of renewable resources in final energy consumption was already 28.6% on 2015, it means that Estonia has already reached its 2020 target and the share of renewable energy only has to be held on the samel level.

4.3.11. Adverse effects of response measures

Annex I Parties are invited to report on the necessary actions to implement their commitment while minimising adverse social, environmental and economic impacts on developing country parties under Article 3.14 of the KP and UNFCCC Decision 31/CMP.1.

Adverse impacts of potential climate change on developing countries are globally reduced when Annex I countries (and Estonia among them) take measures aiming to reduce GHG emissions through energy savings and the promotion of renewable energy sources as the Energy sector is Estonia's by far the largest producer of GHG emissions. Estonian PaMs address not only Energy sector and fossil fuel combustion but also other sectors emissions of all gases covered by the KP. Estonia is a member state of the EU and, as such, designs and implements its policies in the framework of EC directives, regulations, decisions and recommendations.

4.4. Policies and measures no longer in place

During the reporting period most of the PaMs from the previous period were continued without major changes. Nevertheless, some documents and measures expired due to the arrival of target dates. As a rule, these policy documents were replaced with the new versions, which generally carry on the same policy and apply similar measures, albeit with some differences in the descriptions of the measures. Where applicable, this has been described in relevant subsections.

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V

Projections and the total effect of policies and measures, and supplementarity relating to Kyoto protocol mechanisms

KEY DEVELOPMENTS

- **Estonia has compiled two projection scenarios – firstly, *With Measures* including future greenhouse gas emission trends under current policies and measures. Secondly, *With Additional Measures* with a number of additional measures considering their impact.**
- **Projections of greenhouse gas emissions have been calculated for the period of 2015–2035 and 2014 has been used as a reference year.**
- **Estonia's greenhouse gas emissions are expected to decrease by about 22.1% in the With Measures scenario (without Land use, land-use change and forestry) and by about 32.4% in the With Additional Measures scenario (without Land use, land-use change and forestry) by 2035 compared to the base year of 2014.**
- **The main difference in the results of the With Measures and With Additional Measures scenarios is related to measures foreseen to be implemented with regard to energy efficiency and the use of biofuels. This will lead to smaller final consumption of energy in the With Additional Measures scenario compared to the With Measures scenario.**

5.1. Introduction

The main objective of this chapter is to give an indication of future trends of greenhouse gas (GHG) emissions in Estonia, given the policies and measures implemented and adopted within the current national climate policies. Projections are given for all greenhouse gases considered in United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol (KP), presented in the following sectors (CRF categories): Energy (incl. transport); Industrial processes and product use (IPPU); Agriculture; Land use, land use change and forestry (LULUCF); and Waste. Projections of GHG emissions have been calculated for the period of 2015–2035. 2014 has been used as a reference year. Activity data for the year 2015 is in accordance with the 2017 National GHG Inventory (submitted to the UNFCCC on 15 April 2017).

Two projection scenarios are presented. The *With Measures* (WM) scenario evaluates future GHG emission trends under current policies and measures. In the second scenario, a number of additional measures and their impact are taken into consideration in forming the basis for the *With Additional Measures* (WAM) scenario.

The projections in current National Communication (NC) are updated, compared to the previous National Communication (NC6). The projections are updated because pursuant to Regulation No. 525/2013 of the European Parliament and Council, EU Member States must update their GHG projections every two years. Key assumptions and differences in assumptions between the current NC and the previous NC are presented in Chapter 5.2.7.

5.2. Projections

Projections of GHG emissions have been calculated for the period of 2015–2035 and 2014 has been used as a reference year. Two scenarios are presented. The WM scenario evaluates future GHG emission trends under current policies and measures. In the second scenario, a number of additional measures and their impact are taken into consideration, forming the basis for the WAM scenario.

5.2.1. Energy

The Energy sector includes GHG emissions from the consumption and production of fuels and energy (electricity and heat). The main sub-sectors in this sector are: Energy industries; Manufacturing industries and construction; Transport; Other sectors (Commercial/institutional, Residential and Agriculture/Forestry/Fishing/Fish farms sub-sectors) and Fugitive emissions from natural gas distribution.

The Energy sector's projected emissions in the WM scenario are presented in Table 5.1 and Figure 5.1. In the WM scenario, the emissions are projected to decrease by 27.1% from 2014 to 2035. The largest decrease occurs in the Energy industries sector.

The main electricity producer in Estonia is Narva Elektrijaamad AS (Narva Power Plants) incl. the Eesti Power Plant and the Balti Power Plant. Both of these plants mainly use oil shale for electricity production. Narva Power Plants are also the largest producers of GHG emissions in Estonia. Due to the phasing out of direct oil shale combustion in these plants, the building of a more effective Auvere oil shale combustion plant, and the introduction of new shale oil production plants, GHG emissions are projected to decrease by 36.7% by 2035 compared to 2014 in the Energy industries sector.

GHG emissions in the Manufacturing and construction sector (divided into iron and steel; non-ferrous metals; chemicals; pulp, paper and print; food processing, beverages and tobacco; non-metallic minerals; and other industries) are projected to increase by 12.3% by 2035 compared to 2014. In this sector, only one WM scenario is projected, as there are no additional planned policies or measures.

The emissions from the Transport sector are projected to increase by 11.7%, mainly due to the increased use of compressed natural gas (CNG). At the same time, the share of biofuels and electricity is expected to increase from 0.5% in 2014 to 10.0% in 2035 in the WM scenario.

The emissions in Other sectors (Commercial/institutional, Residential and Agriculture/Forestry/Fishing/Fish farms) are expected to increase by 7.7% in 2035 compared to 2014. GHG emissions from other sources are projected to decrease by 17.1% by 2035 compared to 2014. Only the WM scenario is projected, as there are no additional policies or measures defined. Due to increased natural gas use, the Fugitive emissions are expected to increase by 29.6% by 2035 compared to 2014.

Table 5.1. Total projected WM scenario GHG emissions from the Energy sector, kt

WM		2014	2015	2020	2025	2030	2035
Energy industries	CO_2	14,889.9	12,188.3	12,634.8	12,026.0	9,880.4	9,350.0
	CH_4	0.6	0.6	1.3	1.5	1.6	1.6
	N_2O	0.1	0.1	0.2	0.2	0.2	0.2
	Total CO_2 eq.	14,936.0	12,237.2	12,727.9	12,131.1	9,991.4	9,455.6
Manufacturing and construction	CO_2	698.3	489.8	707.4	739.2	771.0	784.9
	CH_4	0.1	0.1	0.1	0.1	0.1	0.1
	N_2O	0.02	0.02	0.02	0.02	0.02	0.02
	Total CO_2 eq.	706.0	497.6	715.1	747.1	779.1	793.1
Transport	CO_2	2,234.7	2,293.1	2,323.8	2,448.8	2,581.0	2,486.4
	CH_4	0.2	0.2	0.2	0.3	0.4	0.4
	N_2O	0.1	0.1	0.1	0.1	0.1	0.1
	Total CO_2 eq.	2,264.4	2,323.8	2,359.3	2,489.0	2,626.0	2,530.4
Other sectors	CO_2	558.0	591.0	564.3	580.3	596.3	601.2
	CH_4	4.9	4.8	5.4	5.4	5.3	5.3
	N_2O	0.2	0.2	0.2	0.2	0.2	0.2
	Total CO_2 eq.	734.1	762.4	751.6	769.1	786.5	790.9
Other sources	CO_2	32.6	26.8	26.8	26.8	26.8	26.8
	CH_4	0.002	0.001	0.001	0.001	0.001	0.001
	N_2O	0.002	0.001	0.001	0.001	0.001	0.001
	Total CO_2 eq.	33.2	27.3	27.3	27.3	27.3	27.3
Fugitive emissions	CO_2	0.03	0.03	0.05	0.04	0.04	0.04
	CH_4	0.7	0.6	1.1	0.9	0.9	0.9
	Total CO_2 eq.	17.5	15.5	26.6	23.3	22.8	22.7
Energy total	CO_2	18,413.6	15,589.1	16,257.0	15,821.0	13,855.4	13,249.3
	CH_4	6.5	6.3	8.1	8.2	8.4	8.3
	N_2O	0.4	0.4	0.5	0.5	0.6	0.6
	Total CO_2 eq.	18,691.2	15,863.9	16,607.7	16,186.8	14,233.0	13,619.9

The projected emissions of the Energy sector in the WAM scenario are presented in Table 5.2 and Figure 5.1. In the WAM scenario, the emissions are projected to decrease by 38.8% in the period of 2014–2035. The increased reduction of GHGs in the WAM scenario results from higher energy efficiency requirements for buildings (entails additional funding for renovation purposes) and district heating networks, which help to decrease energy consumption for heat production. Decreased GHG emissions also result from an increased amount of energy unions that help to produce energy more efficiently for certain locations or interest groups. The largest absolute decrease occurs in the Energy industries sector. The decrease is projected to be 42.0% in the period of 2014–2035.

The emissions of the Transport sector are projected to decrease by 44.0% by 2035 compared to 2014 in the WAM scenario. The larger decrease compared to the WAM scenario is caused by additional measures, which result in a higher use of electricity and biofuels in transport (the part of electricity and biofuels is expected to be 33% in 2035). Additional measures, e.g. increasing the use of public transport, rail transport, also result in lowered private transport demand which in return lowers emitted GHGs.

Due to the decreased use of natural gas, Fugitive emissions are expected to decrease by 17.1% by 2035 compared to 2014.

Table 5.2. Total projected WAM scenario GHG emissions from the Energy sector, kt

WAM		2014	2015	2020	2025	2030	2035
Energy industries	CO_2	14,889.9	12,188.3	12,361.2	11,706.3	9,290.9	8,569.3
	CH_4	0.6	0.6	1.3	1.4	1.5	1.4
	N_2O	0.1	0.1	0.2	0.2	0.2	0.2
	Total CO_2 eq.	14,936.0	12,237.2	12,451.7	11,806.8	9,394.1	8,664.4
Manufacturing and construction	CO_2	698.3	489.8	707.4	739.2	771.0	784.9
	CH_4	0.1	0.1	0.1	0.1	0.1	0.1
	N_2O	0.02	0.02	0.02	0.02	0.02	0.02
	Total CO_2 eq.	706.0	497.6	715.1	747.1	779.1	793.1
Transport	CO_2	2,234.7	2,293.1	2,080.0	1,775.3	1,460.9	1,242.7
	CH_4	0.2	0.2	0.4	0.4	0.4	0.4
	N_2O	0.09	0.09	0.09	0.08	0.07	0.06
	Total CO_2 eq.	2,264.4	2,323.8	2,115.3	1,808.7	1,491.7	1,269.1
Other sectors	CO_2	558.0	591.0	535.3	536.7	538.1	530.1
	CH_4	4.9	4.8	4.7	4.3	4.0	3.6
	N_2O	0.2	0.2	0.2	0.2	0.2	0.2
	Total CO_2 eq.	734.1	762.4	702.4	695.1	687.9	670.3
Other	CO_2	32.6	26.8	26.8	26.8	26.8	26.8
	CH_4	0.002	0.001	0.001	0.001	0.001	0.001
	N_2O	0.002	0.001	0.001	0.001	0.001	0.001
	Total CO_2 eq.	33.2	27.3	27.3	27.3	27.3	27.3
Fugitive emissions	CO_2	0.03	0.03	0.04	0.04	0.03	0.03
	CH_4	0.7	0.6	1.0	0.8	0.7	0.6
	Total CO_2 eq.	17.5	15.5	24.2	20.5	17.3	14.5
Energy total	CO_2	18,413.6	15,589.1	15,710.7	14,784.3	12,087.6	11,153.8
	CH_4	6.5	6.3	7.4	7.1	6.7	6.1
	N_2O	0.4	0.4	0.5	0.5	0.5	0.5
	Total CO_2 eq.	18,691.2	15,863.9	16,035.9	15,105.5	12,397.3	11,438.6

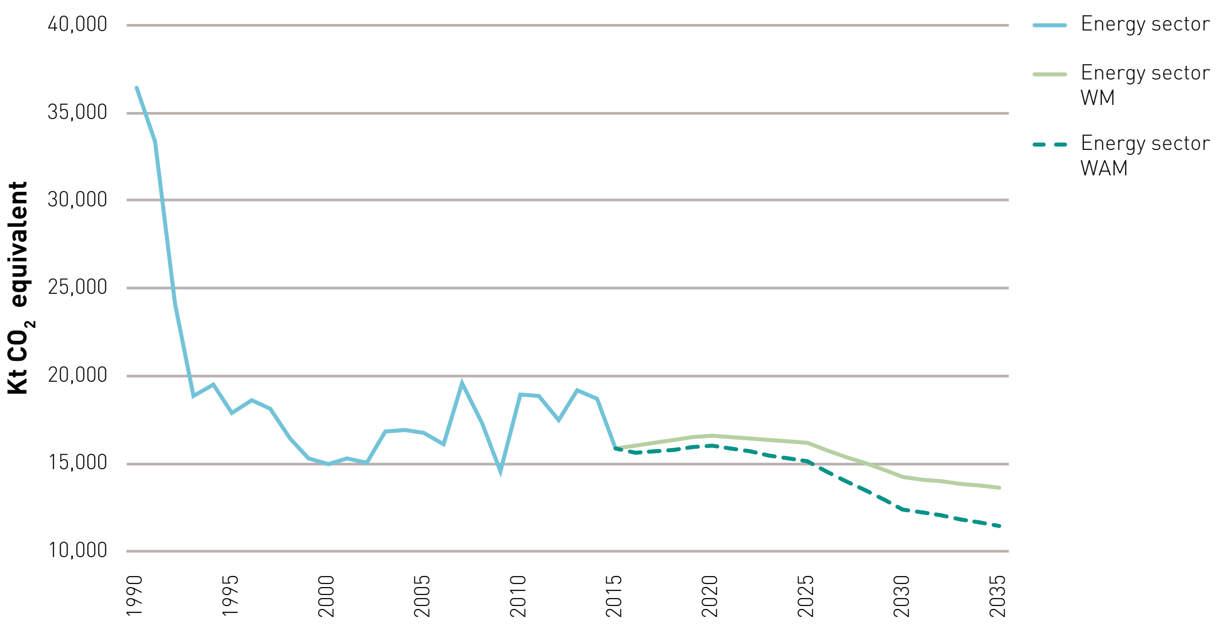

Figure 5.1. Total projected WM and WAM scenario GHG emissions from the Energy sector 1990–2035, kt CO_2 eq.

Transport

The main share of GHG emissions in the Transport sector originate from road transport. Historically, the share of GHG emissions of road transport have been more than about 95% of total GHG emissions of the Transport sector.

The emissions in the Transport sector in the WM scenario are expected to rise about 11.7% in 2035 compared to 2014. The emissions in the Road transportation and Railways sector are projected to increase in the future. Domestic aviation emissions are expected to stay at the same level during the period of 2014–2035. The biggest relative growth is taking place in rail transport due to a modal shift from Road transport. Domestic navigation emissions are projected to decrease due to decreased fuel consumption. The total projected GHG emissions in the WM scenario are presented in Table 5.3 and Figure 5.2.

Table 5.3. Total projected WM scenario GHG emissions from the Transport sector, kt

WM		2014	2015	2020	2025	2030	2035
Domestic aviation	CO_2	1.2	1.2	1.2	1.2	1.2	1.2
	CH_4	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007
	N_2O	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003
	Total CO_2 eq.	1.3	1.3	1.3	1.3	1.3	1.3
Road transportation	CO_2	2,140.6	2,192.9	2,215.4	2,324.0	2,427.2	2,333.5
	CH_4	0.2	0.2	0.2	0.3	0.4	0.4
	N_2O	0.06	0.07	0.07	0.07	0.07	0.07
	Total CO_2 eq.	2,162.7	2,216.1	2,240.7	2,352.8	2,458.9	2,364.2
Railways	CO_2	61.2	59.4	86.5	101.6	129.2	128.6
	CH_4	0.003	0.003	0.005	0.02	0.06	0.06
	N_2O	0.02	0.02	0.03	0.04	0.04	0.04
	Total CO_2 eq.	68.4	66.4	96.7	113.0	142.6	141.8
Domestic navigation	CO_2	31.7	39.6	20.6	21.9	23.3	23.1
	CH_4	0.003	0.004	0.001	0.001	0.002	0.002
	N_2O	0.0009	0.001	0.0002	0.0002	0.0002	0.0002
	Total CO_2 eq.	32.1	40.1	20.7	22.0	23.4	23.2
Other transportation	CO_2	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO
	Total CO_2 eq.	NO	NO	NO	NO	NO	NO
Transportation total	CO_2	2,234.7	2,293.1	2,323.8	2,448.8	2,581.0	2,486.4
	CH_4	0.2	0.2	0.2	0.3	0.4	0.4
	N_2O	0.1	0.1	0.1	0.1	0.1	0.1
	Total CO_2 eq.	2,264.4	2,323.8	2,359.3	2,489.0	2,626.0	2,530.4

NO - not occurring: GHG emissions do not occur.

The emissions in the Transport sector in the WAM scenario are expected to decrease significantly (44.0%) in 2035 compared to 2014. Domestic aviation emissions are expected to stay approximately at the same level (as in the WM scenario) during the period of 2014–2035. Domestic navigation and Road transportation emissions are projected to decrease compared to the base year. The largest emission reductions occur in Road transportation sector – emissions are projected to decrease by 48.0% in 2035 compared to 2014 – a total of 1,039.74 kt CO_2 equivalent (eq.), which is the result of higher use of biofuels, increased use of public transport, and a lower demand for private transport. The emissions of the Railways sector are expected to increase less compared to the WM scenario. The total projected GHG emissions in the WAM scenario are presented in Table 5.4 and Figure 5.2.

Table 5.4. Total projected WAM scenario GHG emissions from the Transport sector, kt

WAM		2014	2015	2020	2025	2030	2035
Domestic aviation	CO_2	1.2	1.2	1.2	1.2	1.2	1.2
	CH_4	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007
	N_2O	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003
	Total CO_2 eq.	1.3	1.3	1.3	1.3	1.3	1.3
Road transportation	CO_2	2,140.6	2,192.9	1,920.2	1,620.9	1,311.9	1,106.7
	CH_4	0.2	0.1	0.2	0.3	0.3	0.2
	N_2O	0.1	0.1	0.1	0.1	0.04	0.04
	Total CO_2 eq.	2,162.7	2,216.1	1,943.1	1,642.5	1,331.6	1,123.7
Railways	CO_2	61.2	59.4	141.3	137.7	134.1	123.3
	CH_4	0.003	0.003	0.1	0.1	0.1	0.1
	N_2O	0.02	0.02	0.03	0.03	0.03	0.02
	Total CO_2 eq.	68.4	66.4	153.7	149.4	145.1	132.6
Domestic navigation	CO_2	31.7	39.6	17.2	15.5	13.7	11.5
	CH_4	0.003	0.004	0.001	0.001	0.001	0.001
	N_2O	0.0009	0.001	0.0001	0.0001	0.0001	0.0001
	Total CO_2 eq.	32.1	40.1	17.3	15.5	13.8	11.5
Other transportation	CO_2	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO
	Total CO_2 eq.	NO	NO	NO	NO	NO	NO
Transportation total	CO_2	2,234.7	2,293.1	2,080.0	1,775.3	1,460.9	1,242.7
	CH_4	0.2	0.2	0.4	0.4	0.4	0.4
	N_2O	0.1	0.1	0.1	0.1	0.1	0.1
	Total CO_2 eq.	2,264.4	2,323.8	2,115.3	1,808.7	1,491.7	1,269.1

NO- not occurring: GHG emissions do not occur.

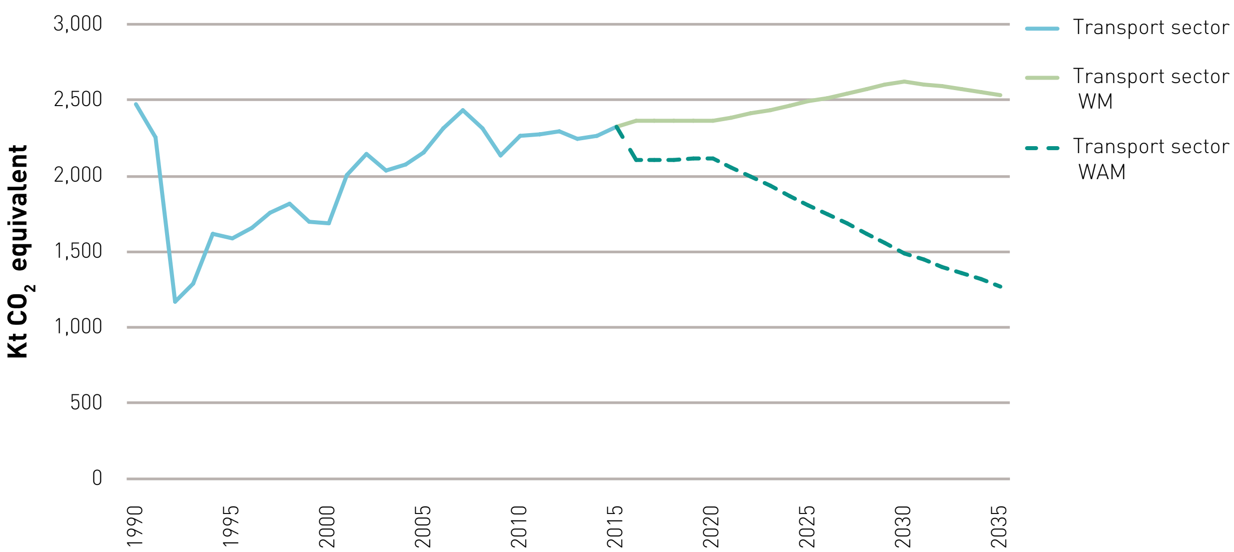

Figure 5.2. Total projected WM and WAM scenario GHG emissions from the Transport sector 1990–2035, kt CO_2 eq.

5.2.2. Industrial processes and product use

Emissions from the IPPU sector are projected only based on the WM scenario. Existing measures are bans and duties stipulated in the Regulation (EU) No. 517/2014 on fluorinated GHG and Directive 2006/40/EC related to emissions from mobile air conditioners (MACs).

Projections of GHG emissions from the IPPU sector by subcategory and GHG type are presented in Table 5.5 and Figure 5.3.

Table 5.5. Total GHG emissions from the Industrial processes and product use sector in the WM scenario, kt

WM		2014	2015	2020	2025	2030	2035
Mineral industry	CO_2	464.5	262.7	784.1	837.3	837.3	837.3
Chemical industry	CO_2	NO	NO	NO	NO	NO	NO
Non-energy products from fuels and solvent use	CO_2	20.5	21.4	20.3	20.4	20.3	20.0
	Indirect CO_2	15.7	15.9	14.9	14.6	14.3	14
Product uses as substitutes for ODS	HFCs	0.1	0.1	0.1	0.1	0.08	0.07
	Total CO_2 eq.	217.5	222.8	194.7	150.0	108.7	83.5
Other product manufacture and use	SF_6 kt·10^{-3}	0.09	0.1	0.1	0.1	0.1	0.1
	N_2O	0.01	0.01	0.01	0.01	0.01	0.01
	Total CO_2 eq.	5.3	6.0	6.0	6.0	6.1	6.1
Industrial processes total	CO_2 (incl. indirect CO_2)	484.9	284.1	804.3	857.7	857.7	857.3
	Indirect CO_2	15.7	15.9	14.9	14.6	14.3	14.0
	HFC	0.1	0.1	0.1	0.1	0.08	0.07
	N_2O	0.01	0.01	0.01	0.01	0.01	0.01
	Total CO_2 eq.	707.7	512.9	1,005.0	1,013.8	972.5	946.8

NO – not occurring: GHG emissions do not occur.

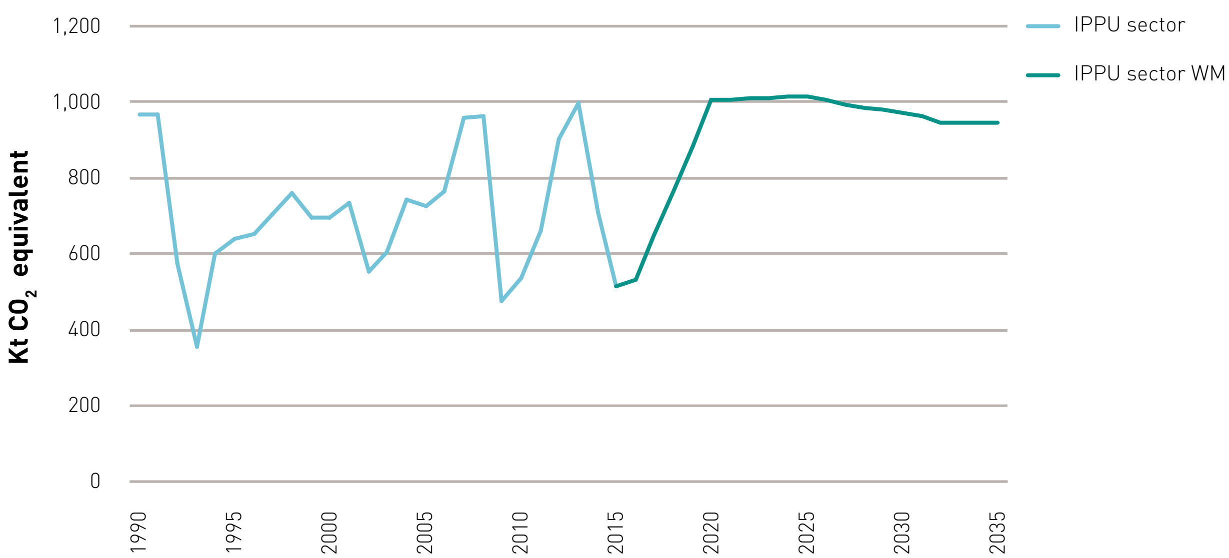

Figure 5.3. Total GHG emissions from the Industrial processes and product use sector, kt CO_2 eq.

Emissions of fluorinated GHG (substitutes for ozone-depleting substances (ODS)) are projected to decrease significantly after 2025, by 51% in 2030, and by more than 62% by 2035. This will be the result of Regulation (EU) No. 517/2014 and Directive 2006/40/EC.

The Mineral industry's production plants hope to recover from economic slowdown and reach their maximal production capacities in 2025 and stay at that level. Therefore, until 2025, emissions are projected to rise by 1.8 times of the low level of 2014. All the plants are already using best available technologies (BATs) according to current reference documents for BATs (BREFs).

Emissions from non-energy products, fuels and solvent use are projected to stay almost constant. Consumption of these products depends on the economic situation of many small industries and solvent use also depends significantly on population size. As very little economic growth can be foreseen and population is not growing, these emissions are projected to stay almost constant.

5.2.3. Agriculture

In the WM scenario, total emissions from the Agriculture sector are projected to grow steadily, reaching 1,679 kt CO_2 eq. in 2035, which is an increase of 25% compared to 2014. The upward trend (Table 5.6 and Figure 5.4) in GHG emissions in the Agriculture sector is the result of Enteric fermentation, Manure management, Agricultural soils and Liming subsectors due to the growth in livestock numbers and an increased milk yield in the case of dairy cows. The rise in emissions from agricultural soils is the result of the expected increase in the use of synthetic and lime fertilisers.

Table 5.6. Total projected WM scenario GHG emissions from the Agriculture sector, kt

WM		2014	2015	2020	2025	2030	2035
Enteric fermentation	CH_4	22.4	21.6	23.7	25.8	27.0	28.2
	Total CO_2 eq.	560.3	540.5	592.0	643.9	674.4	705.3
Manure management	CH_4	3.4	3.1	3.4	3.7	3.8	3.9
	N_2O	0.2	0.2	0.3	0.3	0.3	0.3
	Total CO_2 eq.	150.0	139.8	162.3	174.8	183.0	188.9
Agricultural soils	N_2O	2.1	2.2	2.3	2.4	2.5	2.5
	Total CO_2 eq.	620.9	646.1	698.2	727.4	741.7	755.6
Liming	CO_2	8.3	8.3	12.7	17.1	21.5	25.9
	Total CO_2 eq.	8.3	8.3	12.7	17.1	21.5	25.9
Urea application	CO_2	2.5	3.0	3.0	3.0	3.0	3.0
	Total CO_2 eq.	2.5	3.0	3.0	3.0	3.0	3.0
Agriculture total	CO_2	10.8	11.2	15.6	20.0	24.4	28.8
	CH_4	25.8	24.7	27.1	29.4	30.8	32.2
	N_2O	2.3	2.4	2.6	2.7	2.8	2.8
	Total CO_2 eq.	1,341.9	1,337.6	1,468.1	1,566.1	1,623.6	1,678.6

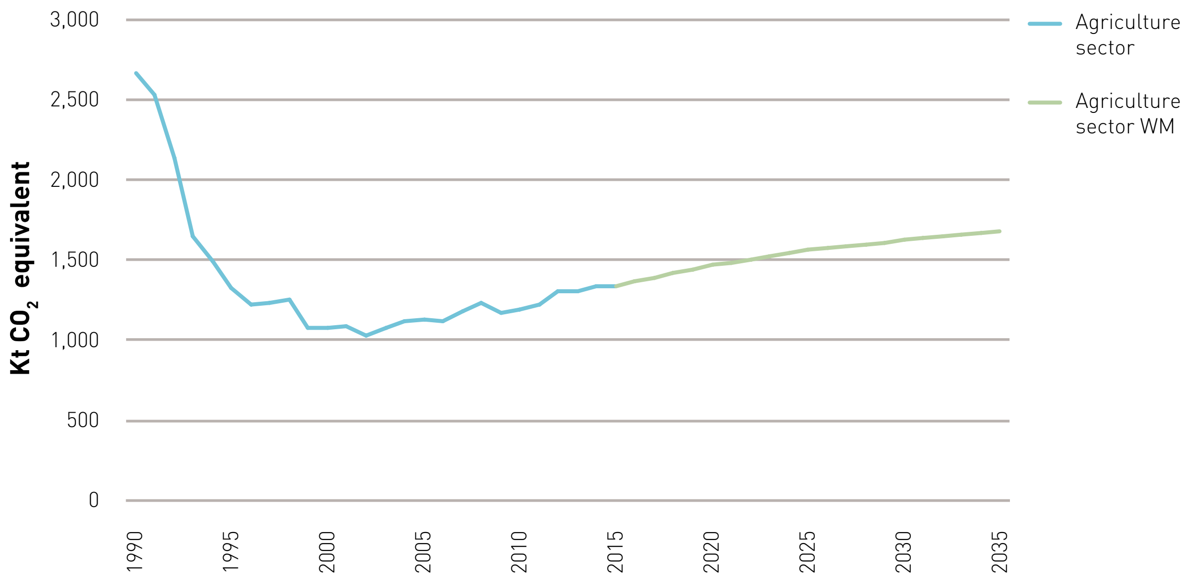

Figure 5.4. Total GHG emissions from the Agriculture sector, kt CO_2 eq.

5.2.4. Land use, land-use change and forestry

The LULUCF sector includes emissions and removals of GHGs from Forest land, Cropland, Grassland, Wetlands, Settlements, Other land and Harvested wood products. There are a number of factors that have affected the use of land during the last 25 years, the most important of which is the land reform, but also accession to the EU, economic rises and falls.

Table 5.7. Projected land use in the Land use, land-use change and forestry sector, thousand hectares

Land use class	2014	2015	2020	2025	2030	2035
Forest land	2,420.4	2,420.7	2,439.9	2,456.2	2,472.5	2,488.8
Cropland	1,038.5	1,038.3	1,027.1	1,017.6	1,008.2	998.7
Grassland	290.3	289.7	278.8	269.2	259.6	250.1
Wetlands	420.0	420.1	419.0	418.1	417.1	416.2
Settlements	321.4	321.7	327.7	332.9	338.1	343.3
Other land	42.9	42.9	41.1	39.5	37.9	36.4
LULUCF total	4,533.5	4,533.5	4,533.5	4,533.5	4,533.5	4,533.5

Predicted area of land use by classes is presented in Table 5.7. Forest area grew steadily until 2015. As there are currently several EU support schemes for agricultural activities, only a slight change in forest land area is foreseen in the future (mainly the conversion of grassland to forest land). At the same time, a decrease in arable land took place from the 1990s. This process was stopped in 2004 after Estonia became a member of the EU and agricultural subsidies were implemented. However, the area of cropland is not expected to increase further. Grasslands should continue to decline in the near future, mainly due to natural afforestation. The area of Infrastructure and settlements is continuously growing at the expense of all other land use classes. According to Estonian Forestry Development Programme until 2020, regeneration fellings, cleanings and thinnings are expected to increase further. This described management method causes a temporary decrease in GHGs sink from forest land. As there are no additional measures intended in the LULUCF sector, then the WAM scenario emissions are equal to the WM scenario emissions (Table 5.8).

Table 5.8. Total projected WM scenario GHG emissions from the Land use, land-use change and forestry sector, kt

WM	GHG	2014	2015	2020	2025	2030	2035
Forest land	CO_2	-2,183.5	-2,475.4	-2,067.9	-1,660.3	-1,252.8	-845.3
	CH_4	0.002	0.0001	0.013	0.008	0.002	-0.003
	N_2O	0.00001	0.000001	0.0001	0.00008	0.00002	-0.00003
	Total CO_2 eq.	-2183.4	-2475.4	-2067.5	-1660.1	-1252.8	-845.4
Cropland	CO_2	133.4	119.8	147.0	174.3	201.5	228.7
	N_2O	0.02	0.02	0.03	0.04	0.05	0.05
	Total CO_2 eq.	138.8	125.2	155.8	185.5	215.1	244.8
Grassland	CO_2	6.7	37.6	33.1	28.6	24.1	19.6
	CH_4	0.00003	0.000003	0.001	0.001	0.001	0.001
	N_2O	0.000003	0.0000003	0.00008	0.00008	0.00009	0.00009
	Total CO_2 eq.	6.7	37.6	33.1	28.6	24.1	19.6
Wetlands	CO_2	905.7	794.7	755.2	715.8	676.3	636.8
	CH_4	0.002	0.002	0.002	0.002	0.002	0.002
	N_2O	0.004	0.004	0.004	0.004	0.004	0.003
	Total CO_2 eq.	907.0	796.1	756.4	716.9	677.4	637.8
Settlements	CO_2	235.1	214.1	254.2	294.4	334.5	374.6
Other land	CO_2	23.4	23.4	6.5	-10.3	-27.2	-44.1
HWP	CO_2	-882.6	-1,080.2	-1,278.4	-1,476.6	-1,674.8	-1,873.0
Other*	CO_2	0.00006	0.00006	NE	NE	NE	NE
LULUCF total	CO_2	-1,761.7	-2,366.0	-2,150.2	-1,934.4	-1,718.6	-1,502.7
	CH_4	0.004	0.002	0.016	0.011	0.005	-0.00003
	N_2O	0.02	0.02	0.03	0.04	0.05	0.06
	Total CO_2 eq.	-1,754.9	-2,359.2	-2,139.8	-1,921.7	-1,703.7	-1,485.6

*NE – not estimated: Indirect N_2O Emissions from Managed Soils (Nitrogen Leaching and Run-off) are reported as indirect emissions in GHG inventory and their projections have not been estimated.

The LULUCF sector is expected to stay sink category according to the projections (Figure 5.5).

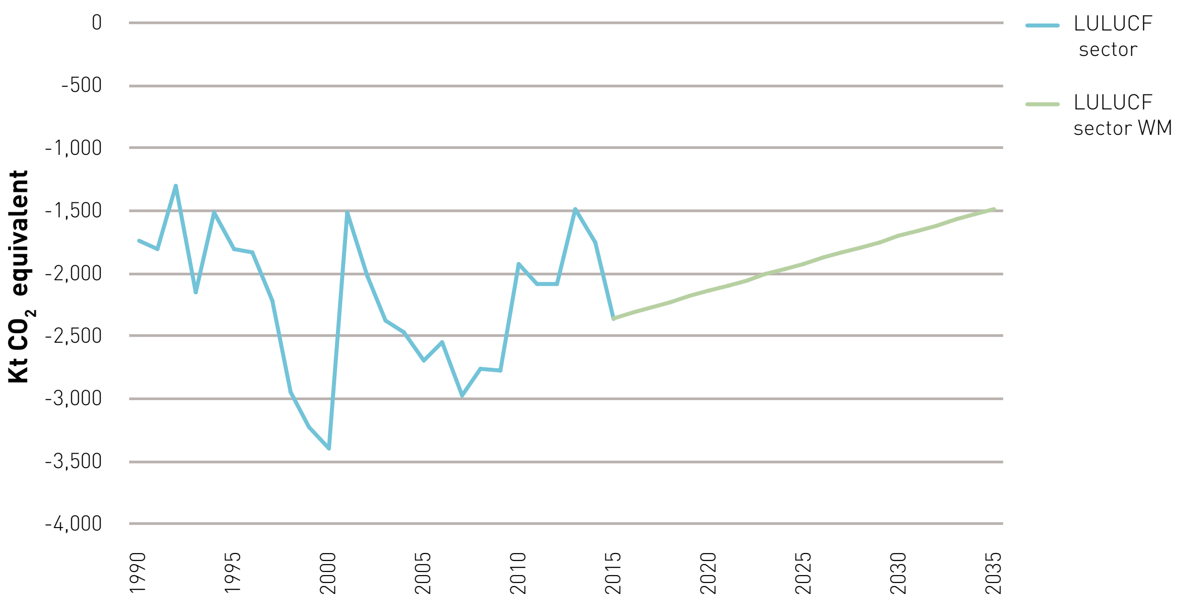

Figure 5.5. Total GHG emissions from the Land use, land-use change and forestry sector, kt CO_2 eq.

5.2.5. Waste

Compared to 2014, the 2035 WM scenario CO_2 eq. projections from the Waste sector will decrease by 46% (Table 5.9 and Figure 5.6). The decrease in emissions is mainly related to the increase in reusing and recycling waste materials, decrease in the amount of biodegradable waste deposited in landfills as well as to waste incineration in Iru CHP plant, as the main emission share originates from the solid waste disposal on land. The increase in GHG emissions from biological treatment of solid waste is related to the decreased amount of biodegradable waste in the total amount of solid waste disposed in landfills. The emission decrease from wastewater treatment and discharge is related to the expanding sewerage network.

Table 5.9. Total projected WM scenario GHG emissions from the Waste sector, kt

WM		2014	2015	2020	2025	2030	2035
Solid waste disposal on land	CH_4	8.0	7.5	4.4	2.9	2.3	1.4
	Total CO_2 eq.	201.1	187.3	110.3	73.0	57.9	35.0
Biological treatment of solid waste	CH_4	0.5	0.6	1.0	1.1	1.3	1.4
	N_2O	0.03	0.04	0.06	0.07	0.08	0.08
	Total CO_2 eq.	22.0	25.7	44.0	48.9	54.1	59.4
Waste incineration and open burning	CO_2	1.0	1.0	1.0	0.5	NO	NO
	CH_4	0.02	0.02	0.01	0.01	NO	NO
	N_2O	0.0003	0.0003	0.0002	0.0001	NO	NO
	Total CO_2 eq.	1.5	1.5	1.4	0.7	NO	NO
Wastewater treatment and discharge	CH_4	2.5	2.4	2.2	2.2	2.1	2.1
	N_2O	0.1	0.1	0.1	0.1	0.1	0.1
	Total CO_2 eq.	91.7	89.1	84.5	83.1	81.4	79.8
Other (Burning biogas in a flare)	CH_4	0.9	0.9	0.4	0.4	0.4	0.4
	N_2O	0.004	0.003	0.002	0.002	0.002	0.002
	Total CO_2 eq.	24.0	22.5	11.0	11.0	11.0	11.0
Waste total	CO_2	1.0	1.0	1.0	0.5	NO	NO
	CH_4	12.0	11.3	8.1	6.6	6.1	5.3
	N_2O	0.1	0.1	0.2	0.2	0.2	0.2
	Total CO_2 eq.	340.3	326.1	251.2	216.7	204.4	185.2

NO – not occurring: GHG emissions do not occur.

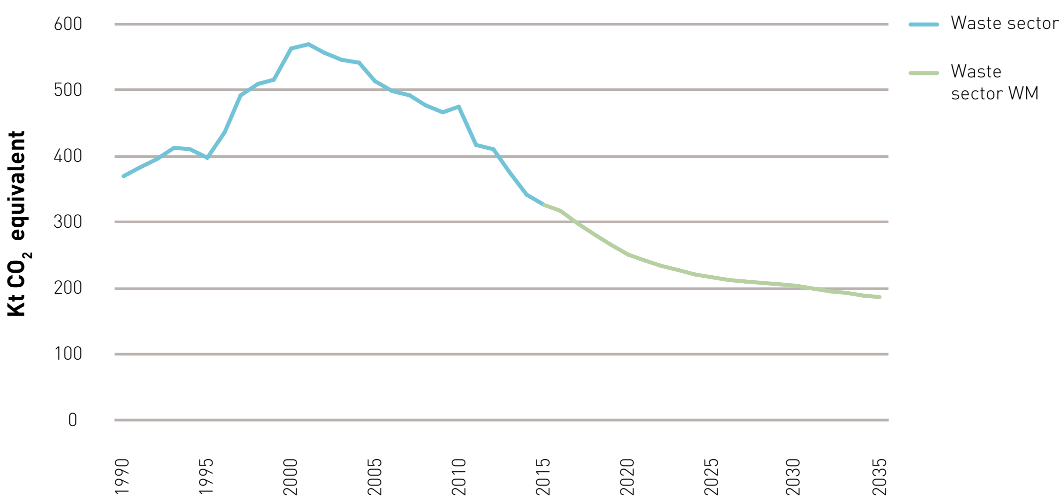

Figure 5.6. Total GHG emissions from the Waste sector, kt CO_2 eq.

5.2.6. Total projected GHG emission and comparison of WM and WAM scenarios and national GHG target

The projected GHG emissions of Estonia are presented in Table 5.16 and Figure 5.7. Estonia's GHG emissions are expected to decrease by about 22.1% in the WM scenario (without LULUCF) and by about 32.4% in the WAM scenario (without LULUCF) by 2035 compared to the base year of 2014. GHG emissions in the WM scenario (with LULUCF) are expected to decrease by about 22.7% and in the WAM scenario (with LULUCF) by about 34.0% by 2035 compared to the base year of 2014.

The main difference in the results of the WM and WAM scenarios is related to measures foreseen to be implemented with regard to energy efficiency and the use of biofuels. This will lead to smaller final consumption of energy in the WAM scenario compared to the WM scenario.

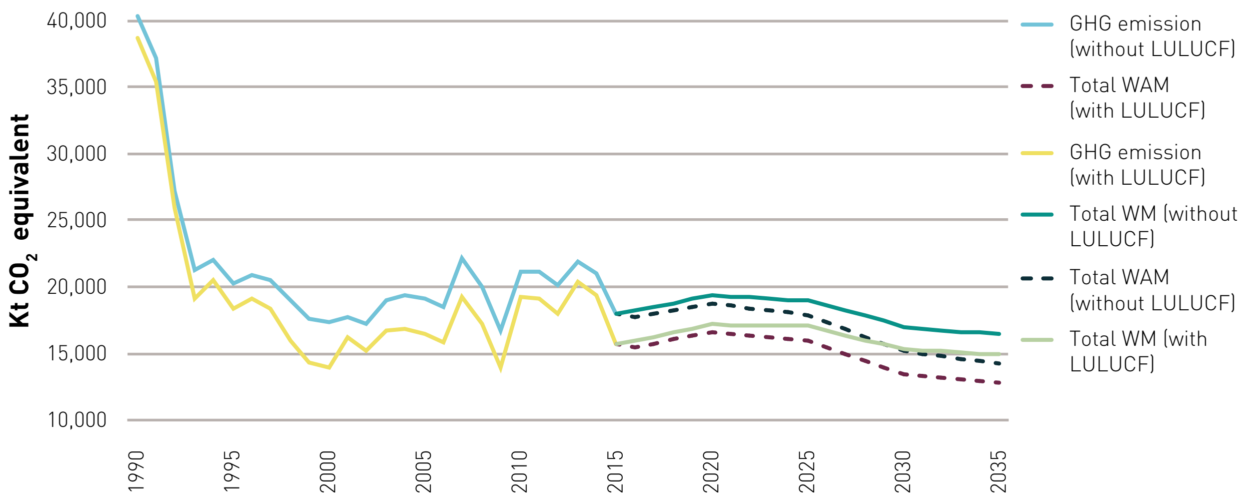

Figure 5.7. Total GHG projections until 2035, kt CO_2 eq.

At the EU level, Estonia has set a national GHG emissions target for the emissions that fall outside the scope of the EU Emissions Trading System (ETS). Therefore, the projected GHG amounts are divided between ETS and non–ETS sectors. According to the Effort Sharing Decision (ESD; 406/2009/EC), GHG emissions not covered by the EU ETS in Estonia have to be limited by at least 11% by 2020 compared to the 2005 level, after binding annual GHG emission targets for the period of 2013–2020 (Annual Emission Allocations (AEA)).

Due to changes in reporting methodologies and with a view to ensuring consistency between the methodologies used for the determination of the AEAs and the annual reporting by the EU Member States, in 2017 the European Commission revised all Member States' AEAs for the years 2017–2020 (Decision (EU) 2017/1471). This resulted in a decrease of AEAs for Estonia for these years. Regardless, Estonia is expected to fulfil its 2020 target with surplus.

As seen in Figure 5.8, the projected GHG emissions in non-ETS sectors until 2020 are expected to stay below the AEA levels in total for the period 2013–2020.

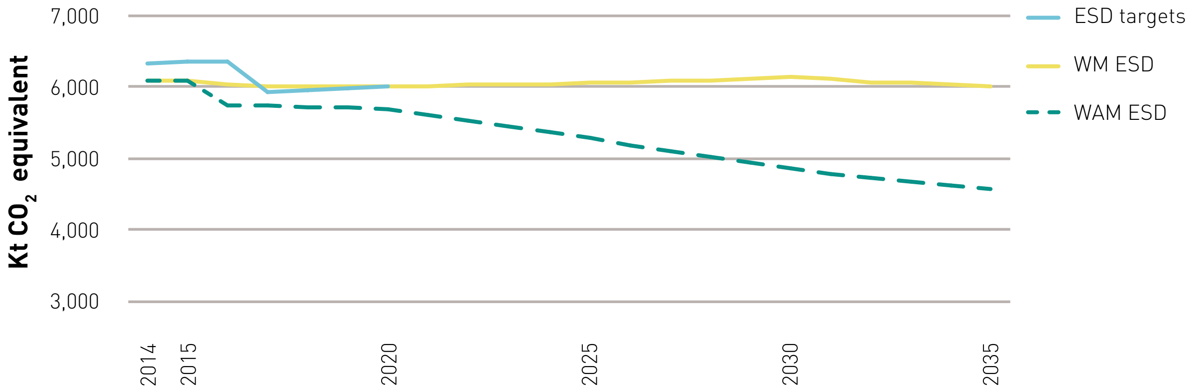

Figure 5.8. Non-ETS projections in WM and WAM scenarios compared to AEA, kt CO_2 eq.

5.2.7. Sensitivity analysis

Energy

The Shale Oil Production industry is a growing branch in Estonia. According to the projections, the companies are planning to expand their production by more than 4 times in the next twenty years. However, this scenario is optimistic and such a wide expansion might not happen. Therefore, an alternative scenario has been modelled (SEN scenario).

In the SEN scenario, it is expected that instead of seven additional solid heat carrier (SHC) technology shale oil production plants, only three will be built in the period of 2015–2035. This could happen if the economic situation is not suitable for shale oil production etc. This means that instead of about 20 million tons of oil shale (geological[1]), only about 15 million tons of oil shale will be used for shale oil production. By this, the amount of oil shale gas used for electricity production is reduced compared to the WM scenario. In the SEN scenario, it is expected that the amount of electricity produced from oil shale gas is imported. The results of the SEN scenario are presented in Figure 5.9.

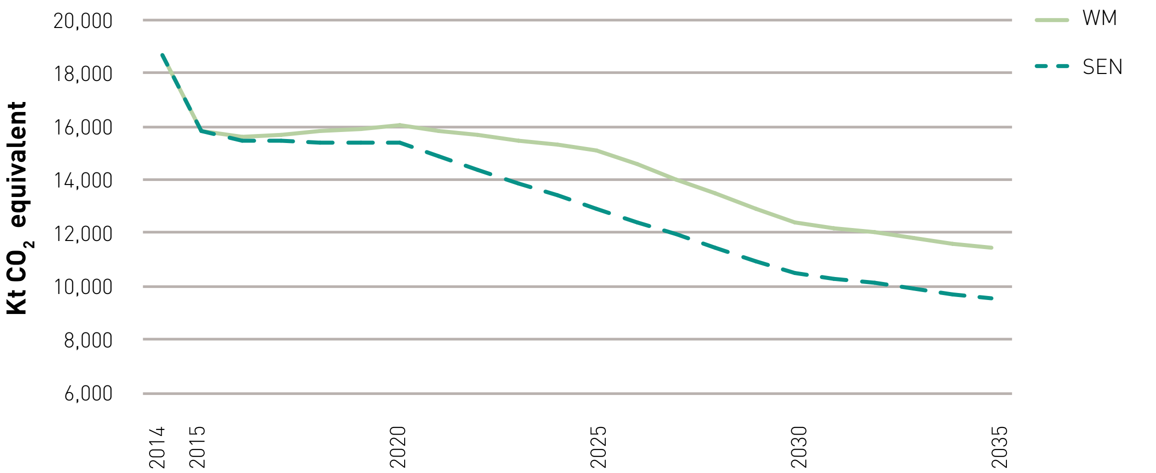

Figure 5.9. Comparison of GHG emissions of WM and SEN scenarios, kt CO_2 eq.

[1] 20 million tons of geological oil shale equals approximately 25 million tons of commercial oil shale.

Industrial processes and product use

Sensitivity analysis for the emissions of the IPPU sector is based on an alternative F-gas phase-down scenario, which is possible but not very probable. This is an alternative WM scenario and no additional measures are involved. This scenario directly affects only emissions from category 2.F, Product uses as substitutes for ODS (and thus total emissions from IPPU). The assumptions for this scenario are the following:

- The use of refrigerant R-404A will end completely in 2020; even in small equipment not covered by the servicing ban. The possible reason for the use of R-404A in small equipment ending is that quota restrictions could cause a deficit of R-404A, which has a high global warming potential (GWP) of 3,922. An important part of this assumption is that refrigerants from disposed equipment are collected properly and destroyed. In the main scenario, it is assumed otherwise – that lots of equipment which has reached its end of service is used further until it breaks down and by that time, a lot of the refrigerant has leaked out;
- Very few new pieces of equipment with the refrigerant R-404A will be marketed in the years 2016–2019. This will be the case if enterprises make more long-term investments in equipment with alternative refrigerants;
- From 2027 onward, there will be no equipment with the refrigerant R-404A.

Emissions are calculated the same way as in the first F-gas scenario (main and most probable WM projection).

This scenario would result in 7% less Hydrofluorocarbon (HFC) emissions in 2025 and 22% less in 2030 in comparison with the main scenario. It may not seem much but the main effect would be the cumulative reduction of HFCs, assuming that a significant part of HFCs from disposed equipment is collected and destroyed. HFC emissions projected according to this alternative scenario and cumulative reduction is shown in Figure 5.10. Emissions from the IPPU sector according to the sensitivity analysis scenario (alternative WM) in comparison with the main WM scenario are presented in Figure 5.10, together with emissions from the category 2.F and the total emissions from IPPU.

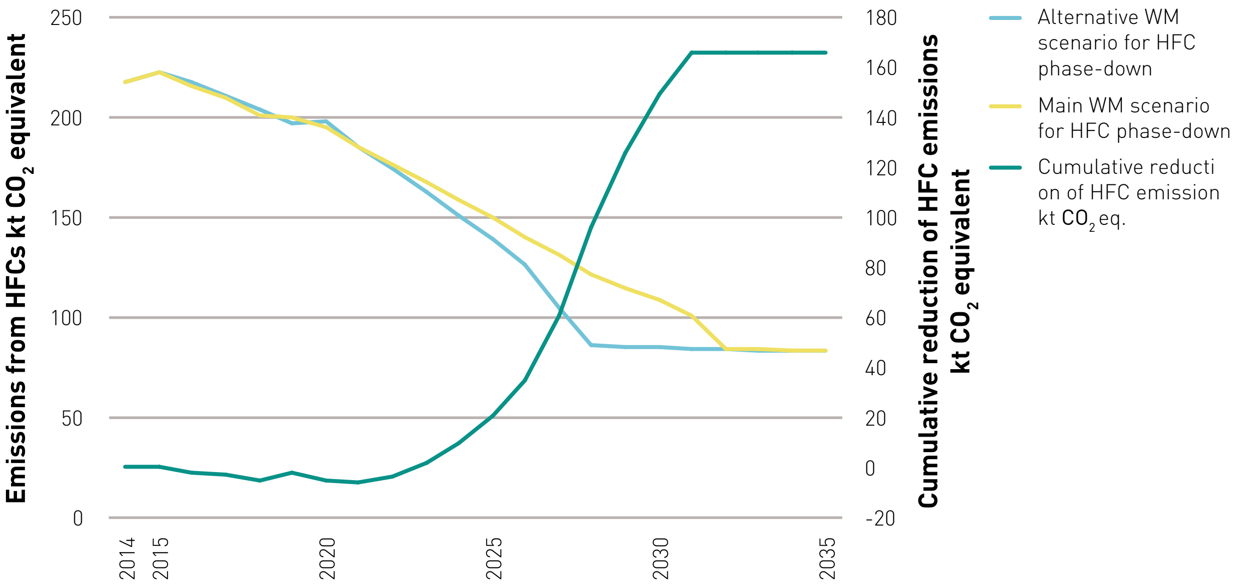

Figure 5.10. Projection of HFC emissions according to the main and alternative scenarios and cumulative reduction of HFC emissions according to the alternative scenario, kt CO_2 eq.

Waste

The sensitivity analysis for the Waste sector emissions is based on the scenarios where population and real annual gross domestic product (GDP) growth rate (Table 5.10) are based on the harmonised values given by the European Commission (Recommended parameters for reporting on GHG projections in 2017, 14.06.2016).

Table 5.10. Harmonised values given by the European Commission

Indicator	2020	2025	2030	2035
Real annual GDP growth rate (in market prices), %	2.2	1.7	1.6	1.4
Population in Estonia, million	1.281	1.243	1.205	1.177

* Emission calculations for the year 2015 are in accordance with the 2017 National GHG Inventory submitted to the UNFCCC on 15 April 2017 and therefore the difference between WM and WAM scenarios is 0.

Under the SEN scenario, the population and GDP growth rate shown in Table 5.10 were both implemented in calculations. The subcategories Waste incineration without energy recovery and Other (Burning Biogas in a flare) are not affected by the change of population and GDP growth rate (Figure 5.11).

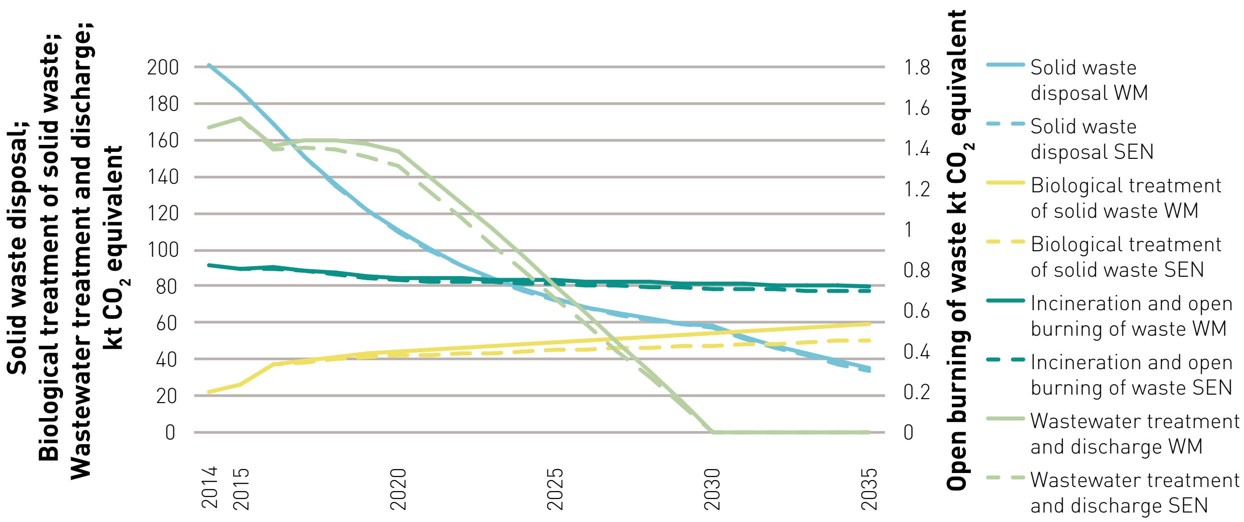

Figure 5.11. WM and SEN scenarios in the Waste sector, kt CO_2 eq.

5.2.8. International bunker fuels

Historically, the emissions from Aviation bunkering form about 10% of all bunkering emissions. The projected GHG emissions of International bunkering are presented in Table 5.11. The emissions of Aviation bunkering are projected to decrease by 19.8% in 2035 compared to 2014. The total GHG emissions of Marine bunkering are expected to decrease by 7.9% in 2035 compared to 2014. Overall, the GHG emissions from International bunkering are expected to increase by 9.1% in 2035 compared to 2014.

Table 5.11. Total GHG emissions of International bunkering, kt

	GHG	2014	2015	2020	2025	2030	2035
Aviation bunkering	CO_2	122.3	73.7	98.0	98.0	98.0	98.0
	CH_4	0.002	0.002	0.002	0.002	0.002	0.002
	N_2O	0.003	0.002	0.003	0.003	0.003	0.003
	Total CO_2 eq.	123.3	74.4	98.8	98.8	98.8	98.8
Marine bunkering	CO_2	979.7	885.3	932.5	932.5	932.5	932.5
	CH_4	0.1	0.1	0.1	0.1	0.1	0.1
	N_2O	0.3	0.02	0.1	0.1	0.1	0.1
	Total CO_2 eq.	1,061.9	894.7	978.3	978.3	978.3	978.3
International bunkering total	CO_2	1,102.0	959.0	1,030.5	1,030.5	1,030.5	1,030.5
	CH_4	0.1	0.1	0.1	0.1	0.1	0.1
	N_2O	0.3	0.03	0.1	0.1	0.1	0.1
	Total CO_2 eq.	1,185.2	969.0	1,077.1	1,077.1	1,077.1	1,077.1

5.3. Assessment of aggregate effects of policies and measures

The total effect of planned Policies and Measures (PaMs) is calculated as the difference between WM and WAM scenarios and presented in Table 5.12.

Table 5.12. Total effect of implemented and adopted PaMs, kt CO_2 eq.

GHG	2015	2020	2025	2030	2035
CO_2	0*	546.4	1,036.8	1,767.8	2,095.4
CH_4	0*	18.6	29.4	43.9	55.8
N_2O	0*	7.8	15.4	24.1	30.1
Total CO_2 eq.	0*	572.8	1,081.6	1,835.7	2,181.3

5.4. Supplementarity relating to mechanisms under Article 6, 12 and 17 of the Kyoto Protocol

Estonia has used two of the three Kyoto flexible mechanisms – Article 6 Joint Implementation (JI) and Article 17 International Emissions Trading (IET) (Table 5.13). The Clean Development Mechanism set out in Article 12 of the KP is not used, as Estonia is not a developing country.

During the first Kyoto period, Estonia had entered into six agreements with different European governments and 15 agreements with different Japanese companies by February 2013. The proceeds received from these agreements were solely disbursed through the Green Investment Scheme (GIS) projects or programmes (The legal framework for the GIS is stipulated in the Atmospheric Air Protection Act (RT I, 05.07.2016, 1)). A special working group led by the State Chancellery was created to develop environmentally friendly projects and programmes to offer these to potential buyers. Each agreement was approved by the Government with a

Table 5.13. Quantitative contribution of Kyoto mechanisms for the first commitment period

Kyoto mechanism	Total projected quantities for the first commitment period (kt CO_2 eq.)
Total for all Kyoto mechanisms *	73,619
International emissions trading	72,592 (as of March 2013)
Kyoto mechanism	Total projected quantities for the first commitment period (kt CO_2 eq.)
All project-based activities	1,027
Joint implementation	1,027
Clean development mechanism	–

* These are quantities that Estonia has transferred or intends to transfer as a JI host country and has sold in IET.

mandate given to the Minister of the Environment to sign the agreements. The primary fields of investments in frames of GIS included:

- renovation (incl. thermal refurbishment) of buildings;
- efficient and environmentally benign transport;
- development of wind energy farms;
- efficiency improvements and wider use of renewables in the district heating sector.

5.5. Methodology used for the presented GHG emission projections

5.5.1. Energy

The scenarios projecting GHG emission in the Energy sector are mostly based on the *Estonian Energy Development Plan until 2030 (EEDP 2030+)* scenarios in which numerous studies were made. In addition, some of the scenarios were updated when compiling Estonian low-carbon strategy *General Principles of Climate Policy until 2050 (GPCP 2050)*. For electricity generation and shale oil production, the updated EEDP 2030+ scenarios were used.

The Balmorel model was used for the electricity generation projections in the Public heat and electricity generation sector. It is a model for analysing the electricity and Combined heat and power sectors in an international perspective while minimising the total costs of the system. The Balmorel model combines the approach of bottom-up modelling in a classic technical modelling tradition with top-down economic analysis, projections and forecasts. The main assumption for the projection was that step-by-step, the use of oil shale shall decrease for the production of electricity and increase for the production of shale oil. The retort gas that occurs as a side product during the production of shale oil is used for electricity production. The projected future usage of fuel based on the model was applied while using the emission calculations of the 2006 IPCC Guidelines. The projections of fuel consumption for electricity generation are in accordance with the Estonia's GPCP 2050.

The projections for heat generation in the Public heat and electricity generation sector are based primarily on the reconstruction rate of the buildings. The projections in the heat production are based on the analysis done in the process of compiling EEDP 2030+. The scenarios developed in the EEDP 2030+ were used in combination with the methodology of the 2006 IPCC Guidelines.

The projections of the GHG emissions of shale oil production in the Manufacturing of solid fuels and other energy industries were calculated based on the scenario set out in Estonia's GPCP 2050. The amounts of oil shale used and the rate of construction of new shale oil production plants were used for the GHG projections.

The GHG projections in the Manufacturing industries and construction sector and in Other sectors are also based on the scenarios created in EEDP 2030+. The emissions are calculated based on the methodology of the 2006 IPCC Guidelines.

5.5.2. Transport

The projections in the Transport sector are based on the thorough analysis of *transport and mobility scenarios* in EEDP 2030+. Relevant data was modelled with LEAP (Long Range Energy Alternatives Planning System) to calculate the GHG emissions. The demand of energy for transport was entered into the model with a bottom-up approach. Fuel consumption data from the EEDP 2030+ along with expert judgements as well as emission factor data from 2006 IPCC Guidelines along with country-specific emission factors were used to estimate GHG emissions.

LEAP is an integrated, scenario-based modelling tool that can be used to track energy consumption, production and resource extraction in all sectors of the economy. It can be used to account for both energy sector and non-energy sector GHG emission sources and sinks. In addition to tracking GHGs, LEAP can also be used to analyse emissions of local and regional air pollutants and short-lived climate pollutants, making it well-suited to studies of the climate action co-benefits of local air pollution reduction. LEAP is developed by the Stockholm Environment Institute.

5.5.3. Industrial processes and product use

The Estonian Industry sector is relatively small and the majority of emissions from subcategories, such as Mineral industry, Non-energy products from fuels and solvents, and Other product manufacture, as well as their respective subcategories, comprise emissions from the activity of only a few companies who also influence the emissions' trend. Due to the specific character of the sector, top-down assessments and models are used only in subcategories Product uses as substitutes for ODS and Urea based catalysts for motor vehicles. Otherwise, bottom-up, companies' own projections and expert judgements are combined and used. This approach ensures the most proximate projections that reflect the actual situation in subcategories with a limited number of emitting agents.

The Mineral industry's projected emissions are based on the projections of industries' operators, taking into account maximal planned production capacities and best available technologies according to the environmental permits of companies.

The operators of the Chemical industry have indicated that they have no plans to restore the production in the near future.

Taking into account the long-term national economic growth forecast of less than 3% and virtually no growth in population, the consumption of lubricants and paraffin waxes is projected to stay roughly at the level of the year 2014.

Indirect CO_2 emissions from solvent use are also projected to slowly decrease in view of low economic growth and no growth in population.

Emissions from urea-based catalyst AdBlue are projected by taking into account:

- the broadening of NO_x emission standards to light vehicles (Euro 6 standards);
- the forecast of the number of vehicles pursuant to EEDP 2030+;
- the average diesel fuel consumption of vehicles pursuant to the COPERT model;
- the current trend in vehicle sales (data from the Estonian Road Administration).

Emissions of fluorinated gases are projected pursuant to the 2006 IPCC Guidelines. Forthcoming bans and restrictions stipulated in the Regulation (EU) No. 517/2014 and Directive 2006/40/EC were taken into account. Companies who own or service large commercial refrigeration systems were interviewed about their intentions towards the restrictions of Regulation (EU) No. 517/2014. In addition, some importers of pre-charged air conditioning equipment and stand-alone refrigeration equipment were interviewed. Their intentions were included in calculations.

Emissions were calculated from large and small commercial refrigeration equipment, industrial refrigeration and cooling, stationary air conditioning/cooling, mobile refrigeration, mobile air conditioning by taking the following bans into account:

- marketing bans, incl.:
  - stationary refrigeration equipment with GWP of 2,500 or more;
  - commercial refrigeration equipment (hermetic equipment with HFCs, multipack systems (40 kW or more) with HFCs, except for multilevel cascade systems partly with HFC-134a;
  - single split stationary air conditioners and heat pumps with GWP of 750 or more;
  - fire protection equipment with HFC-23 (additionally, the use of HFC-227ea containing fire protection systems is sharply decreasing);
  - the ban of sale of new vehicles with EU type approval having refrigerant with GWP over 150 in air conditioner since 1 January 2017 is taken into account (pursuant to the Directive 2006/40/EC);
- ban of refilling equipment with HFCs with GWP of 2,500 or more;
- diminishing amounts of HFCs placed onto the market due to a quota system.

In categories where the use of banned high-GWP HFCs was subtracted with no information about alternatives, substitutions with lower GWP HFCs were taken into account.

SF_6 emissions are not regulated by the Regulation (EU) No. 517/2014. Therefore, the emissions were calculated pursuant to the 2006 IPCC Guidelines, taking into account plans on equipment replacement by the electrical network operators.

N_2O projections are based on the consumption data provided by wholesalers who forecasted that sales will either stay at the current level or decline slowly.

5.5.4. Agriculture

Projections in the Agriculture sector are calculated based on the 2006 IPCC Guidelines by using a bottom-up approach. The agricultural GHG emissions projections reported consist of CH_4 emissions from enteric fermentation of domestic livestock, CH_4 and N_2O emissions from manure management systems, direct and indirect N_2O emissions from agricultural soils and CO_2 emissions from liming and urea fertilisation. Projected values of agricultural output and fertiliser use are based on the expert judgements received from the Estonian Ministry of Rural Affairs.

As a result of the new EU Common Agricultural Policy (CAP) on the abolition of milk quotas and the growth of global food demand in many regions of the world, milk production is presumed to increase. Pursuant to the Estonian Dairy Strategy 2012–2020, milk production may increase by a third, which means that the number of dairy cows must be increased and average milk yield may increase up to 19% by the year 2020.

Gross energy (GE) intake of dairy cows was calculated on the basis of projected milk yields. Expert judgement was used to project the number of livestock (Table 5.15).

Average milk yield per cow should increase until 2020. Projected values for the period 2020–2035 are not available, so it is assumed that milk yield during this period will remain at the level of 2020. Milk fat (%) for the projected period of 2015–2035 was assumed to be the same as in 2015 (3.94%).

Main activity data for the calculation of CH_4 and N_2O emissions from manure management are livestock population, data on animal waste management systems (AWMS) and milk yields.

Projection of N_2O emissions from manure management systems were done by using livestock population (Table 5.15) and AWMS system distribution. Country-specific volatile solids (VS) and nitrogen (N) excretion values of dairy cows have been calculated on the basis of projected milk yields.

Projected N_2O emissions from the Agricultural soils subsector are based on the amount of synthetic N-containing fertilisers applied to soil and quantities of harvested crops.

As a result of the increasing global food demand, it is foreseen that Estonia's cultivated agricultural land area is going to expand, which will most likely boost the use of synthetic fertilisers. The projected activity data on crop production and the data on the use of synthetic N fertilisers are presented in Table 5.14.

CO_2 emissions from liming are foreseen to increase, as the current level of liming used for neutralising the naturally acidic agricultural soils is presently insufficient in Estonia.

5.5.5. Land use, land-use change and forestry

Half of Estonia's territory is covered with forest, 10% of which is strictly protected. Forestry is of great importance for the Estonian economy and environment, therefore forest policies have a major effect on the development of the LULUCF sector as a whole.

Projections in the LULUCF sector are calculated by using land use data from 1990 to 2015 and emissions/removals reported in the National Inventory Report 2017 and CRF tables. Estimates of CO_2, N_2O and CH_4 projections were calculated as an average of:

- linear forecast over whole time series 1990–2015;
- average of time series 1990–2015;
- average of time series 2000–2015;
- estimation of reference year.

The emissions of the LULUCF sector have been quite volatile during the past decades. The year 2005 is the starting point of the current trend of all relevant factors. The period of intensive felling as well as the afforestation of agricultural areas stopped around this time. The main reason for the use of multiple averages in projection calculations is to reduce the sudden or abnormal trends and tendencies.

5.5.6. Waste

CH_4 emission projections in the Solid waste disposal subcategory are done by using the bottom-up 2006 IPCC Waste Model, which has been developed by IPCC for estimating CH_4 emissions from solid waste disposal sites. This model takes into account both municipal solid waste (MSW) and industrial waste generation and depositing, including also the CH_4 recovery from the sites. Projections of the MSW generation are based on the population projection and the projection of the annual real GDP growth rate. The Mixed Municipal Solid Waste Composition Study carried out in 2013 was used for a precise MSW composition projection. Real GDP growth rate was also used for projecting industrial waste generation.

Projections of the Biological treatment of solid waste are based on the annual real GDP growth rate and an expert judgement from GPCP 2050 on the increasing amount of biologically treated sludge.

Only a small amount of waste is incinerated without energy recovery and the Open burning of MSW is prohibited; nevertheless, an expert judgment is used to evaluate the amount of waste that might be open burned based on the amount of MSW generated. Projections were done by using the assumptions from GPCP 2050 stating that no burning without energy recovery nor open burning will be taking place after 2030.

Projections of GHG emissions in the Wastewater treatment and discharge subcategory account human population projections and an expert judgement given by the MoE on the usage of different wastewater treatment types and the coverage of a centralised wastewater system. GHG emissions from Industrial wastewater were calculated by using stable production throughout the time series with a fraction of the annual real GDP growth rate.

Biogas generated at Estonia's solid waste disposal sites are both combusted with energy recovery and burnt in a flare. Projections in the subcategory of Burning Biogas in a flare and recovered methane under the Solid waste disposal subcategory are based on the decrease percentage of biodegradable waste in the total amount by weight of MSW allowed to be deposited in landfills by 2020.

5.5.7. Key assumptions

The key underlying assumptions used in the projections are presented in Table 5.14. Data on the population for the period 2014–2035 was received from Statistics Estonia. Annual real GDP growth rate is in accordance with the EEDP 2030+ estimations.

5.5.8. Comparison of projections of previous and current NC

NC6 as well as NC7 have been compiled by the EERC. The NC6 projections had 2010 as a base year and were prepared for up to 2030, current NC projections have 2014 as the base year with projections up to 2035. There have been several methodological developments since the previous NC, which are mostly related to the Energy and Transport sector. LEAP model is now used only for the Transport sector projections and the projections in the Energy sector are based on the EEDP 2030+. The renewed sectoral development plans described under Chapter 4 allow making projections that are more precise. Some of the main assumptions and results of the previous and current NC projections are presented in Table 5.15.

Table 5.14. Key assumptions used in projections

Parameter used	2014	2015	2020	2025	2030	2035
Population, thousands	1,315.8	1,313.3	1,297.4	1,276.0	1,250.7	1,222.9
GDP growth, real growth rate, %		3.3	3.0	2.5	2.5	2.1
EU ETS carbon price, EUR/EUA			15.0	20.0	26.5	36.5
International (wholesale) fuel import prices: Electricity Coal, EUR/GJ			2.58	2.61	2.64	2.67
International (wholesale) fuel import prices: Natural gas, EUR/GJ			6.69	8.01	9.36	9.83
Final energy consumption: Industry, TJ	24,125	22,965	28,214	29,491	30,769	31,294
Final energy consumption: Transport WM, TJ	31,094	31,821	35,483	37,791	40,098	38,659
Final energy consumption: Transport WAM, TJ	31,094	31,821	31,267	29,897	28,528	25,216
Final energy consumption: Residential WM, TJ	37,373	36,184	43,164	43,290	43,416	43,416
Final energy consumption: Residential WAM, TJ	37,373	36,184	38,376	36,288	34,200	31,572
Final energy consumption: Agriculture/Forestry, TJ	5,459	5,596	5,362	5,655	5,949	6,074
Final energy consumption: Services WM, TJ	17,565	18,470	17,136	17,190	17,244	17,046
Final energy consumption: Services WAM, TJ	17,565	18,470	1,656	1,633	1,609	1,580
Final energy consumption: Other, TJ	446	367	367	367	367	367
Final energy demand for road transport WM, TJ	29,541	30,292	33,997	36,017	37,811	36,363
Final energy demand for road transport WAM, TJ	29,541	30,292	30,020	28,534	26,873	23,741
Livestock: Total cattle, thousand heads	265	256	270	281	292	304
Nitrogen in crop residues returned to soils, kt	24,949	29,843	29,843	29,843	29,843	29,843
Application of synthetic fertilisers, kt	56	56	57	60	61	62
Area of cultivated organic soils, 1,000 hectares	24	24	24	24	24	24
Municipal solid waste (MSW) generation, kt MSW	299.4	310.9	342.8	360.6	376.2	389.3

Table 5.15. Comparison of projections of previous and current NC

	2014	2015	2020	2025	2030	2035
NC6 Annual GDP growth rates, %		3.5	2.3	2.1	2.3	NE
NC7 Annual GDP growth rates, %		3.3	3.0	2.5	2.5	2.1
NC6 Population, thousand people		1,332.4	1,328.3	1,315.9	1,296.4	NE
NC7 Population, thousand people	1,315.8	1,313.3	1,297.4	1,276.0	1,250.7	1,222.9
NC6 International coal import prices, €(2010)/boe		22	22.6	23.7	24	NE
NC7 International coal import prices, €(2010)/boe			15.7	15.9	16.1	16.3
NC6 International oil import prices, €(2010)/boe		86	88.5	89.2	93.1	NE
NC7 International oil import prices, €(2010)/boe			54.2	88.1	93.2	96.6
NC6 International gas import prices, €(2010)/boe		53.8	61.5	58.9	64.5	NE
NC7 International gas import prices, €(2010)/boe			40.8	48.9	57.1	60.0
NC6 Number of total cattle, thousand heads		236.3	236.9	273.7	241	NE
NC7 Number of total cattle, thousand heads		256	270	281	292	304
NC6 Municipal solid waste (MSW) generation, kt MSW		304.6	334.9	354.3	373.3	NE
NC7 Municipal solid waste (MSW) generation, kt MSW		310.9	342.8	360.6	376.2	389.3
NC6 WM total emissions, kt CO_2 eq. (with LULUCF)	18,325.6	18,089.2	17,060.4	16,535.2	16,165.1	NE
NC7 WM total emissions, kt CO_2 eq. (with LULUCF)	19,326.2	15,681.3	17,192.2	17,061.5	15,329.8	14,945.0
NC6 WAM total emissions, kt CO_2 eq. (with LULUCF)	17,991.1	17,670.6	16,549.8	15,951.4	15,797.2	NE
NC7 WAM total emissions, kt CO_2 eq. (with LULUCF)	19,326.2	15,681.3	16,620.3	15,980.2	13,494.1	12,763.6

NE - GHG emissions are not estimated.

Table 5.16. GHG emissions by source, kt CO_2 eq.

Sector	GHG emissions and removals, kt CO_2 eq.							GHG emission projection, kt CO_2 eq.			
	1990	1995	2000	2005	2010	2014	2015	2020	2025	2030	2035
Energy WM	36,397.4	17,855.2	14,974.9	16,787.4	18,939.3	18,691.2	15,863.9	16,607.7	16,186.8	14,233.0	13,619.9
Energy WAM								16,035.9	15,105.5	12,397.3	11,438.6
IPPU WM	965.7	637.4	697.6	726.4	537.6	707.7	512.9	1,005.0	1,013.8	972.5	946.8
Agriculture WM	2,669.7	1,326.1	1,078.0	1,129.1	1,192.4	1,341.9	1,337.6	1,468.1	1,566.1	1,623.6	1,678.6
LULUCF WM	-1,734.7	-1,807.2	-3,396.7	-2,690.9	-1,924.4	-1,754.9	-2,359.2	-2,139.8	-1,921.7	-1,703.7	-1,485.6
Waste WM	369.9	397.7	562.8	513.9	474.2	340.3	326.1	251.2	216.7	204.4	185.2
Total WM (excl. LULUCF, incl. indirect CO_2)	40,402.7	20,216.4	17,313.3	19,156.7	21,143.5	21,081.1	18,040.5	19,332.0	18,983.3	17,033.5	16,430.6
Total WAM (excl. LULUCF, incl. indirect CO_2)								18,760.1	17,902.0	15,197.8	14,249.2
Total WM (incl. LULUCF, incl. indirect CO_2)	38,668.0	18,409.2	13,916.6	16,465.8	19,219.1	19,326.2	15,681.3	17,192.2	17,061.5	15,329.8	14,945.0
Total WAM (incl. LULUCF, incl. indirect CO_2)								16,620.3	15,980.2	13,494.1	12,763.6
Gas											
CO_2 WM emissions incl. net CO_2 from LULUCF	35,332.7	16,395.8	11,963.2	14,442.7	17,084.7	17,148.5	13,519.4	14,927.9	14,765.0	13,018.9	12,632.6
CO_2 WAM emissions incl. net CO_2 from LULUCF								14,381.5	13,728.2	11,251.1	10,537.2
CO_2 WM emissions excl. net CO_2 from LULUCF	37,069.2	18,204.8	15,362.6	17,135.8	19,015.1	18,910.2	15,885.4	17,078.1	16,699.3	14,737.5	14,135.4
CO_2 WAM emissions excl. net CO_2 from LULUCF								16,531.7	15,662.6	12,969.7	12,039.9
CH_4 WM emissions incl. CH_4 from LULUCF	1,909.9	1,264.1	1,240.1	1,208.6	1,196.3	1,106.5	1,059.1	1,081.2	1,107.1	1,134.0	1,143.5
CH_4 WAM emissions incl. CH_4 from LULUCF								1,062.6	1,077.8	1,090.2	1,087.7
CH_4 WM emissions excl. CH_4 from LULUCF	1,909.6	1,263.8	1,238.8	1,208.3	1,196.2	1,106.4	1,059.1	1,080.8	1,106.9	1,133.9	1,143.5
CH_4 WAM emissions excl. CH_4 from LULUCF								1,062.2	1,077.5	1,090.0	1,087.7
N_2O WM emissions incl. N_2O from LULUCF	1,425.4	717.7	631.6	678.6	760.8	851.6	877.7	985.9	1,036.8	1,065.5	1,082.8
N_2O WAM emissions incl. N_2O from LULUCF								978.1	1,021.4	1,041.4	1,052.6
N_2O WM emissions excl. N_2O from LULUCF	1,423.9	716.3	630.2	676.6	754.8	844.9	871.0	975.9	1,024.5	1,050.8	1,065.6
N_2O WAM emissions excl. N_2O from LULUCF								968.1	1,009.1	1,026.7	1,035.5
HFCs WM =WAM	NO	28.5	79.1	135.0	175.5	217.5	222.8	194.7	150.0	108.7	83.5
PFCs WM =WAM	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6 WM=WAM	NO	3.1	2.6	1.0	1.7	2.1	2.3	2.5	2.6	2.6	2.6

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VI

Vulnerability assessment, climate change impacts and adaptation measures

KEY DEVELOPMENTS

- **In 2015, the Estonian Environment Agency drew up a report of the climatic changes in Estonia, which occurred in the course of the last century, as well as of the projections and assessments of the future climate in Estonia until 2100. The report formed the scientific basis for the assessment of the sectors influenced by the climatic condition in drafting the national development plan for adaptation to the impacts of climate change.**
- **The sectoral impacts of climate change in Estonia and vulnerability were thoroughly assessed during the period of 2014–2016.**
- **Development plan for adaptation to the impacts of climate change, which was adopted by the Government on March 2017, enables planning and managing the area of adaptation to the impacts of climate change through a single strategy document both in the short (up to 2030) and in the long (up to 2100) perspective. The estimated cost of the implementation of the development plan for adaptation to the impacts of climate change in the period of 2017–2020 amounts to 6.7 million euros and, in the period of 2017–2030, to 43.75 million euros.**
- **The preparation of local governments for climate change is supported by the continuous development of environmental and weather monitoring systems. Several local governments have taken the risks arising from climate change into consideration in drawing up their local development plans and general spatial plans, as well as in the renovation of water and sewerage or other lines.**

6.1. Introduction

Climate change, whether anthropogenic or the result of other factors, is an eternal and natural component of nature. In the case of natural development, however, climate change is relatively slow and adaptation to the changed conditions can occur in the course of a natural, spontaneous development. However, the exponential industrial development in the 20th century has resulted in very high pollution loads and a decrease in the buffering capability, which in turn have made the changes in the climate very rapid. Amidst rapid environmental changes, it is no longer rational to rely on the spontaneous adjustment of the society and economy to the changes in the environment. The impacts of climate change on different groups of the society differ: the impacts vary by locations (e.g. floods in coastal areas or lower areas) and by members of the society (e.g. the elderly are more vulnerable to extreme cold and heat). The risks are highest for disadvantaged people – those in a poorer socio-economic situation and with less social capital. Thus, extreme weather conditions may deepen the inequality in the society and put the cohesion of the society at risk. On the other hand, the economies, which are able to adjust to the changed conditions more rapidly, achieve a significant competitive advantage. Due to the abovementioned reasons, most European countries (especially the EU Member States and the countries bordering the Baltic Sea) have undertaken to draw up strategies and implementation plans for adaptation to climate change.

The efficiency of adaptation to the impacts of climate change in the society depends, on the one hand, on the actions of the state, the fragmentation of the decision-making structures, and the political and administrative culture, and on the other hand, however, on the activities of non-governmental stakeholders, incl. the research community, on the pressure from the public and non-governmental organisations, and on the interests of commercial enterprises. It is the duty of the state and authorities to create favourable social structures for groups and individuals for adaptation: the legal frameworks, information and mentorship, technical support. The vulnerability of the society and adaptation to climate change are also significantly influenced by the level of research and education in the country, which determine the preparedness of the country for climate change and how accurately the country is able to assess the circumstances accompanying climate change.

The development of measures for adaptation to climate change is based on the determination of the impacts (positive and negative) that accompany climate change. This is best executed by different sectors: health and rescue capability, land use, natural environment, economy, society, infrastructure, energy, etc. Adaptation to climate change and the respective measures are slowly, but surely becoming a topic that concerns all sectors in Estonia, and there are various very important policy documents being drawn up in Estonia, which should take into consideration the impacts of climate change and the potential adaptation measures. Thus, it is important to ensure the inclusion of all relevant sectors and administrative levels in the adaptation measures.

6.2. Climate change and climate change scenarios in Estonia

The aim of this chapter is to provide an overview of the climatic changes, which occurred in Estonia in the course of the last century, as well as of the projections and assessments of the future climate in Estonia up to 2100. The scientific basis used here is the report *Future climate change scenarios in Estonia until 2100* drawn up by the Estonian Environment Agency (ESTEA). This report forms the basis for the assessment of the sectors that are influenced by atmosphere and ground conditions. Where possible, the report was drawn up on the basis of the CMIP5 (CMIP – Coupled Model Intercomparison Project) regional fine-scaling compiled for the latest report of the Intergovernmental Panel on Climate Change (IPCC), AR5. The period of 1971–2000 was used as the base climate period (reference period), if possible, and the periods of 2041–2070 and 2071–2100 as future comparison periods. The climate forecasts were drawn up based on the global climate change scenarios RCP4.5[1] and RCP8.5. (Both also form the basis for the CMIP5 experiment).

The respective results were assembled and published within the framework of the EURO-CORDEX project. Where it was not possible or reasonable to use the results of EURO-CORDEX directly, summaries of published scientific literary works were used, incl. the IPCC reports AR5 (2013) and AR4 (2007), the IPCC special report on extreme climate events, SREX (2012), overview of the scientific literature on climate change in the Baltic Sea basin, BACC (2008), and the project for the assessment of climate impacts, Baltadapt.

[1] RCP – Representative Concentration Pathway, i.e. the scenario for increase in the value of the radiative forcing of the Sun affecting the surface of the Earth depending on the concentration of greenhouse gases by 2100, which is used in the IPCC climate report, where the radiative forcing value will increase by 4.5 w/m^2 in the RCP4.5 scenario by 2100 and by 8.5 w/m^2 in the RCP8.5 scenario compared to the control period of 1986–2005.

6.2.1. The most significant climatic changes observed in Estonia

The main factor influencing Estonia's climate is the country's geographical position. Local climatic differences are mainly caused by the neighbouring Baltic Sea, which warms up the coastal zone in winter and later has a cooling effect, especially in spring. Estonia lies in the transition zone between maritime and continental climates. Compared to the majority of Estonia's territory that has humid continental climate with rather severe winters, the western part of the Estonian islands has more marine climate and milder winters.

The average annual temperature has increased slightly faster in Estonia compared to the world as a whole since the middle of the last century. The trend has been 0.2–0.3 °C per decade, while the global increase in the ground level temperature since 1951 has been 0.12 °C per decade. By months, the assessments of various authors of the trends differ remarkably. The warming trend of the winter, especially in January, is the clearest.

The increase in the average annual precipitation in the second half of the 20th century has been significant in Estonia, between 5–15%, taking into consideration a correction for wetting. A higher trend can be observed in the period from October to March. In 1866–1995, only a weak and statistically insignificant growth trend has been observed in the case of Estonia, which is stronger in autumn and winter and weaker in spring and summer. Regular cycles have also been observed in the total amount of precipitation, which are of the lengths of 50–60, 25–33, and 5–7 years. The average annual precipitation in a specific region may differ by more than twice, for example, 400 mm in 1965 and 850 mm in 1990.

A periodicity similar to that of precipitation is generally also characteristic of the runoff of Estonian rivers. Short-term variability can most often be observed in periods of 3–4 years and long-term variability in periods of 26–27 years, which reflect the regularity of the water-rich and water-hungry periods in the 20th century. No one-way increases or decreases in runoff have been observed in Estonia in the last 150 years and the impacts of climate change on runoff are not as clear or clearly targeted as the observed long-term increase in precipitation.

The data on the water temperature of Lake Peipus and Lake Võrtsjärv show an increasing trend similarly to other lakes in the Baltic Sea basin and the end of the winter in the Estonian inland waterbodies moved to a month earlier in the period of 1946–1998. The ice cover period of Estonian rivers and lakes has shortened. The runoff maximum of the rivers has moved to an earlier time and the peak runoffs are less steep. The likelihood of high runoffs in spring (≤ 10%, i.e. runoff, which occurs once in ten years) decreased in the period of 1922–2010.

6.2.2. Future climate change scenarios in Estonia

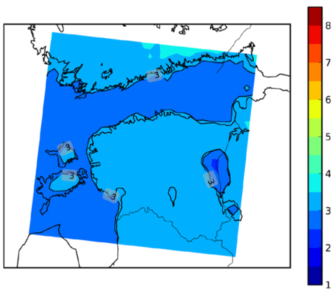
Air temperature

The average annual increases in air temperature provided in Table 6.1 and Figure 6.1 are higher than the global average values forecasted in AR5. This matches the distribution of the increase in the average temperature in the CMIP5 forecasts, which shows that the increase in temperature is high in the northern hemisphere, especially at higher latitudes.

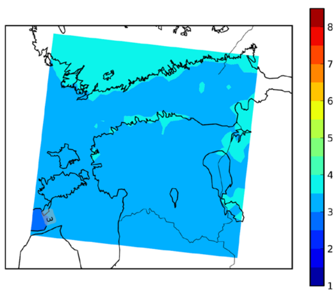
The highest average increase in the temperature by months is observed in March in the case of both scenarios. This may be explained by the faster warming of the ground due to springs with less snow. Higher increases in the temperature are also observed in other winter (December, January, February, i.e. DJF) and spring (March, April, May, i.e. MAM) months. The absolute seasonal changes in air temperature are provided in Table 6.1 and Figure 6.1. In the period of 2041–2070, the increase in the temperature will be lowest in the summer months (June, July, August, i.e. JJA), and, in the period of 2071–2100, in the autumn months (September, October, November, i.e. SON).

Table 6.1. Absolute seasonal change in air temperature based on the EURO-CORDEX ensemble at the height of 2 m at the end of the 21st century compared to the control period of 1971–2000, °C (Estonian Environment Agency, 2014)

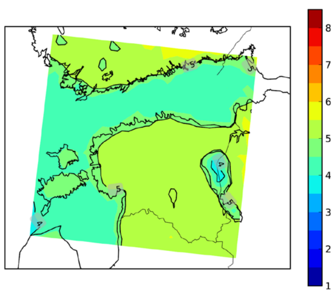
Period	2041–2070		2071–2100	
Scenario	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Winter (DJF)	2.3	2.9	3.1	4.9
Spring (MAM)	2.4	3.1	3.4	4.9
Summer (JJA)	1.6	2.2	2.2	3.8
Autumn (SON)	1.7	2.2	2.2	3.6
Annual average	2.0	2.6	2.7	4.3



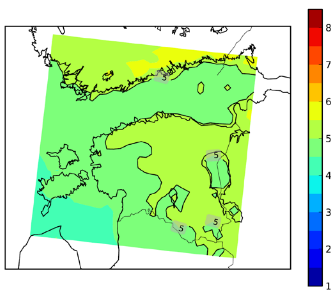
(a) RCP4.5, DJF



(b) RCP4.5, MAM



(d) RCP8.5, DJF



(d) RCP8.5, MAM

Figure 6.1. Absolute seasonal change in the average temperature by the end of the 21st century compared to the control period of 1971–2000; top row (a, b): scenario RCP4.5, bottom row (c, d): scenario RCP8.5; left to right: winter (DJF), spring (MAM), °C (Estonian Environment Agency, 2014)

Shortwave radiative forcing of the Sun affecting the surface of the Earth

Table 6.2 presents an overview of the relative change in the shortwave radiative forcing affecting the surface of the Earth found by the EURO-CORDEX high resolution model. The main outcome of the calculations performed by using the model ensemble was a decrease in the shortwave radiative forcing affecting the surface of the Earth. The decrease is more obvious in the colder part of the year with the change in the radiative forcing remaining insignificant in the summer months. This result matches the expected strengthening of the western flow, which will result in cloudier weather in the colder half of the year.

Table 6.2. Relative seasonal change in the average shortwave radiative forcing affecting the surface of the Earth by the end of the 21st century compared to the control period of 1971–2000, % (Estonian Environment Agency, 2014)

Period	2071–2100	
Scenario	RCP4.5	RCP8.5
Winter (DJF)	−6	−11
Spring (MAM)	−3	−6
Summer (JJA)	0	−1
Autumn (SON)	−4	−3
Annual average	−3	−5

Wind

The majority of the sources are referring to an increase in the average wind velocity in winter and partly in spring. The increase is likely to range between 3–18% and is related to the increase in the number of cyclones moving to our territories from the Atlantic Ocean. The average wind velocity in the summer season will increase less or will not increase at all. The forecasts concerning extreme wind velocities are not deemed reliable enough to be used.

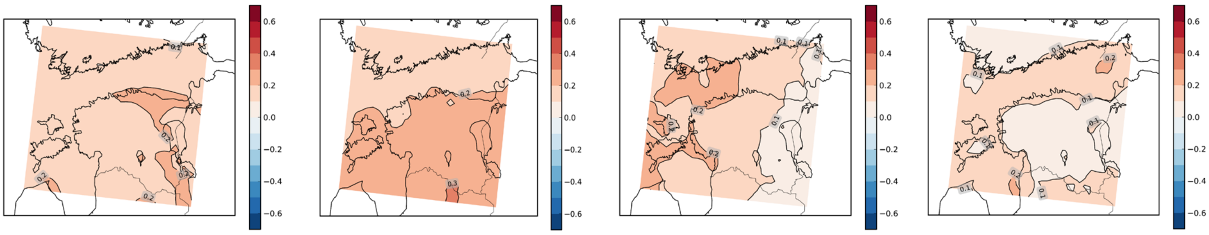
Precipitation

Table 6.3 and Figure 6.2 summarise the modelled relative change in average precipitation. By the end of the century, higher precipitation will be experienced in the spring months; however, in the period of 2041–2070, primarily in the summer months. The change in the precipitation is lowest in the autumn months. The geographical distribution presented in Figure 6.2 clearly shows that, irrespective of the scenario, an increase in the precipitation in the winter and spring months can be expected on land and in the summer and autumn months over the sea.

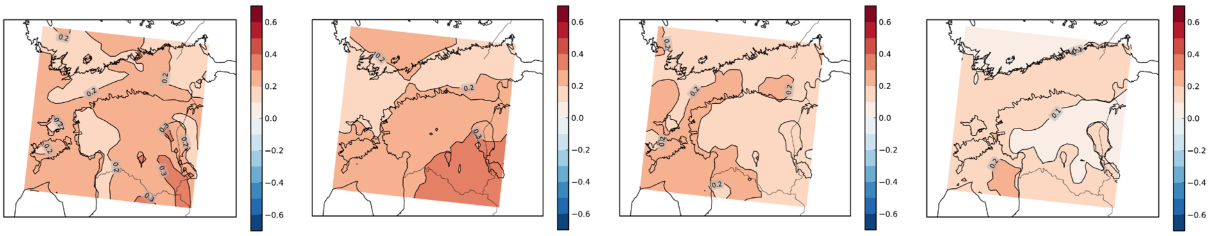
The average annual increase in precipitation of 19% in the RCP8.5 scenario accurately matches the precipitation forecast provided in AR5, based on which the changes in the territory of Estonia will remain between 10–20%. Examining the forecasted increases in precipitation for all seasons in the case of both scenarios and combinations of the period, the highest increase in precipitation in the RCP8.5 scenario can be observed in spring, and in the RCP4.5 scenario, however, in summer.

Table 6.3. Average seasonal change in precipitation in the periods of 2041–2070 and 2071–2100 compared to the control period of 1971–2000, % (Estonian Environment Agency, 2014)

Period	2041–2070		2071–2100	
Scenario	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Winter (DJF)	9	15	16	22
Spring (MAM)	10	16	21	24
Summer (JJA)	11	18	15	19
Autumn (SON)	10	8	11	12
Annual average	10	14	16	19



(a) RCP4.5, DJF (b) RCP4.5, MAM (c) RCP4.5, JJA (d) RCP4.5, SON



(e) RCP8.5, DJF (f) RCP8.5, MAM (g) RCP8.5, JJA (h) RCP8.5, SON

Figure 6.2. Relative seasonal change in the average precipitation by the end of the 21st century compared to the control period of 1971–2000; top row (a, b, c, d): scenario RCP4.5, bottom row (e, f, g, h): scenario RCP8.5; left to right: winter (DJF), spring (MAM), summer (JJA), autumn (SON), the scale division value 0.1 = 10, % (Estonian Environment Agency, 2014)

Extreme values of precipitation

Table 6.4 presents the likelihood of the occurrence of more than 30 mm of precipitation over 24 hours by seasons and scenarios as analysed with the EURO-CORDEX model. The last column of the table provides the likelihood of the occurrence of more than 30 mm of precipitation at a certain point on a certain day as an average of the entire area included in the model ensemble. The summarised likelihood of all seasons remains slightly under the value of 85% presented by Tammets and Mätlik (2012).

Based on the models, an increase in the number of occurrences of extreme precipitation is forecasted, but taking into consideration the very low likelihood thereof in the majority of the year, these occurrences are only significant in summer.

Table 6.4. Relative changes in the occurrences of more than 30 mm of precipitation over 24 hours by seasons, scenarios, and periods compared to the likelihood of the event at a certain point in a certain day in the control period of 1971–2000, % (Estonian Environment Agency, 2014)

Period	2041–2070		2071–2100		1971–2000
Scenario	RCP4.5	RCP8.5	RCP4.5	RCP8.5	Control
Autumn (SON)	188	174	184	245	16
Winter (DJF)	201	231	141	435	1
Spring (MAM)	158	209	207	244	8
Summer (JJA)	124	139	137	165	54

Snow cover

In the control period of 1971–2000, there were 1–6 days of snow, on average, in April. Based on both scenarios, RCP4.5 and RCP8.5, the likelihood of snow in April is very low. According to the RCP4.5 scenario, the number of days of snow in March will decrease by more than 10 days compared to the control period and, according to the RCP8.5 scenario, by up to 15 days, rarely exceeding 5 days. In January-February, according to the RCP4.5 scenario, snow cover will also decrease by at least 10 days, reaching the average of 15 days, which means that permanent snow cover will not form. In more than half of the days, snow can only be found in rare areas in Northeastern Estonia. According to RCP8.5, the duration of snow cover in January and February remains under 10 days, as a rule.

Sea level

The local change in the sea level of the Baltic Sea is the highest in the Gulf of Finland and in the Gulf of Riga, with the relative increases of 6–8 cm. This study disregards the land uplift, which equals approximately 1 mm in Pärnu, over 2 mm in Hiiu County, and even more towards the northwest, reaching the maximum level of approximately 9 mm at the bottom of the Gulf of Bothnia near the coast of Sweden. In Estonia, studies of the time series of the sea level in the period of 1924–2004 have shown that the slight rising of the sea level in summer is balanced by the land uplift in Pärnu. In the winter period, however, an average increase of 15 cm in the sea level has been observed. In Ristna, where the land uplift is higher, lowering of the average sea level in summer has been observed, while there are no changes in winter. As the relative local change and the land uplift have a balancing effect with respect to one another on the western coast of Estonia, it is mostly necessary to consider the average global rising of the sea level here, which may mean an average rise of the sea level on the coasts of Estonia by 20–40 cm based on the RCP4.5 future scenario and by approximately 40–60 cm based on the RCP8.5 future scenario by the end of the 21st century.

Seawater surface temperature

According to the estimations of BACC (2008), the seawater surface temperature will rise by 2.9 °C as an average of the model ensemble by 2071–2100 compared to the period of 1961–1990. The increase in the seawater surface temperature will be the highest in May and June and will be expressed most in the southern and central areas of the Baltic Sea. In the Gulf of Bothnia and Gulf of Finland, the highest increase in the seawater surface temperature for spring in the SRES-A1B scenario (similar to the RCP6 scenario, between the scenarios RCP4.5 and RCP8.5) is forecasted. Based on the same modelling results, the seawater surface temperatures in the Estonian coastal waters will be 2.1–2.8 °C higher in winter and spring and 1.0–2.0 °C higher in summer and autumn in the period of 2061–2090 compared to the period of 1970–1999.

Sea ice

The time series of the sea ice of the Baltic Sea show that in the last 50 years the maximum extent of the ice cover of the Baltic Sea has ranged from 50,000 km^2 to 400,000 km^2. Earlier, it has extended to up to 420,000 km^2. There was an abrupt change in the maximum extent of the ice cover at the beginning of the 1990s, which was mainly preceded by years of extensive ice and followed by years of little ice. Shrinking of the surface area of sea ice has been accompanied by a shorter duration of the ice cover period in the Estonian coastal areas – the ice cover has begun to appear later and disappear earlier.

Recent modelling based on the AR5 scenarios shows that according to the RCP4.5 scenario, the coverage of the Baltic Sea with ice in a typical winter in the 2040s has decreased. The coastal areas of the Gulf of Finland, the Väinameri Sea, and the Gulf of Riga are still covered with ice, but the thickness of the ice layer has decreased by half or up to three times. By the 2080s, the ice cover of the Baltic Sea has decreased further – the Väinameri Sea and the Gulf of Riga are almost completely ice-free, but the coastal areas of the Gulf of Finland are still covered with ice. In the RCP8.5 scenario, the ice cover in the 2040s is slightly less extensive than in the RCP4.5 scenario, but still quite similar to the more optimistic scenario. In a typical winter of the 2080s, however, most of the Baltic Sea is ice-free. Only a 30–40 cm ice layer forms on the Gulf of Bothnia and a 0–10 cm ice layer in the northeastern part of the Gulf of Finland. The estimated extent of the ice cover on the Baltic Sea by 2085 is 75,000 km^2 (30,000 km^2 to 140,000 km^2) in the case of the RCP4.5 and 45,000 km^2 (23,000 km^2 to 70,000 km^2) in the case of the RCP8.5 compared to the current average of 115,000 km^2.

Inland water

According to the IPCC SRES-A2 emission model scenario (similar to the RCP8.5, but with a slightly lower radiative forcing), the water temperature of the lakes in Europe, incl. in Estonia, will rise by 2–7 °C by 2100.

Due to the increasing winter temperatures, the ice cover period of Estonian rivers is shortening or no ice cover will form on most of the rivers. This will result in runoff in the winter period, as the precipitation will no longer accumulate in the form of snow.

Due to the forecasted decreasing of the snow cover, the maximum runoffs modelled for the future are smaller than the current runoffs and distributed more evenly over the year, thus, the maximum water levels are also lower. The significant decrease in the runoff in the maxima period (typically in April and May) will result in the lengthening of the minima period in the summer towards spring, which will cause the decreasing of the water supply during the first half of the vegetation period and the risk of small streams and rivers becoming vulnerable to decreasing runoff during the first half of the summer. The seasonal distribution of the runoff of the rivers in Southern and Eastern Estonia will remain relatively unchanged compared to the base period. In Northern Estonia, where the rivers are influenced by karst, the autumn runoff will increase significantly. The impact of climate change on the seasonality of runoff is the greatest in Western Estonia and on the islands, where the autumn runoff will increase and even exceed the spring runoff. There will be two main hydrological seasons instead of the current four. Thus, the increase of precipitation in autumn will increase the autumn runoff and autumn may become the most water-rich period in Northern and Western Estonia and on the islands.

6.3. Climate change impacts and vulnerability assessment

From the implementation aspect, the correct interpretation of the forecasted parameters of the future scenarios has an important role in climate change impacts and vulnerability assessment. It is important to deduct the so-called secondary weather data from the monthly average data. In this case, two approaches may be applied.

First, we can presume that the weather structure and pattern will remain similar to those in the control period (1971–2000). This means that, for example, the number of arrivals of arctic air masses or summer heat waves in the periods of 2041–2070 or 2071–2100 will be the same as in the control period, but due to the overall warming of the climate, the air temperature in Estonia during a cold wave will not be -30 °C, but -26 °C.

Thus, the respective coefficient provided in a future scenario may be added to the data of the control period. This enables finding various air temperature indexes required for the implementation tasks, the average beginning and end dates of seasons of a 30-year period, the durations of vegetation and other similar periods. At the level of the average values of a 30-year period, the results are relatively reliable and the potential errors small.

This solution is, however, not universal. The problem is that there is a very high peak of around 0 °C in the distribution of the frequencies of daily temperatures in the cold half of the year (in Estonian climatology, traditionally in November, December, January, February, and March, when precipitation occurs in solid form), for example. This means that in the control period, in almost a fourth of the days of the cold half of the year the air temperature ranged from -1 to +1 °C. Summation shifts this peak to approximately +4 °C and we can come to a rough, but incorrect conclusion – e.g. that the glaze hazard on Estonian roads will reduce or even disappear completely in the future. The glaze hazard is the highest when the minimum temperature over 24 hours ranges from 0 to -3 °C and the maximum temperature from 0 to +3 °C.

Thus, future scenarios can be interpreted by following another approach, based on the tendencies, which are already climatologically observable and have expressed themselves today, will strengthen in the future.

For example, comparing the changes in the temperature in the cold half of the year in Türi in the periods of 1952–1981 and of 1981–2010, the average of the first period is 7 °C and the average of the second -5.4 °C. Relating this warming to the changes in the distribution of air temperature over 24 hours, we must admit that the warming does not arise as much from the number of warmer days with temperatures over 0 °C, as it does from the significant increase in the number of days with the temperature around 0 °C. While in the first period, the share of the days with the air temperature between -1 and +1°C was 23%, the share was considerably higher in the second period, i.e. 29%. Assuming that, based on the RCP8.5 scenario, the average temperature in the cold half of the year in the period of 2071–2100 is -0.9 °C, it is possible to draw up a mathematical model based on the changes that have occurred so far and estimate the number of the 0 °C days in the future (ca 50%).

However, it should be kept in mind that such mathematical models are only of theoretical value and strengthening the tendencies based on these models comes with a very high level of uncertainty. Still, the issue of distribution frequencies must be taken more seriously than it has been so far (especially in the case of precipitation), as a large percentage of climate change impacts are determined by changes in the frequency of certain particularly extraordinary events, not average events.

The climate change impacts and vulnerability assessment in the basic research of the national development plan for adaptation to the impacts of climate change described below are mainly based on the risk assessment methods of the IPCC and on the relevant scientific sources, which connect climate change, exceptional weather conditions, and extremities of the climate with the developments of the society. The assessment methods connect factors based on climate, the environment, and human activity/existence, which are expressed in the impacts of climate change. The assessment and management of risks is also covered, with several non-climatological factors having a relatively important role. Thereat, equal attention should be paid to natural and anthropogenic climate changes, as well as socio-economic processes. Vulnerability depends on exposure, sensitivity, and the ability to adapt; thereat, exposure means the manner, extent, and frequency of the system coming into contact with climate factors; sensitivity means the extent to which climate stressors have an impact on the observed system; and ability to adapt means the potential of the system to adapt to climate change. Sensitivity comprises people, the assets created by people, such as buildings and infrastructure, biological species and ecosystems. The contact, or also exposure and sensitivity together determine the potential impacts of climate change on the system. The ability to adapt describes the potential of a region or a country to cope with the impacts of climate change. All of the abovementioned factors together determine the vulnerability to climate change.

The potential impacts of climate change and the vulnerability vary greatly by regions, but adaptation must be based on the location and on territorial risk assessments. An assessment of vulnerability and climate change impacts is drawn up based on the assumption that exposure, sensitivity, and ability to adapt are phenomena that vary spatially. In addition to climatic changes moving in different directions in different regions and due to the fact that some regions are more exposed than others, all regions have their own clearly distinguishable environmental, social, and economic features, which are sensitive to climate change in a larger or smaller extent. In order to assess vulnerability, the impacts of change and the regional ability to adapt are integrated. This is based on the principle that a region with high impacts of climate change may still be moderately vulnerable if it is well-adapted to the presumed climate change. On the other hand, high impacts may be expected to result in higher vulnerability if the ability of the region to adapt is low.

6.4. Sectoral impacts of climate change and vulnerability in Estonia

In 2014, the Republic of Estonia commenced drafting of the development plan for adaptation to the impacts of climate change, the process of which was based on the EC Guidelines on developing adaptation strategies, the EU strategy on adaptation to climate change, the methodology of other EU countries, the 5th IPCC assessment report, the analyses of climate change scenarios drawn up by the ESTEA, the knowledge base of Estonia, other national cohesion policies (see Chapter 6.5), and the measures and practices being implemented.

Drafting of the development plan was coordinated by the Ministry of the Environment (MoE) and Estonian Environmental Research Centre (EERC) in cooperation with the ESTEA, the University of Tartu, the Estonian University of Life Sciences, the Stockholm Environment Institute Tallinn Centre, and the Norwegian Directorate for Civil Protection, which described the most important problems in the area of adaptation to climate change and analysed vulnerability (see Chapter 6.3), the impacts of climate change in this century, and the potential adaptation measures (see Chapter 6.5) based on the future climate change scenarios in Estonia drawn up by the ESTEA in eight priority areas:

1) health and rescue capability;
2) land use and planning;
3) natural environment;
4) bioeconomy;
5) economy;
6) society, awareness, and cooperation;
7) infrastructure and buildings;
8) energy and security of supply.

The first stage included the collection and analysis of available information on key sectors listed above. If possible, the information was collected and presented in the form of spatial data. Forecasts and analyses of the society were mainly based on national statistics. In the sectoral vulnerability analysis, climate-related factors were discussed in the context of regional variability, which formed the basis for thorough sectoral analyses of the impacts of climate change.

Vulnerability assessment, climate change impacts and adaptation measures described for priority areas are based on results outlined in the Estonian development plan for adaptation to the impacts of climate change.

Synopsis of important climate change impacts in Estonia until 2100:

- the spread of new pathogens and increasing health disorders;
- increasing flooding risk and pressure for building relocation;
- changes in hydrological cycle and vegetation and the spread of alien species;
- unfrozen and waterlogged forest land in the winter and new plant pests;

- transient effects of global trends on the economy;
- immigration from global migration;
- additional requirements on infrastructure and building durability;
- changes in seasonal energy consumption.

6.4.1. Health and rescue capability

Health

The impact of higher temperatures on hot days and the increased number of heat waves have been already manifested, as mortality was quite high during hot weather periods (with the maximum temperature of the day exceeding 27 °C) in the period of 1996–2013. The health of the population of Estonia was especially significantly impacted by the hot summer of 2010, when the mortality in the summer months presumably increased by almost 30%. As heat waves are becoming more frequent due to climate change, depending on the climate change scenario used (RCP4.5 or RCP8.5), 506 or 679, or almost 655 or 1,068 excessive deaths per year, on average, can be expected in the periods of 2030–2050 or 2050–2100, respectively. In spite of the general warming of the climate, the health risks arising from very low temperatures or formation of glare ice on roads should also not be underestimated in Estonia in the future. Further extreme weather conditions, which may endanger human health, include storms and heavy rain (the resulting floods), which may also make medical assistance less accessible or completely inaccessible.

Air quality also has an important effect on health. Although the pollutant content of the air may increase (formation of ground level ozone intensifies during heat waves, the conditions for the diffusion of fine particles may deteriorate in certain periods, and forest fires may become more frequent), the most direct impact of climate change related to air quality is increased spread of pollen. In the RCP8.5 scenario, the duration of the pollen season will increase by the end of the century and new allergenic plant species will spread to the territory of Estonia, which will increase the health risk.

Changing climate impacts the spread of vector-borne diseases of animals and plants (e.g. spread by fleas, ticks, mosquitos), which may pass on dangerous infections. Changes in the spreading areas of vector-borne diseases will result in more frequent occurrences of both the diseases already prevalent in Estonia, such as tick-borne encephalitis and Lyme disease, as well as diseases that are currently relatively rare in Estonia, such as leishmaniasis, hantavirus, tularaemia, dengue fever, etc. Thereat, the impacts of various climate components are conflicting – milder winters and periods of higher humidity (but not heavy rain) generally support, while drought periods prevent the spread of diseases. Heavy rain may cause the carrying of hazardous substances or excessive nutrients (the former of which may present a direct hazard to human health and the latter may cause more intensive eutrophication) and many parasites (which may end up in drinking water in the case of insufficient treatment processes) from the environment into the water. Long drought periods, however, may leave shallow drinking water wells dry. A higher frequency of hot summers may also increase the frequency of algal blooming, which deteriorates the quality of bathing water. Wider spread of plant diseases and mycotoxins presents a hazard related to food safety, which, according to the RCP8.5 scenario, may increase in the period of 2050–2100.

Rescue capability

The main factors to be taken into consideration from the aspect of rescue capability are floods in densely populated areas and extensive forest and landscape fires. The risk of both of the abovementioned emergencies was deemed high in the nationwide risk analyses drawn up in 2013. As 60% of forest fires occur in May and June, the higher frequency of drought periods in spring and summer also increases the forest fire hazard. These emergencies do not present a very high risk to human lives and health in Estonian conditions, but may cause huge proprietary damage and interruptions in operative rescue works or the processing of emergency calls. It is remarkable that human activity may still be deemed the main cause of forest fires. Sharpening of the impacts of climate change calls for a need for more extensive involvement of volunteers as well as defence structures and the private sector in responding to emergencies, while the amount of human assets and money spent will also increase.

6.4.2. Land use and planning

Coastal areas

Due to changes in the trajectories of cyclones and the resulting higher frequency of western storms, Estonian coastal areas may be at a risk of increasingly frequent rises in the water level and floods, the extent of which in the future will probably exceed what has been experienced so far. Rising of the global sea level, more frequent western storms, and the decreasing extent of ice cover in winter together will probably bring forth more intensive erosion processes in the Estonian coastal areas in the next few decades, which may also endanger the objects in the direct vicinity of the coastal zone, incl. cultural heritage, and coastal tourism may suffer. For a more accurate and operative assessment of the floods caused by storm surges, management of risks, and operative responding to the consequences, methods and systems for monitoring coastal areas must be applied, significant endangered objects must be identified and the protection of such objects planned, which will be accompanied by higher financial costs.

Other areas affected by flood risk

There are 15 areas exposed to floods in densely populated areas in the Western Estonian hydrographic basin and 5 in the Eastern Estonian hydrographic basin. Floods, which are likely to occur once in 10 years, endanger approximately 1,000 people in coastal settlements, those likely to occur once in 100 years approximately 6,600, and those likely to occur once in 1,000 years approximately 15,000 people. Floods, which are likely to occur once in 10 years, endanger 843 residential buildings, those likely to occur once in 100 years approximately 3,200, and those likely to occur once in 1,000 years approximately 6,400 residential buildings. The flood risk in inland waters is assessed as considerably lower compared to that in coastal areas.

Land improvement

The forecasted increase in the ground water level as a result of climate change is not high, but may cause significant changes in the quality of the ground water as well as in the hydrography of the ground level water table. The latter determines the water regime of the soils and the use of drained land. In low, level areas, especially in the case of heavy-textured soils and organic soils, the level of the ground level ground water table may rise so much that the total area of wetlands will expand. Climate change together with deterioration (amortisation) of the condition of drainage systems will in turn bring forth changes in land use – excessively wet areas will expand and may be left out of use as the yield or harvestability of the areas decrease. The selection of the cultivated cultures will depend on the resistance of the cultures to excessively wet conditions or drought. The decreasing of the amount of agricultural land available for crops, which provide higher added value, may, for example, result in less land for cultivating potatoes, rapeseed, and cereals, and thus in the expansion of the areas of grasslands.

High-intensity rain with a high amount of precipitation may start causing local floods. An increase in the amount of precipitation will increase the risk of flushing out of nutrients from the soil into the surface or ground water. Milder winters will decrease the water supply in the soil in the first half of the vegetation period, which will in turn bring forth a need for more irrigation.

Renovation of many land improvement objects established in previous decades is highly resource-exhaustive, the need for renovation, however, is several times higher than the investment capability, thus, in order to ensure the operability of the land improvement systems in the near future, decisions must be made on which drainage systems are important for the Estonian economy and which should be abandoned.

Cities

Both direct as well as indirect impacts of climate change above all affect the larger cities, Tallinn, Tartu and Pärnu, where the majority of the population, economic activity, assets, capital, and cultural objects have accumulated. The technogenic city environment of a high population density and complex city planning interdependencies is unable to buffer the impacts quickly enough – new structures often even amplify the risks.

Taking into consideration the geographical location of Estonia and the sparse settlement system, the risks related to climate change here are relatively low and, as a rule, the area of influence is local (specific streets or districts), on the other hand, however, the planning practice used here does not consider climate change. The main risks which Estonian towns face according to the future climate forecasts arise from a higher frequency of exceptional weather conditions, incl. storms, floods, and heat waves. Of the above, the negative impact of the flooding of the coastal sea is the highest and endangers the cities of Kuressaare, Haapsalu, Pärnu, and Tallinn as well as eight small towns. The impact is the most extensive in Virtsu, Nasva, Uuemõisa, Võiste, and Paralepa. The flooding risk of Estonian rivers is the likeliest and potentially most extensive on the shores of River Emajõgi in Tartu and the flooding risk of the lakes is the highest on the shores of Lake Tamula in Võru.

Heat waves, which have already presented themselves as climate-related risks in the summers of the last decades in Estonia, are amplified in the cities due to the heat island effect, which affects most the chronically ill, small children, and the elderly. The abovementioned population groups are more vulnerable to the risks of morbidity and mortality. A study of the heat wave of July 2014 revealed that all densely populated areas are affected by the heat island effect, not only larger cities. The negative impact of heat waves is amplified by the aging of the population and urbanisation, which can already be observed in Estonia today and will accelerate in the future.

6.4.3. Natural environment

Biological diversity

Based on the current knowledge, the species that have adapted to specific environmental conditions and those in the peripheral areas of their habitats are the most vulnerable to climate change. Climate change may expand the spread of invasive foreign species and reduce the efficiency of the control measures applied so far. Invasive foreign species anchor themselves outside of their natural habitats and endanger ecosystems, habitats, and ingenious species, thereby causing economic losses.

Terrestrial ecosystems

Warmer winters prevent the freezing of the soil, which, above all, increases the extent of storm damages in excessively wet forest areas with a superficial root system and makes the performance of forestry works more difficult, thereby increasing the risk of damaging the soil. Higher frequency of spring and summer drought periods increases the prevalence of forest fires and facilitates the reproduction and spread of forest pests. Climate change impacts the spread and coherence of forest habitats, biological diversity, interspecies relationships, and forest habitat types.

Climate change increases the frequency of droughts in wetland areas and a higher risk of floods and fires. Increasing air temperature and a higher amount of precipitation causes a rise in the greenhouse gas (GHG) emissions from natural and drained peat areas, thereat, the areas, which are affected by human activity, can be expected to generate significantly (up to twice) higher GHG emission. Climate warming and changes in the precipitation regime also cause long-term shifts in the species composition of the vegetation of wetlands, changing the ratios of peat moss species and increasing the competitive advantage of shrubs compared to peat mosses.

Higher temperatures accelerate the decomposition of the organic matter in agricultural land and grasslands, which in turn impacts the fertility of the soil. Higher precipitation increases the production of grasslands and may also somewhat accelerate the decomposition of organic matter. It is very difficult to distinguish the changes in the grasslands, which have occurred as a result of climate change so far from those arising from human activity. It is clear that more frequent, deeper, and more extensive cultivation of the soil increases the carbon dioxide (CO_2) emission from the soils of agricultural land and grasslands, thereby reducing the fertility of the soil, and extensive tillage helps to preserve the humus content and fertility of the soils.

Ecosystem services

Until 2030, ecosystem services will be most impacted by the increasing frequency of extreme weather phenomena. Although various climate risks will manifest in a significant extent in the case of both climate change scenarios by 2050 and 2100, bringing along changes in provision of the supply and adjustment as well as cultural services, the higher frequency of extreme weather phenomena will likely be the main force behind the changes in the quantities and qualities of ecosystem services. The impacts of climate change on ecosystem services may differ, i.e. may be simultaneously positive as well as negative. The effect of the negative impacts will presumably be highest in the case of the ecosystem services for sea and freshwater communities and somewhat lower in the case of services for terrestrial ecosystems; urban ecosystems, on the other hand, will show most positive effects.

6.4.4. Bioeconomy

Agriculture

In agriculture, climate change mainly impacts the selection of cultures and species, the yield thereof, the efficiency and productivity of animal husbandry, and the spread of plant pests and infectious animal diseases. The conditions for growing the traditional cultures, e.g. for wintering of winter crops, may deteriorate. Nutrients are flushed out of unfrozen soil in winter and may be washed into the ground water or waterbodies. Earlier spring has enabled earlier sowing of cultures while later autumn allows for later harvesting. Later harvesting may be complicated due to excessive water content of the soil in some areas. Extreme weather phenomena increase the risk of crop failures and may result in the deaths of agricultural animals due to power cuts or floods. Heat waves and drought periods in summer endanger the welfare, productivity, and feed supplies of animals. Longer cultivation periods increase the mass of forage plants, while longer grazing periods reduce the animal upkeep costs in winter. Higher temperatures allow growing of frost-sensitive cultures. In gardening, the increase in the outside temperature will bring forth significant changes in the profitability of glasshouse agriculture and in the selection of open area plants.

Forestry

The higher frequency and longer duration of drought periods in spring and summer will facilitate the development of root rot and the reproduction of bark beetles and increase the fire hazard in the forests. The increase in summer temperature and milder winters will potentially create favourable living conditions for various pests, which can usually be found in masses south from the territory of Estonia, in addition to our local pests.

In the excessively wet habitat types in Estonia, forests have been traditionally cut when the ground is frozen. Due to the reduced number of winter periods of lower temperatures, the soils in Estonian forests fail to freeze deeply, which may result in more extensive damages to the soils during felling work.

Pine and fir trees are also growing well in habitats where the temperature is 5 °C higher than in Estonia, if there are no drought periods. Thus, the potential increase in temperature will not be accompanied by considerable changes in the species composition of Estonian forests; changes in the percentage of certain species are, however, possible. Due to changes in the natural conditions, the conditions will improve for the forest species, which have been rarely found in Estonia so far and are on the northern border of their habitat, while the conditions will deteriorate or become unsuitable for the species on the southern borders of their habitats.

Fisheries

The forecasted climatic changes may mainly impact the size and species composition of the fisheries resources, which directly influence the opportunities for industrial and hobby fishing. The signs of climate change (changes in the water level and temperature, extreme weather phenomena, unstable ice cover or no ice cover, inflow of saline water into the Baltic Sea or the lack thereof) may directly impact the abundance of fisheries resources, which are important from the fisheries management perspective and are less resistant (more vulnerable) to climate change, and the amount of fisheries resources in the Baltic Sea as well as in Estonian inland waters. Increasing temperature should increase the general productivity of these water ecosystems and accelerate the growth of the fish, but this is also dependent on many other factors (e.g. the eutrophication, pollution arising from human activity, overfishing). There are fish species of quite different ecological needs living side-by-side in Estonian waterbodies and the forecasted climatic changes may have conflicting impacts on the size of the resources of these species: the numbers of freshwater and coldwater fish (e.g. the Salmonidae, European whitefish, Peipsi whitefish, burbot, smelt) may decrease further in the future and their habitat may become narrower compared to the warm water fish species (e.g. Cyprinidae, pike perch), who prefer more nutrient-rich habitats. Gradual changes in the water temperature may have a smaller impact on the fisheries resources than sudden changes in the regime (e.g. heat waves, inflow of saline water into the Baltic Sea), which may cause drastic changes in the living environment of the fish within a short period of time (even in hours).

The status of the fisheries resources may be strongly impacted by the ice conditions and changes in the water temperature within one year (seasonal changes), which determine the successful reproduction of the fish, the strength of the generation, and the size of the progeny. For example, shortening of the ice cover period may have conflicting effects on the fisheries resources: 1) it may decrease the mortality risk of fish in shallow lakes in winter due to lack of oxygen; 2) it may affect negatively the success of the reproduction of the fish, which spawn in late autumn or in winter, such as the European whitefish, powan, and burbot; 3) it may damage the opportunities for hobby fishing in winter. Climate change also facilitates the spread of invasive foreign species and new fish parasites and diseases, which have a negative impact on the fisheries resources.

Peat production

In the period of 1992–2013, the volume of peat extraction has ranged from 0.3 to 1.5 million tons per year. The large fluctuation mainly arises from the weather conditions – primarily the amount of precipitation, but also from the number of precipitation-free days and the air temperature. Expansion of the extraction areas from 15,800 hectares to 18,000 hectares may not necessarily ensure stable peat extraction and consumption volumes. The increase in the average air temperature arising from climate change will presumably bring forth more extensive mineralisation of the peat in the extraction areas and thereby up to twice higher CO_2 emissions. Furthermore, it may be significantly impacted by the amount of precipitation and the humidity of the soil. Warming of the air temperature will prolong the extraction period by up to two months. A solution must be found to the question of whether or not it is possible to take into use a new (wet) technology, which would enable using a smaller area for the extraction of the same amount of peat, which would decrease the environmental impact of extraction and cover the demand for peat.

6.4.5. Economy

Estonia as a small country with open economy is more vulnerable to the impacts of climate change to the global economy than to the local processes related to climate change. The global need for technological progress, more sustainable management, and environmentally friendlier manufacturing arising from climate change has above all placed the issues of climate change in the sector of opportunities for entrepreneurship in Estonia. The success of the sector of technology companies is showing a growing trend in Estonia, and the availability of natural resources (timber and other natural materials), which enable sustainable production, and the traditions of using such materials provide a developmental advantage.

Estonian companies must take into consideration the environmental safety requirements and restrictions applicable to the use of the environment which have formed in time. For example, the impacts of climate change on the industrial sector mainly manifest through alleviation measures – adjustment of the building, availability and prices of raw material, changes in the supply chain and transportation. The pressure from consumers arising from the threats of climate change, however, has remained rather modest in Estonia so far.

6.4.6. Society, awareness, and cooperation

More frequent extreme weather phenomena are accompanied by the need for the assistance of social workers, especially for servicing vulnerable groups, who are in danger of social isolation. The need for cooperation between the (civil and military) institutions, organisations, and individuals who are involved in rescue work also increases.

The hazards accompanying extreme weather phenomena impact different groups of the society differently – the impacts vary locally (e.g. floods in seaside or lowland areas) and by members of the society (e.g. the elderly are more vulnerable to extreme cold and heat). Climate change endangers most the disadvantaged people, i.e., those in a poorer socio-economic situation and those of less social capital, who may not have the resources or networks for buffering the impacts of climate change that affect them directly, or for the management of climate-related risks. The impacts on health are mainly prevalent in the children, the elderly, and in chronically ill people or those affected by several health conditions. Thus, extreme weather phenomena may further deepen the inequality in the society.

From the aspect of climate change, Estonia is most influenced by EU climate policies in international communication. Estonia is also one of the parties of main international treaties and participates in the developmental cooperation oriented to third countries as a member of the EU and the Organisation for Economic Co-operation and Development (OECD). At the global level, Estonia is mainly the party that provides assistance and thus global agreements as well as any agreements in the area of adaptation to climate change, which are reached within the EU, mainly impact the Estonian policies of cooperation for development. Increased immigration pressure arising from climate change is also possible.

6.4.7. Infrastructure and buildings

Transport system

In this century, significant changes can be seen in the need for upkeep and maintenance of the transport infrastructure. For example, there is a need for more frequent removal of storm or flood debris from roads, ports, and airports. Overhead transmission lines must be maintained due to increased number of days of glaze. Some circumstances arising from the climate, which may damage the transport infrastructure, can also be foreseen, such as softening of road surfaces, deformation of railroads, or destruction of roads or bridges as a result of floods. In comparing various types of transport, the most vulnerable are the entire transport on the roads and streets as well as the safety of people related to the infrastructure arising from changes due to interruptions in traffic, slipping hazard, reduced load-bearing capability of unpaved side roads, and safety of cycle and pedestrian tracks. Small Estonian ports are also vulnerable due to rising of the sea level and more frequent storms.

Water and sewerage infrastructure

Increased average amount of precipitation, less extensive snow cover and decreased amount of floodings in spring due to a rise in temperature as well as more frequent climate events, such as droughts or heavy rains, all have a direct impact on the functioning of the water and sewerage system. Shorter snow cover periods and faster vaporisation of the water supplies from the soil due to higher temperatures in summer will result in reduced productivity of the upper ground water layer over a longer period of time, which may cause drying of the wells in sparsely populated or karst areas. On the other hand, isolated and very intensive rain periods accompanying southern cyclones may be expected in the conditions of higher temperature in summer, which may bring forth local floods in lower parts of cities due to the limited capacities of the storm drains.

Buildings and energy efficiency

The higher the efficiency of buildings and the equipment in the buildings, the lower the vulnerability thereof to the impacts of climate change. Estonian buildings, however, are characterised by low energy efficiency and quality compared to other EU Member States and the Estonian building stock is old and the construction quality of the new developments unstable. The thermal insulation of the poorly built building structures is low and higher springtime wind velocity increases the heat losses of the buildings. On the other hand, the need for air conditioning in the indoor premises increases as the summer temperatures grow. The steeply increasing power consumption due to heating or cooling in the case of very cold or very hot weather may overload the system and cause power cuts.

6.4.8. Energy and security of supply

Energy resources

Based on the statistics from 2013, the largest non-renewable energy resource used in Estonia is oil shale, which will also serve as the largest energy resource available in 2030 and 2050, based on currently known resources. The largest renewable energy source is timber, which will also remain the largest source of renewable energy in the future, based on the information available today. The changes in the climate factors forecasted have relatively little impact on the availability of energy resources up to 2100. In 2015, the largest primary energy consumption energy resource in Estonia was oil shale, while renewable energy resources, such as biomass, wind and solar energy, are of the highest consumption potential. The forecasted changes will have positive as well as negative impacts on the availability and quality of energy resources. The compliance of the technology used, the timing, and the infrastructure with the weather conditions is of increasing importance in the collection of bioenergy resources. For example, the collection of timber, herbaceous biomass, or peat is a highly seasonal activity. These fuels require interim storage, which increases vulnerability if the storing conditions are not protected from the weather conditions. By 2100, the ongoing climatic changes can be expected to bring a positive total impact on the wind energy resource, while a small negative impact can be presumed in the case of solar energy (due to an increase in the number of cloudy days), and on the consumption of timber as an energy resource. The impact of weather conditions and the changes thereof are the lowest on using the energy source of oil shale. The changes forecasted have no impact on the extent of the oil shale resource to be used.

Heat production and cooling

Centralised heat production is more susceptible to climate change than local heating, as the lower heat consumption as a result of climate change may turn the operating of district heating networks unfeasible from an economic perspective. Shortening of the heating period will increase the percentage of the losses in the transmission of the heat, which is used for heating centralised domestic water outside of the heating period.

In Estonia, the remaining of the maximum air temperature during 24 hours ≥ 30 °C for at least five days is deemed especially hazardous to human health. Currently, the air conditioning systems of buildings are not designed to take into consideration the heating solar radiation permeating through the windows which makes it difficult to maintain a specific temperature (e.g. the estimated temperature range in offices during a cooling period is 22–27 °C). Climate change has a dual impact on the energy sector. On the one hand, increasing of the temperature in winter will decrease the thermal energy consumption in the cold half of the year. On the other hand, the increase in the average temperature, the higher temperature in summer and more frequent short heat waves (7–10 days, on average) increase the need for cooling buildings, which is mainly fuelled by electricity. Thereat, the decrease in the demand for thermal energy is not proportional to the increase in the winter temperatures, as the higher winter temperatures are primarily related to windy weather and inflow of a warmer, humid air mass over Estonia. Due to the higher humidity and wind velocity, additional energy is needed to maintain a comfortable temperature. The higher amount of precipitation raises the level of the upper level of ground water. The higher level of ground water and higher humidity of the soil cause large heat losses, especially in old, uninsulated heating pipelines, as the heat conductivity of the soil increases.

6.5. Progress of adaptation to climate change

The awareness of Estonians of climate change as an increasingly sharpening global problem is among the lowest in the EU, according to 2017 Eurobarometer survey. Only one fourth of the population of Estonia deem climate change a worldwide issue, thereat, only one in ten acknowledge climate change as the most serious worldwide problem. At the same time, Estonia is in the 158th position among all countries in the world in the Global Climate Risk Index (descending ranking) with 0 deaths and an economic loss of 15,316 million US dollars (0.052% of the gross domestic product) and, based on this assessment, Estonia is a relatively safe place. Compared to the general situation in Europe, the aggregated impacts of climate change in Estonia are also either very low or positive, the ability to adapt, however, remains below the average compared to other European countries.

The ability to adapt is high in the case of known or experienced risks, but low in the case of indirect or complex impact chains. Adaptation activities can be continuously planned and implemented in Estonia mainly on the basis of the experience and lessons from recent climate events. As the knowledge on (but partly also the awareness of) adaptation to the climate increases, it will be possible to focus research more accurately and conduct targeted studies. Cohesive cross-sector studies are required above all (for example on the impacts of floods or heat waves).

6.5.1. Adaptation measures at the national level

The strategic development documents of Estonia include direct and indirect measures, which may help the society in adapting to the impacts of climate change. Most of the measures are concerned with climate change mitigation and the regulation of emergency situations (pursuant to the Emergency Act and Water Act). A lot of attention is paid to human health and development of environmental education in the Estonian Environmental Strategy 2030. The Estonian Nature Conservation Development Plan until 2020 and the Development Plan of the Area of Government of the Ministry of the Environment 2017–2020 cover public awareness as well as development of environmental education and climate research. Unfortunately, awareness is discussed in these documents in the traditional key of information campaigns and materials, which is not very efficient. The development plans adopted so far have also not addressed the transfer of the global impacts of climate change to Estonia.

Of the acts of legislation of Estonia, the topic of adaptation to the impacts of climate change is discussed most extensively in the Emergency Act. The Emergency Act is the basis to the following Rescue Board initiated emergency situation risk analyses, which may arise as a result of extreme climate events or conditions: *Floods in densely populated areas, Extremely cold weather, Extremely hot weather, and Extensive forest or landscape fires*. The Health Board led the drawing up of the *Risk analysis of the emergency of an epidemic outbreak*. The Emergency Act governs the drawing up of risk analyses of emergencies and plans for responding in emergency situations, emergency-related trainings, notification of emergencies, management of responding to emergencies, as well as declaring of emergency situations and the measures applied during emergency situations. This includes the obligation to work for third parties, expropriation of movables, prohibition on staying and other restrictions on the freedom of movement. Although the risk analyses do not highlight the impacts of climate change or the importance of adaptation to climate change, the existing measures help to manage climate risks and are, by nature, works, which should be performed by the administrator of the systems anyway or which should be ordered by the state from enterprises. That includes modernisation of storm drains, maintenance of dams, drawing up of detailed maps of at-risk areas and risk management plans, training of local governments on emergency-related issues. For example, the average prevalence of forest fires by years has decreased, which shows the efficiency of the measures applied for prevention of the fires caused by human activity. The number of the forest fires, which meet the definition of an emergency, has also decreased significantly (there have been the total of 7 of such cases since 1991). The law also provides the legal basis for ensuring the continuous operation of vital services, such as functioning of the power and gas supply, emergency medical care, water supply and sewerage. This may also be impacted by climate change if extreme weather phenomena become more frequent.

Risk analyses of continuous operation and continuous operation plans must be drawn up to ensure continuous operation of vital services. The measures related to the Emergency Act are mainly focused on increasing the awareness of the population and those providing vital services, notification of at-risk groups, and cooperation, as well as on increasing the efficiency of weather forecasts and weatherproof infrastructure.

The impacts of climate change are also discussed in the Water Act in connection with the assessment and management of the risks related to floods (updating of management plans). The Water Act establishes the obligation to draw up maps of flood hazard areas, to assess flood hazards, and to draw up flood hazard management plans (water management plans 2015–2021). The aim of these activities and plans is to manage the potential damaging consequences arising from floods to human health, property, environment, cultural heritage, and economic activities and decrease the likelihood of such damages in the future primarily by increasing awareness, as well as by identifying and assessing new, increasing risks. Implementation of the measures will commence at the national level, at the level of the local government of the area at risk, or at the level of companies, organisations, or residents. The management plans for hydrographic basins have been drawn up based on the current use of land, rather than the existing spatial plans. Integration of the management plans into the spatial plans could be organised within the framework of a pilot project, otherwise, integration of the management plans into the plans may simply remain a formality.

The activities discussed in the Water Act are coordinated by the MoE in cooperation with the Ministry of the Interior (MoI), the Ministry of Finance, and the Ministry of Rural Affairs, by involving local governments and county governments. Certain obligations have also been placed on landowners.

The EU strategy on adaption to climate change, which was approved by the European Commission in April 2013, sets the goal of decreasing the vulnerability of economic sectors, fields of life, natural and human systems, and property to the impacts of climate change. To achieve this, it is necessary to increase the preparedness and capability of all European countries. The best adaptation policy is ensured by transnational, collective, joint preparedness and action of the public and private sector, whereat, it is important to proceed based on local, location-based conditions and circumstances. One of the activities, which frame and coordinate the adaptation policy, was drafting of the national adaptation strategies by 2016 at the latest.

The area of adapting to the impacts of climate change is planned and managed in Estonia comprehensively in a short (up to 2030) and long (up to 2050 and 2100) perspective via the abovementioned **Climate Change Adaptation Development Plan until 2030.** The development plan has been drawn up based on the EU strategy on adaptation to climate change, the guidelines for developing national strategies, and the distribution of prioritised sectors, which brings together and harmonises the approach of adaptation to the impacts of climate change.

The general goal of the plan is to **decrease the vulnerability of Estonia to climate change and achieve the preparedness and capability to cope with the impacts of climate change at the local, regional, and national level** with the help of a framework of activities. Furthermore, the development plan includes eight sub-goals, which are directly based on the vulnerability of prioritised areas, describe the areas, and are phrased accordingly. The implementation of the development plan is supported by measures for adaptation to the impacts of climate change in addition to the activities, outcomes, and costs in the

Table 6.5. Summary of information on vulnerability and adaptation to climate change

Sector and goal	Vulnerability	Adaptation measures applied in the sector
1. Health and rescue capability Improved rescue capability and the ability of people to protect their health and property has decreased the negative impacts of climate change on health and living environment.	The main vulnerability of the health sector arises from the capability and preparedness of healthcare systems to adapt to the changing climate and extreme weather phenomena (availability of medical care may be interrupted), from the sensitivity and inequality of the population, from the share of more vulnerable people (the elderly, children, chronically ill), and from the existence and functioning of warning systems. In the case of rescue capability, vulnerability depends on processing of large amounts of emergency calls (in the case of floods, forest or landscape fires), on the learnt helplessness of people, and on interruptions in rescue work and in ensuring public order.	1.1. Development of information, monitoring, and support systems and drawing up of action plans to increase the efficiency of the management of the health risks arising from climate change and the management of the health risks
		1.2. Increasing of rescue capability
2. Land use and planning The risk of storms, floods, and erosion has been managed, the heat island effect has been managed, the climate resistance of settlements has been increased by selecting the best land use and planning solutions.	Realisation of climate risks in land use depends on the maintenance of or a failure to maintain drainage systems, as well as the natural depreciation thereof. The main risks related to climate change manifest and are amplified in the cities, which are exposed to extreme weather phenomena, where the activities of people are restricted to certain areas, where there is specific land use, constructed environment, and urban landscape. The vulnerability of Estonian cities to climate change primarily depends on population processes, which include shrinking and aging of the population, declining birth rate, but also increasing spatial polarisation, the population in Harju County becoming denser, suburbanisation, fading away of small towns, moving to peripheral locations, and extensive emigration.	2.1. Increasing awareness of the impacts and risks of climate change on land use, urban organisation and planning, development of planning methods for areas at risk, and adjustment of the legal framework
		2.2. Management of the flood hazard and development of green areas and green areas in cities to manage climate risks
3. Natural environment Variety of certain species, habitats, and landscapes, the favourable condition and completeness of terrestrial and aquatic ecosystems, and provision of socio-economically significant ecosystem services in a sufficient extent and with a sufficient quality have been ensured in the changing climate conditions.	The highest vulnerability in the sector of the natural environment is the susceptibility of the favourable condition and completeness of all ecosystems (terrestrial ecosystems, freshwater ecosystems, marine environment) and the volume and quality of ecosystem services to changes in the hydrologic (incl. ice and snow cover) regime and, from the perspective of biodiversity, the species, which have adapted to special environmental conditions, are most vulnerable.	3.1. Preservation of biodiversity in changing weather conditions
		3.2. Prevention of the entry of invasive foreign species into nature, and the eradication and control of such species in the changing climate
		3.3. Ensuring the favourable condition of biotas and the variety of landscapes, and organising nature conservation in the changing climate
		3.4. Ensuring the stability, favourable condition, functions, resources, and variety of terrestrial ecosystems and habitats in the changing climate

		3.5. Monitoring the condition of surface water, structure of the composition of biota, the external and internal loads of substances arising from changes in temperature and the hydrologic regime and minimising climate risks
		3.6. Minimising the negative impacts of climate change to achieve a good condition of the marine environment and preservation of biological diversity
		3.7. Ensuring the sufficient extent and sufficient quality of the ecosystem services, which are important from the socio-economic perspective, taking into consideration climate-related risks
4. Bioeconomy Sustainability of the bioeconomic sectors, which are important to Estonia, is ensured through planning the agriculture, forestry, water management, fisheries and the leisure industry as well as peat extraction by taking into consideration the climate.	Planning the agriculture, forestry, water management, fisheries, and the leisure industry without considering the climate (failure to take into consideration changes in the hydrologic regime and increase in the average temperature) endangers the sustainability of the bioeconomic sectors, which are important to Estonia.	4.1. Ensuring food supplies in the changing climate through the development of land improvement systems, increasing the competitiveness of agriculture, and through the creation and transfer of knowledge
		4.2. Ensuring the productivity and viability of forests, and the diverse and efficient use of forests in the changing climate
		4.3. Ensuring the sustainability of the fisheries resources and the welfare of the people who earn their living from the fisheries sector in the changing climate
		4.4. Diversification of tourism and increasing the satisfaction of visitors
5. Economy Participants in the economy are using the opportunities, which accompany climate change, in the best possible manner and manage the risks related thereto.	The relatively slow pace of climate change and the response speed of Estonian companies to external changes and their adaption capability ensure low vulnerability of the economy even if the adaption consists of the cessation of activities in regions significantly impacted by climate change or of the considerable changing of such activities. The vulnerability increases when the economy as a whole is unable to take advantage of the new opportunities presenting themselves as a result of climate change.	5.1. Management of household risks accompanying climate change
		5.2. Supporting the entrepreneurship, which takes the impacts of climate change into consideration
6. Society, awareness, and cooperation People understand the hazards and opportunities accompanying climate change.	The vulnerability of the society and the ability of the society to adapt to climate change are significantly impacted by the level of understanding of the accompanying hazards and opportunities and the level of research and education in the country. People who are less informed, disadvantaged, in a poor socio-economic condition and have a lower social capital are most vulnerable to climate change.	6.1. Increasing the efficiency of risk management and ensuring the ability of the employees of state and local government authorities to manage the risks accompanying climate change
		6.2. Supporting the adaptation to climate change of preschool education institutions, general educational institutions and hobby schools, environmental education centres and vocational educational institutions to the impacts of climate change
		6.3. Ensuring the availability of up-to-date and thorough information about the impacts of climate change, incl. the transferred impacts of global climate change on Estonia
		6.4. Participation in international cooperation for management of the impacts of climate change and adaptation to the impacts as well as in the development of a strong international climate policy

7. Infrastructure and buildings The impacts of climate change will not result in decreased availability of vital services or decreased energy-efficiency of buildings.	Increasing frequency of extreme weather phenomena will put to the test the entire transport system, with the concurrence of several circumstances potentially resulting in unpredictable risks or hazardous situations. In comparing various types of transport, the most vulnerable are the entire transport on the roads and streets as well as the safety of people related to the infrastructure arising from changes due to interruptions in traffic, slipping hazard, reduced load-bearing capability of unpaved side roads, and safety of cycle and pedestrian tracks. The direction of the development of the vulnerability of transport technologies and fuels in the second half of the century is unknown. The vulnerability of buildings is higher due to the aging building stock compared to the average of the EU, which is of low quality and highly energy-consuming.	7.1. Ensuring safe traffic, delivery of goods, and access to vital services in changing weather conditions 7.2. Ensuring the durability and energy-efficiency of buildings and a comfortable indoor climate for people in changing weather conditions
8. Energy and security of supply Climate change will not result in decreased energy independence, energy security, security of supply or usability of renewable energy resources or in the increase of the volume of the final consumption of primary energy.	The energy independence and security of supply, which are largely built on the oil shale industry and above all depend on the existence and availability of domestic energy resources and the sufficiency of the production capacities required for generation of energy (electricity, heating, and fuels), are generally not very vulnerable to the climatic changes forecasted for the end of the century. The use of renewable energy sources, such as timber, biomass, or peat, is more vulnerable than the oil shale energy industry due to the seasonality of collection and the need for interim storage.	8.1. Ensuring the availability of renewable energy resources and energy and heating supply to the consumers in changing climate conditions

Even though all societies throughout human history have had to continuously adjust to the changing climate, active implementation of adaptation measures may also come into conflict with restrictions arising from social processes and legal restrictions. For example, information about the impacts may be too discouraging for people, there may be too much (overburdening) or too little (unawareness) information. In general, there are much more relevant problems in people's lives than climate change, for the improvement of which they need to reshape their lives. The focal task is to translate the issue of climate change, which has remained very abstract so far, into tangible solutions for people. According to 2017 Eurobarometer survey, Estonians awareness of climate change, of adaptation to the impacts of climate change, and of the measures for the management of climate-related risks is relatively low, as officials and Estonian researchers have also not yet contributed enough to providing such information to the public. In addition, climate-related issues are not of very high priority in people's daily lives. The measures included in the development plan for adaptation are focused on increasing awareness and resilience and on the following leading principles based on the implementation of the principle of caution:

- Awareness – increasing the awareness of the public (the society as a whole, people, officials) and decreasing the gaps in knowledge related to climate change and the uncertainties arising therefrom (measures related to knowledge).
- Preparedness and resilience – ensuring the capability to manage climate-related risks and

increasing the strategic and operative preparedness.

- Caution – acknowledging long-term changes and preventive operation in the long-term perspective.

Measures of the health and rescue capability sector

The measures of the health sector mainly stress the increasing of the awareness of the population of the health impacts of climate-related risks and improvement of the monitoring capability of the healthcare system. Increasing risks call for further studies to specify the nature of the risks in detail.

The prerequisite for increasing the rescue capability is increasing the efficiency of risk management. The efficiency of risk management can be increased in emergency situations related to climate change in order to ensure better possibilities for the prevention and management of emergencies. Communication of the risks also requires development – notifying and warning of the public in time to bring vital information smoothly to the vulnerable population. It is also important to increase the awareness of the population of the hazards and to teach about coping and assisting others in emergency situations. Organising cooperation must be focused on more than before, both between the civil and military institutions and between authorities and the private sector. Acquiring and development of the rescue service equipment required for responding to emergencies related to climate change is also important, as even though the general number of forest and landscape fires is decreasing, the number of fires caused by climate factors is on the rise.

Measures of the land use and planning sector

In the case of land use and planning measures, spatial planning is the instrument, which enables preventing the adaptation-related risks affecting cities and coastal areas. Another important factor is the competence and ability of local governments and county governments in the field of planning, i.e. existence of specialists competent in the area of adaptation to the impacts of climate change. Thus, integration of the knowledge of both the people as well as specialists into plans, strategic assessment of environmental impacts, as well as urban organisation is important.

It is important to organise pilot projects of comprehensive and detailed plans and draw up guidelines for managing the risks related to climate change on the basis thereof, as well as recommendations for climate-proof implementation of design criteria (e.g. buildings and planting of greenery, storm water removal). The projects will determine the circumstances and problems that various levels of the plan must focus on. The experimental projects will also provide an efficient input into legislative drafting and the compilation of a spatial database.

Taking into consideration the demands of adaptation to the impacts of climate change also requires detailed information for expressing the extent of certain problems in the area at risk. Thus, it is important to study the microclimates of larger cities and draw up relevant analyses and maps. Risks related to climate change must be mapped and collected into a single nationwide spatial database.

The measures are focused on the prevention of the potential damage arising from heat waves and heat islands, floods and storms and on the management of risks by applying measures related to land use, the management of risks related to flood and heat waves by creating and maintaining green areas, using the cooling effect of water and various construction technology solutions, such as reconstruction and construction of storm water systems, consideration of the heat-reflecting, heat-absorbing, and heat-retaining qualities of surfaces and air circulation in the designing and construction of buildings. Implementation of the measures is primarily the landowners' duty. The state and local governments must guide the application of the implementation measures within the scope of their legal and administrative competences.

Measures of the natural environment sector

The adaptation measures of the natural environment sector are based on the general nature conservation measures and activities, which also help to adapt to the impacts of climate change. The adaptation measures of the sector are focused on reducing the unfavourable impacts of climate change on the condition of species and biotas and on the integrity and functioning of ecosystems. The diverse biotas, sufficient protected areas, and healthy biological communities, which the measures aim to achieve, will ensure a higher ecological resistance to the factors – both those arising from climate change as well as other human activities – which decrease biological diversity.

In the case of terrestrial ecosystems, the aim of the measures is to preserve the good condition of the ecosystems and the functions and resources in the changing climate. A significant share of the measures consists of scientific research on the impacts of climate change and monitoring of ecosystems, which provide the grounds for making more aware decisions related to adaptation. In order to increase the adaptation capability of ecosystems, it is recommended to apply natural management (e.g. preservation of genotypes and the variety of habitats as well as the balance of the ecosystem matter cycles) and restore the natural state of the areas strongly affected by human activities.

In the case of freshwater ecosystems, both regulative and notifying measures are required as well as one-time studies and complementation of long-term monitoring. To increase the forecasting capability and accuracy, the changes related to climate change in the washing out of nutrients, internal loads, and water and stratification regimes in Estonia must be immediately modelled. These results would allow determining the need for further adaptation measures and switch the measures into the programmes of measures of water management plans or to implement them in the form of independent measure programmes.

To minimise the increase in the environmental impacts caused by climate change in the marine environment, it is first necessary to ensure a good condition of the marine environment. In connection with the changes in the environment arising from climate change and the management thereof, both regulative measures as well as plans and further studies are required to ensure a good condition of the marine environment.

Almost half of the measures related to ecosystem services are oriented to the preservation of the volumes and quality of the water-related ecosystem services (e.g. preservation of the water regime, water purification, fish, seafood, drinking and irrigation water, fishing, water tourism opportunities, etc.). Regulative activities also play an important role and it is advised to increase the awareness of the population and target groups of climate risks and invest in the preservation of the volume and quality of ecosystem services.

The need for the development of a classification of ecosystem services and for finding the volumes, quality and the financial value must be highlighted. A freshwater and marine ecosystem classification based on the conditions prevalent in Estonia has been drawn up, but similar classifications are also required for other ecosystems (forest, wetlands, meadows, soil, cities). There is also a clear need for a study, which would determine the functioning of the ecosystem matter cycles, based on which it would be possible to assess the climate risks of ecosystem services. Eventually, the climate sensitivity indicators of green zones, meadows, and grasslands as well as the soils should also be reflected in county and comprehensive plans.

Measures of the bioeconomy sector

Agricultural measures are above all focused on ensuring the companies' economic coping and competitiveness in order to create the prerequisites for adaptation to climate change. Due to the high level of uncertainty and the need to create the primary data required for decision-making, research measures must be used to designate a significant part of the Estonian scientific potential into basic and applied research analysing the changing conditions. The measures of information exchange help to communicate better knowledge to the target groups, which help to implement new, relevant technologies in practice and preserve a decent quality of life and safe and clean living environment. A contribution by the state in the investment measures would help to develop systems for modelling the agroclimatic and agricultural environment and for issuing warnings of natural damage and emergencies in time to ensure food supply and food safety both in a shorter and longer perspective.

The main measure for preservation of the fisheries resources and thus also fishing opportunities in the changing climate conditions is, above all, changing the ratio of the fishing regime and the methods of use of the fisheries resources (hobby fishing and industrial fishing). The fisheries resources should be managed more accurately and skillfully, taking climate risks into account. Though optimisation of minimum size limits, creation of better spawning conditions, spatial and seasonal restrictions on fishing, and regulating fishing efforts is already a common practice in Estonia, these measures should be brought into compliance with changing climate and resources. One of the prioritised measures is reducing the factors, which damage fish fauna (e.g. anthropogenic eutrophication, pollution). This helps to compensate the negative impacts of climate change on the living environment of fish. In order to prevent remarkable damage, large investments must be immediately made in Lake Peipus and the Baltic Sea (cross-border, if possible) to implement measures, which are of decisive importance for preserving the habitats of fish. A measure, which can be implemented to increase the efficiency of the use of diminishing fisheries resources, is more extensive and efficient adding of value to the fish (incl. the fish of low value and foreign species) and restriction of illegal fishing. If necessary and possible, alternative jobs should be created in a timely manner in the home regions of the population groups who are dependent on fisheries to provide an additional income source in coastal areas (e.g. development of tourism, incl. accommodation, catering establishments, car parks, transportations to the fishing sites on lakes or at sea) and fish farming should be developed. The lack of scientific information, which the adaptation measures could be based on, is of decisive importance here, incl. inaccurate assessment of the fisheries resources. Thus, complex studies of the pressure factors influencing the fish fauna and communities (e.g. climate change and eutrophication) must be conducted in the coming years and hobby fishing should be monitored at the national level, allowing the state to get a better overview of the use of the fisheries resources. In order to make knowledge-based decisions in the management of the fisheries resources, the results of the monitoring of the fisheries resources must be integrated better with other biota and environmental monitoring. The aim of such studies is to implement scientifically proven and thoroughly planned measures for adaptation to the climate in the fisheries sector all over Estonia.

The activities focused on increasing the awareness and ability in the sector have an important place in the tourism sector, incl. the required studies and notification activities. Implementation of the investment and support activities will commence, which will help to increase the estimated number of tourists due to the warmer weather conditions in summer and manage the impacts in the winter period, which is becoming less favourable. The most important of these includes the diversification of what is offered, increasing the satisfaction of the visitors, and reducing the load on the local community.

Measures of the economy sector

Insurance plays a very important role in the adaptation process. Insurance can be used to manage and direct the risks accompanying extreme weather conditions. However, it is very important from the perspective of insurance to collect information on the coverage of the risks and thus an additional study must be conducted in this sector.

The measures of the economy sector are primarily focused on companies to notify them of the risks and opportunities, which accompany climate change, followed by supporting the companies in the necessary restructuring. Thus, the main task is to make the information about climate change readily available, as well as to notify the companies operating in the at-risk areas of the risks accompanying climate change and make them prepare for hazardous situations.

Measures of the society, awareness, and cooperation sector

From the perspective of equal and sustainable development of the society, it is important for the information on the impacts of climate change and the potential impacts of extreme weather phenomena to be equally and easily accessible for all. Based on this information, local governments and local communities can plan their activities and response in hazardous situations, and adaptation measures can support them in such planning (trainings, provision of equipment, etc.). It is essential to assess the awareness and knowledge of the population of the potential impacts of climate change and their ability to serve themselves. This information can be collected systematically via specific studies.

The success of adaptation to the impacts of climate change depends on the accuracy of the information available in Estonia on climate change. For the continuous updating of the information and increasing the accuracy of the forecasts, it is vital to support climate research and participate in international cooperation initiatives related to climate research (e.g. Copernicus, JPI Climate). The aim of notification and educational measures is to support schools and informal education institutions in adaptation to the impacts of climate change and to supply them with the required supporting materials, trainings, etc. for the integration of adaptation to the impacts of climate change in their curricula.

In the area of international relations and cooperation, it is necessary to increase the percentage of adaptation to the impacts of climate change in the Estonian development cooperation.

That will help to increase the ability to adapt of all countries and to manage the international problems accompanying climate change, such as environmental migration, as well as provide the prerequisites for receiving assistance in the case of more extensive manifestation of the negative impacts of climate change in Estonia.

Measures of the infrastructure and building sector

In the sector of technical support systems, it is planned to increase the preparedness of the technical support systems in the case of any weather conditions designed for ensuring the dependability of the transport infrastructure (incl. roads, railways, and bridges) and operability of the infrastructure in extreme weather conditions.

Based on the current statistics, past weather conditions have been taken into consideration in the development of building standards, presuming that this information would also remain applicable in the future. However, changing weather conditions may have a significant impact on buildings and damage buildings. Thus, construction principles should be adjusted so that future climate conditions are primarily taken into consideration in the construction of buildings. Many problems related to the durability and indoor climate of the buildings arise from the poor construction quality and, keeping in mind the future climate, the poor construction quality may cause even more damage. It is equally important to increase the efficiency of heat supply and to minimise the climate risks in the area of supplying the consumers with hot water.

Measures of the energy and security of supply sector

The activities of the measure of energy independence, security of supply, and energy security sector are tightly connected to the national development plan of the energy sector. Those activities increase energy independence, security of energy supply, and energy security today as well as in the case of less favourable weather conditions and more frequent extreme weather phenomena, at the national and regional level.

Funding and monitoring of the development plan for adaptation to the impacts of climate change

The estimated cost of the implementation of the development plan for adaptation to the impacts of climate change in the period of 2017–2030 is 43,745,000 euros. The cost of the implementation plan of the development plan for the period of 2017–2020 amounts to 6,700,000 euros. The majority of the cost of the implementation plan is formed by implementation of the measures and activities of the sub-goals of bioeconomy, society, awareness, cooperation, and the natural environment.

The activities of the implementation plan are financed from the state budget (mainly from the budget of the MoE), from the environmental programme of the Environmental Investments Centre, and from foreign resources (the EU structural and investment funds, support from the European Economic Area). Implementation of the planned activities from the state budget is ensured in the composition of the maximum expenditure of implementing agencies in the financial plan of the state budget strategy. The activities, which other ministries are responsible for, are mainly funded through the implementation plans of the development plans of other sectors.

After the approval of the development plan by the Government of the Republic, the working group of the development plan will be formed, tasked with the coordination of the implementation and updating of the development plan for adaptation to the impacts of climate change.

As of 2018, the MoE will be presenting an overview of the implementation of the development plan and achievement of the goals and efficiency of the measures to the Government of the Republic by 1 March each year, making suggestions for complementation or amendment of the development plan, if necessary.

6.5.2. Adaptation in the vision of the general principles of the climate policy of Estonia

In parallel to drafting of the development plan for adaptation to the impacts of climate change, the draft of the vision General Principles of Estonian Climate Policy until 2050 was also prepared under the leadership of the MoE and in cooperation with stakeholders. The General Principles of Estonian Climate Policy until 2050 specifies the long-term vision of Estonian climate policy and the sectoral and comprehensive policy directions, which set a clear path to the management of climate change, i.e. reduction of the emissions of GHGs and adaptation to the impacts of climate change until 2050. The majority of the climate change adaptation related input and analyses to the draft of the GPCP 2050 came from the same experts involved in the draft of Climate Change Adaptation Development Plan. Accordingly, the approaches to the goals of adaptation to climate change in the two documents are also largely similar. The approaches follow one of the principles of the general principles of climate policy of Estonia as a developed country contributing to cross-border management of climate change and adaptation to the impacts within the framework of development cooperation by involving the best know-how available in Estonia, if possible. Current and future flexibility mechanisms are applied to increase the cost-efficiency of the achievement of climate-related goals.

To ensure regular reporting, the Government of the Republic has been placed under the obligation to submit to the Parliament at least once every four years overviews of the implementation of the general principles of the climate policy as of 2019. This includes updating the analyses of the assessment of GHG emissions and socio-economic impacts accompanying implementation of the general principles of the climate policy. To ensure that the development document will be updated and relevant, the document is also reviewed and, if necessary, updated once every four years as of 2019. This is important to enable the inclusion of significant changes in, for example, the development of technology or in the ambitions of the EU and international climate policies in the content of the long-term development document applicable until 2050.

6.5.3. Adaptation at the local level

The role of the national level (incl. regional agencies of ministries – the Rescue Board, the Health Board, the Environmental Board) is to shape the common understanding with respect to the important adaptation goals (strategies and policies), to support (training, technical and financial support) and monitor implementation of the policies (general and detail spatial plans, inspection of the existence of evacuation and local crises management plans).

The role of local governments is to shape, plan, and undertake specific adaptation activities, as this level is best-acquainted with the local conditions. The level of local governments is responsible for the application of measures, which would facilitate the local initiatives of different institutions and stakeholders. The community as well as the volunteer groups, which will later be implementing the measures, should be involved in shaping these measures.

The continuous work of local governments in planning for climate change and preparing for extreme weather conditions are supported by the development of environmental and weather monitoring systems. A public water information system was created within the framework of the National Environmental Action Plan of Estonia for 2007–2013, which enables keeping the population updated about the condition of waterbodies. This information system is supported by bathing and drinking water-related response plans for entrepreneurs and local governments. The National Environmental Action Plan also supported the development of the judicial area, models, analyses, and warning systems for the prevention of emergencies related to the natural environment. Continuing cooperation between officials also strengthens better preparedness in an actual emergency situation. In the course of the implementation of the Environmental Action Plan, methods for the involvement of volunteers in emergency situations and a respective training system at schools were also modelled and trainings were organised. The cooperation between local governments and citizens was supported even further by the Development Plan of the Area of Government of the MoI for 2013–2016. The measures of the plan supported taking into consideration risk analyses for emergencies in the planning activities of local governments, updating the emergency response handbooks, and practising the cooperation between local governments and the Rescue Board in the form of joint work of crisis committees, organisation of trainings, exercises, and rescue work (natural process of social and administrative learning). The same plan also supported the development of cooperation within local governments, which is a supporting factor in emergency situations.

The regional level has been involved in drawing up situation-based risk analyses in very different manners in Estonia. Based on the guidelines for the preparation of risk analyses, a competent authority is required to submit the regional part of the risk analysis of an emergency situation to the regional crisis committee to express their opinion. So far, local governments have not been involved much in drawing up the risk analyses of emergency situations. Some local governments have drawn up risk analyses on their own initiative, such as the cities of Pärnu and Tallinn.

Some other local governments have also taken the hazards arising from climate change into consideration in their development plans as well as in the renovation of water and sewerage or other lines, and in drawing up of detailed plans and comprehensive plans. Water undertakings are regularly monitoring the conditions of water pipelines in order to ensure the quick outflow of storm water from the city in the case of heavy rain.

Four regional crises committees have been formed pursuant to the Emergency Act (Northern, Western, Southern, and Eastern Estonian) as well as permanent crises committees of local governments. A local government with fewer than 40,000 inhabitants may form a joint crisis committee with one or several other local governments.

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VII

Financial resources and transfer of technology, including information under articles 10 and 11 of the Kyoto protocol

KEY DEVELOPMENTS

- **At COP21 United Nations Climate Change Conference in Paris, Estonia pledged to contribute 1 million euros annually until the year 2020 for financing international climate cooperation by supporting environmentally sustainable development in developing countries through contributing to bilateral projects, multilateral organisations and regional funds.**
- **During the period of 2015–2020, Estonia has decided to channel 5 million euros from the revenues of the auctioning of EU Emissions Trading System allowances to international climate cooperation and 100% of the revenues from EU Emissions Trading System Aviation auctions to funding innovative climate projects and start-ups.**
- **To date, funding from the private sector has been mobilised into domestic climate-related activities rather than climate cooperation. In the future, Estonia is planning to involve the private sector in financing climate cooperation in developing countries.**
- **Estonia has been and will be supporting developing countries in the fight against climate change via bi- or multilateral channels under bi- or multilateral agreements.**

7.1. General overview of climate finance policy and transfer of technology

Estonia is not one of the Parties listed in Annex II to the Climate Convention; consequently, Estonia is not obliged to fulfil the commitments under Articles 4.3, 4.4 and 4.5 of the Convention. Despite this, Estonia has contributed to climate finance voluntarily.

The Government of Estonia is committed to fighting against global climate change, focusing especially on the situation in countries which are most affected by climate change, such as the least developed countries and the Small Island Developing States.

Estonia recognises that the need for financing to reach the climate policy objectives is one of many important elements that need to be tackled continuously. Both public and private funding should support investments into programmes and policies aimed at reducing emissions and increasing resilience to climate change.

As stipulated by the Government of the Republic Act, the Ministry of Foreign Affairs coordinates Estonia's development cooperation. In relation to cooperation focusing on climate policy objectives, this is done in cooperation with other relevant institutions, incl. the Ministry of the Environment (MoE) and others. Estonia intends to continue to contribute to development cooperation according to its capabilities. The general goal of Estonia's development cooperation is to contribute to the eradication of world poverty and to attain the Sustainable Development Goals. Environmental protection is also one of the three main measures of sustainable development. The topic is most directly included in the Sustainable Development Goal 13 *Take urgent action to combat climate change and its impacts* that suggests strengthening resilience and adaptive capacity to climate-related hazards and natural disasters in all countries, integrating climate change measures into national strategies, improving awareness on climate change mitigation and adaptation, increasing relevant institutional capacity and support, and above all, taking action in the least developed countries by increasing climate change capacity.

To achieve sustainable development goals, the sustainable use of the environment and natural resources is indispensable. Considering this, one of the goals of Estonian development cooperation is to contribute to finding environmentally sustainable solutions in partner countries as well as at the global level. Estonia's development policy supports low carbon and sustainable development. The framework of both the European Union 2020 Strategy and the *National Reform Programme Estonia 2020*, one of the core objectives of which is green growth, is valuable to promoting the awareness of different sectors about the potential multiple benefits of climate objectives related financing. However, the possibility to plan climate-related contributions is also related to the tight financial situation at international, national and other levels, as other policy areas are of increasing importance, too. Consequently, continuous efforts should be made to find more synergy with investments made in sectors with a high impact on climate change, such as energy, transport and housing.

At COP21 United Nations Climate Change Conference in Paris, a number of climate funding announcements were made by developed countries, including Estonia. Estonia pledged to contribute 1 million euros annually until the year 2020 for financing international climate cooperation by supporting environmentally sustainable development in developing countries through contributing to bilateral projects, multilateral organisations and regional funds. The main focus is planned to be on climate change mitigation and adaptation, for example by supporting renewable energy, energy efficiency, sustainable transport and industry efficiency projects, as well as by strengthening administrative capacity regarding climate action or supporting solutions for adapting to climate change.

Living up to our commitment made in Paris during COP21, Estonia is and will keep contributing to climate-oriented cooperation with developing countries.

Estonia follows the principles set out in Article 10 (3) of the Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2013 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, that at least 50% of the auction revenues should be used for climate objectives. The climate-related measures designed to achieve these objectives form a part of the State Budget Strategy, based on national objectives and the objectives of sectoral development plans.

One of the measures in the State Budget Strategy 2017–2020 to be funded by the revenues from greenhouse gas emissions allowance trading system in 2013–2020 is Estonia's contribution to international climate change cooperation.

During the period of 2015–2020, Estonia has decided to channel 5 million euros from the revenues of the auctioning of EU ETS (Emissions Trading System) allowances to international climate cooperation and 100% of the revenues from EU ETS Aviation auctions to funding innovative climate projects and start-ups.

To date, funding from the private sector has been mobilised into domestic climate-related activities rather than climate cooperation. In the future, Estonia is planning to involve the private sector in financing climate cooperation in developing countries. For this, we have conducted a feasibility study to identify Estonia's cleantech and green growth sectors with the biggest export potential. In these sectors, the interest to participate in cooperation efforts would be consequently higher. On the basis of the results of the study, we plan to have annual calls for projects where the main focus is on Estonian greentech companies and non-governmental organisations which could export their products and know-how to developing countries.

7.2. Assistance to developing country Parties that are particularly vulnerable to climate change

Estonia fully shares the concerns and understands the problems of the Small Island Developing States. We also know from our own experience that information and communications technology (ICT) can be an affordable solution for many development problems. To that end, the Government of Estonia decided to contribute 100,000 euros to the project *Implementing the Climate Change Adaptation Component of the Satellite Communications Capacity, and Emergency Communications Solutions Project for the Small Island Developing States of the Pacific* carried out in cooperation with the International Telecommunication Union (ITU). This project was initiated as one of the 300 new partnerships at the SIDS Conference in September 2014 in Apia, Samoa, attended also by Estonia. The abovementioned project targets 11 Pacific islands and is being implemented from 2014 to 2017. The aim of the project is to improve connectivity in the remote areas of the signatory countries by providing broadband access to vulnerable areas, enabling that the regional vision of ICTs for all can become an achievable target. On 23 March 2015, ITU informed that Estonia's funding would be used for purchasing solar panels to charge VSAT satellites that help distant small islands frequently suffering from power failures. The first solar panels were installed on the island of Vanuatu to recover electricity after the destruction of category 5 cyclone Pam. On 22 May 2017, ITU reported the procurement of 5 solar systems which are going to be installed in Kiribati (2 systems), Tonga (1 system), and Tuvalu (2 systems). In addition, three VSAT systems were provided to Tonga. Trainings related to VSAT installation were completed. The next steps include the deployment of equipment to target sites, providing trainings on climate change adaptation and emergency communication, and providing internet access and services related to disaster management to the local communities.

In addition, the MoE of Estonia made a contribution of 1,605,008 euros to the United Nations Environment Programme (UNEP) for *Strengthening Climate Change Adaptation in Rural Communities, for Agriculture and Environmental Management in Afghanistan* within the UNEP project *Environmental Cooperation for Peacebuilding-Phase III* in 2012–2015. The project entailed building national capacity in planning community resilience to threats related to climate change in Afghanistan. The focus was on sustainable water, pasture and environmental management in pilot sites and strengthening communities in Kabul province, the North and Central Highlands of Afghanistan. Core activities involved working with national government planners, advisors and decision-makers to strengthen planning and action for community resilience in vulnerable areas of the country where high potential existed for productive, financially sustainable and ecologically sound agricultural development. The project was extended at the end of 2014 with additional funding of 323,000 euros from Estonia and the activities were finished by the end of 2016.

7.3. Provision of financial resources

Estonia has been and will be supporting developing countries in the fight against climate change via bi- or multilateral channels under bi- or multilateral agreements. Please see Table 7.1. Provision of public financial support: summary information 2013–2016.

Table 7.1. Provision of public financial support: summary information 2013–2016, euros

Allocation channels	2013					2014					2015					2016				
	European euro – EUR					European euro – EUR					European euro – EUR					European euro – EUR				
	Core/ general	Climate-specific				Core/ general	Climate-specific				Core/ general	Climate-specific				Core/ general	Climate-specific			
		Mitigation	Adap-tation	Cross-cutting	Oth-er		Mitigation	Ad-apta-tion	Cross-cutting	Oth-er		Mitigation	Adapta-tion	Cross-cutting	Oth-er		Mitiga-tion	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:	105,798.69					108,883.73														
Multilateral climate change funds														800,000.00					200,000.00	
Other multilateral climate change funds																				
Multilateral financial institutions, including regional development banks																45,000.00				
Specialised United Nations bodies	105,798.69			10,385.00		108,883.73			11,799.00		32,771.88			11,799.00		229,589.26			12,099.00	
Total contributions through bilateral, regional and other channels		108,166.00		114,755.00			74,134.00		535,204.00			70,000.00	80,581.00	243,145.00			70,000.00	102,000.00		
Total climate-specific finance		233,306.00					621,137.00					1,205,525.00					384,099.00			

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VIII

Research and systematic observation

KEY DEVELOPMENTS

- **Reduction in the percentage of research and development expenses from the gross domestic product.**
- **The acknowledgement of the professionalism of Estonian researchers internationally.**
- **Increase in the percentage of foreign projects and funding in the funding of Estonian research.**
- **Increased level of systematic monitoring.**

8.1. General policy on research and systematic observation

Research and development (R&D) include activities which may be related to entrepreneurial or the governmental innovation. R&D is the first stage in the development of a new product or service. R&D includes fundamental and applied research as well as experimental and development activities which may partially coincide. R&D also includes innovative activities related to the production and marketing of the results.

The organisational structure of Estonian R&D activities is represented in Figure 8.1. Decisions related to Estonia's R&D policies are made by the Riigikogu on the basis of regulations and legal acts drafted by the Government of the Republic. The basis for the organisation of R&D is established with the Organisation of Research and Development Act. The Government of the Republic is advised in its activities by the Research and Development Council. The Ministry of Education and Research (MoER) is responsible for the planning, coordination, execution and monitoring of education and research policies; it also organises the evaluation of R&D institutions. In addition to R&D institutions and ministries, the MoER also cooperates with the Estonian Academy of Sciences and the foundations Estonian Research Council and Archimedes in the field of R&D. The Minister of Education and Research is advised by the Research Policy Committee on matters of strategic development plans for Estonia's R&D and the development of Estonia's research policy.

In 2014–2020, Estonia will base its R&D on the Research and Development and Innovation Strategy Knowledge-Based Estonia, approved by the Riigikogu on 22 January 2014. While the previous strategies mainly focused on the development of the capacity of R&D and innovation, this strategy sets an objective of applying the created potential for the benefit of Estonia's development and economic growth. Priorities are established based on a new smart specialisation methodology. The implementation plan of the strategy was approved with an order of the Government of the Republic and sets forth the activities for executing the strategy, the responsibilities of the institutions and the financial resources for the years 2014–2017. More attention is paid on ensuring the progeny of researchers and internationalisation. More emphasis is placed on expanding the scope of field-specific research activities commissioned by the ministries.

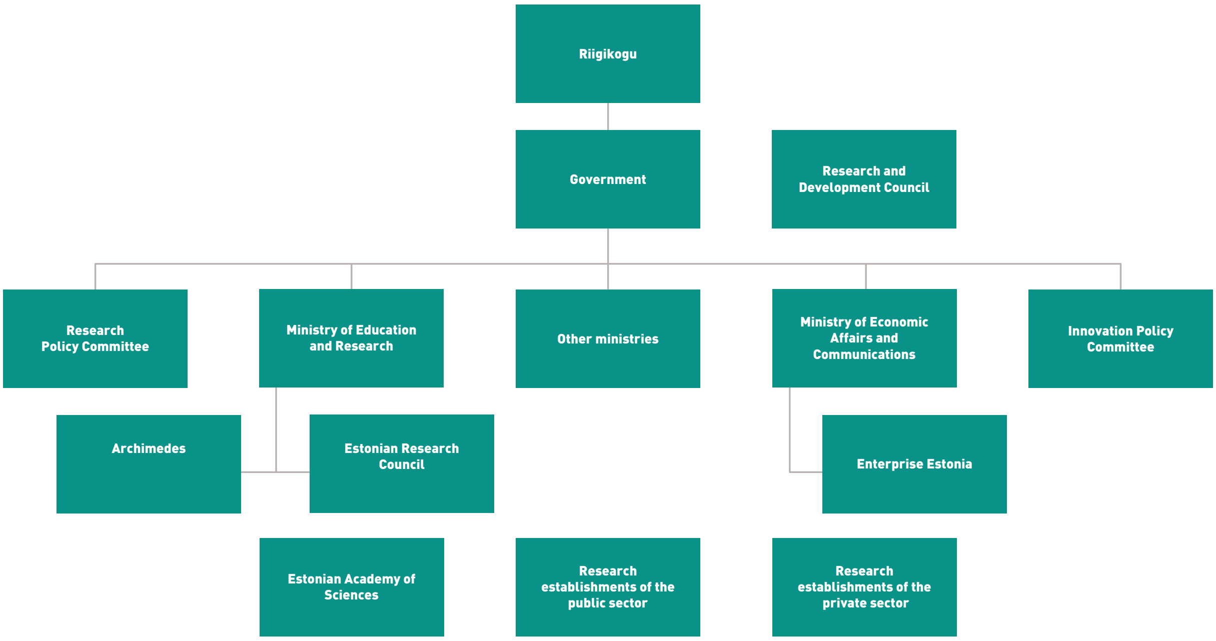

Figure 8.1. The organisational structure of Estonian R&D (Estonian Research Council, 2016)

R&D is financed within the system of the MoER of the Republic of Estonia from the following resources:

- baseline funding;
- research funding;
- national research programmes;
- support for centres of excellence and doctoral studies;
- compensation of the expenses of R&D institutions.

The competitiveness strategy Estonia 2020 sets a goal of increasing the funding of R&D activities to 3% of gross domestic product (GDP) by 2020. Furthermore, such growth should mainly be supported by the private sector's increased financing of development activities. It has been highlighted that Estonia's activities for improving innovation have so far produced more modest results than expected. In order to increase the impact of R&D, it is planned to focus more on better interconnectivity between the fields of R&D, more exact prioritising, placing more value on human resources and their development, linking research with entrepreneurship and developing a support infrastructure based on clear principles.

In comparison with the information in Estonia's Sixth National Communication Under the United Nations Framework Convention on Climate Change (UNFCCC), expenses on R&D have decreased since 2012 (see Figure 8.2). The downward trend in the R&D expenses of 2014 and 2015 was somewhat expected, as the large investments made in relation to initiating the pilot project of the oil industry in 2010–2012 caused a sudden increase in Estonia's total R&D expenses. The share of investments started to fall in 2013 as the plant started operating and the after-effect can clearly be seen in the following years as well.

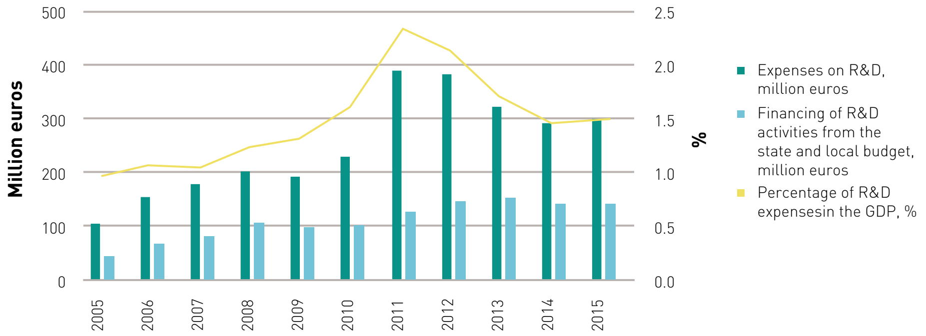

Figure 8.2. Research and Development Expenses, million euros (Statistics Estonia, 2017)

There are several factors for the success of Estonian researchers in the framework programmes, mainly their strong level of expertise and high reliability in the eyes of foreign partners, readiness to write competitive projects, desire to cooperate with foreign partners and a well-functioning support system for framework programmes. Although increasing foreign research funding is one of the objectives of Estonian research policy, it is not possible to achieve a significant growth, as our researchers are already extensively included in international cooperation.

Research is also carried out to perform different parts of the national environmental monitoring programme. The national environmental monitoring programme which is the responsibility of the **Estonian Environment Agency** (ESTEA) consists of 12 sub-programmes:

- Biodiversity and landscape monitoring;
- Radiation monitoring;
- Integrated monitoring;
- Meteorological and hydrological monitoring;
- Forest monitoring;
- Soil monitoring;
- Groundwater monitoring;
- Marine monitoring;
- Seismic monitoring;
- Inland water bodies monitoring;
- Support programme;
- Ambient air monitoring.

8.1.1. Research and Development programmes and funding of research and systematic observations

The main instruments of the Estonian R&D funding system are institutional research funding and personal research funding. **Institutional research funding** is used to finance high-level research and development (R&D) and related activities (research topics) of research and development institutions. **Personal research funding** is a contribution to the costs of innovative or high-risk research projects carried out by researchers or small research groups.

Young researchers can participate in Mobilitas Pluss and Dora Pluss Programme. **Mobilitas Pluss programme** finances among others, returning of researchers to Estonia after completing post-doctoral or comparable research abroad. **Dora Pluss programme** finances Estonian Master's and PhD students' studies and research abroad or foreign students master and doctoral studies and research in Estonia.

Interreg Baltic Sea Region is a joint research programme of the Baltic Sea Region. The objective of its project *the Baltic Science Network (BSN)* is to provide ministries handling the research issues of the Baltic Sea region with a coordinating framework for developing research policies. This should enable introducing macro-regional interests to the wider public. In addition to strengthening macro-regional ties, the BSN project also helps to develop international strategies and action plans with the goal of facilitating the development of higher education, R&D and innovation as well as increasing top-level research in all countries and the Baltic Sea region in general. The project partners are Estonia, Latvia, Lithuania, Poland, Germany, Denmark, Sweden, Finland and several international organisations and associations of universities. The project period is from 1 March 2016 until 29 February 2019.

RITA is a programme supported by the European Regional Development Fund with the goal of increasing the state's role in strategic steering of research and the capability of R&D institutions in executing societally significant research. Through the programme, the Estonian Research Council finances applied research projects with socio-economic objectives that fulfil the needs of the state. The RITA programme is used to finance strategic R&D activities that help to execute interdisciplinary applied research with socio-economic objectives of state-level significance. One of the programme's objectives is the development of more efficient, environmentally friendly and sustainable usage options of the Earth's resources.

The general objective of the **Norwegian-Estonian Research Cooperation Programme** is to facilitate the development of research knowledge in Estonia through research cooperation between Norway and Estonia. The purpose of the programme is to ensure high-level and high-quality research. The programme strengthens bilateral relationships to enhance long-term cooperation, capabilities and the development of competence. One of the main goals of the programme is to increase human resources in scientific research by facilitating international relations and including the students of Masters and Doctoral programmes in projects. The environmental area is one of the research areas of the programme.

The aim of the programme ***Environmental Monitoring and the Development of Data Acquisition*** was to develop the tools necessary for the administration, publication and use of monitoring data, according to user needs. In the framework of the programme, existing monitoring data was reviewed and organised, the needs of the data users studied, solutions developed for data collection as well as possibilities for the better use of the data. The practical aim was to minimise manual work related to the collection and release of environmental monitoring data. Automatisation of data acquisition enables to better focus on the analysis of data and evaluation of trends, the operative monitoring of the status of the environment, as well as the development of environmental information services for the customers. The programme was approved on 13 October 2011 and was in force until the end of 2015. The cost of the programme was 1.53 million euros.

The foundation **Environmental Investment Centre** (EIC) is a financial institution, mediating state budget funds (revenues from environmental charges), EU funds, funds from foreign aid programmes and the Green Investment Scheme, as well as granting loans for the implementation of environmental projects.

EIC's main activity is the mediation of the following financial resources for financing environmental projects:

- revenues from Estonian environmental charges (the environmental programme);
- support from the EU's Cohesion Fund, the European Regional Development Fund and the European Social Fund;
- support for the EU emissions trading system (EU ETS);
- granting loans from the resources of received environmental charges or credit lines.

In 2013–2016, Estonia received about 427 million euros for the support of 39,523 different projects. Climate research and analysis is executed within the framework of the ambient air sub-programme. In 2012–2016, 77 national and 12 international projects for the protection of ambient air were financed in the amount of more than seven million euros.

8.1.2. Systematic monitoring

The weather service of the **ESTEA** fulfils the obligations of Estonian national meteorological service in accordance with its standard and the recommended practices of the World Meteorological Organisation (WMO). The ESTEA's weather service participates in WMO's climate programme, incl. the Global Climate Observing System (GCOS).

The **Tartu-Tõravere station** is included in the Baseline Surface Radiation Network (BSRN) from 1999. Through the BSRN network, the data from the station is used by the World Climate Research Programme (WCRP), the Global Energy and Water Exchange Project (GEWEX), the GCOS and the Global Atmospheric Watch (GAW).

The **Copernicus programme** is an extensive environmental and safety monitoring programme initiated by the EU in cooperation with the European Space Agency and other partners. Within the framework of the programme, six Sentinel-series mission satellites are put to work and corresponding databases are created. Although data from the Sentinel missions are free of charge and accessible, it has so far been difficult to ensure a stable and seamless treatment of all data necessary for the creation of operative services. For this reason, Estonia plans to create the ESTHub data centre in the area of administration of the Land Board. First steps have already been taken – on 13 September 2016, the European Space Agency and Enterprise Estonia (the official contact point in Estonia) signed a data exchange agreement which granted the Land Board access to the Space Agency's data servers.

Estonia is a member of the international **Group on Earth Observations** (GEO). The objective of the GEO is to create a Global Earth Observation System of System (GEOSS) for ensuring the sustainable development of humankind to improve the health and safety of humankind and to protect the global environment. It is therefore necessary to systematically understand the changing nature of the Earth's climate, oceans, land and ecosystems as well as to know how to evaluate the effect of anthropogenic as well as natural factors on humankind. The collection and analysis of such data is however only possible through international cooperation, as data needs to be collected for the whole Earth, it must comply with specific quality requirements and must be comparable. Estonia's participation in GEO's activities is coordinated by the MoER and the Ministry of the Environment (MoE).

8.2. Research

Research related to climate and climate change has been carried out by the ESTEA, the Tartu Observatory, the Department of Geography of the Institute of Ecology and Earth Sciences of the University of Tartu, the Laboratory of Atmospheric Physics of the Institute of Physics of the University of Tartu, the Estonian Marine Institute of the University of Tartu, the Centre for Applied Social Sciences of the University of Tartu, the Estonian University of Life Sciences, the Institute of Ecology of the Tallinn University, the Department of Marine Systems of the Tallinn University of Technology, the Centre for Nonlinear Studies of the Institute of Cybernetics of the Tallinn University of Technology, the Geological Survey of Estonia, the Baltic Environmental Forum, the Tallinn Centre of the Stockholm Environment Institute and the Estonian Environmental Research Centre (EERC).

Information about Estonian researchers and their articles (incl. the opportunity to order the articles) is available at the online catalogue ESTER of Estonian libraries (*http://www.nlib.ee/*), the Estonian Research Information System (*https://www.etis.ee/*) and through the international ResearchGate (*https://www.researchgate.net*).

8.2.1. Climate process and climate system studies, including paleoclimate studies

The Institute of Ecology of the Tallinn University is a R&D institution with the objective of researching the impact of changes in climate conditions and the hydrodynamics of coastal waters on the development of different types of beaches; preparing forecasts for beach development models and for changes of coastal zones; analysing the condition and development of wetland ecosystems and the factors affecting them; above all researching the impact of disturbances on the structure, functioning and nutrient cycles of wetland ecosystems; developing research methods for and the scientific principles of the ecological restoration of wetlands; evaluating the temporal-spatial impact of natural and anthropogenic processes on the condition of ecosystems; developing paleoecological research methods; and modelling ecosystem development scenarios.

In 2014, the institute started the project ***Environmental Changes and Their Effects on the Coastal Landscape of Estonia: Past, Present and Future – ENCHANTED*** which will end in 2019. The main goal of the project is to identify temporal changes in the frequency of storms by using ecological, sedimentological and geomorphological data, and to evaluate the impact of such changes on the evolution, vegetation and land use of beaches in Estonia during the past millennia.

In 2015, the Institute of Ecology and Earth Sciences of the University of Tartu started the project ***Baltic paleosol: implications to atmosphere composition and quantitative paleoclimatology during Earth final oxygenation at Proterozoic-Phanerozoic transition***.

The aim of the project was to identify the environmental conditions and the composition of the atmosphere during the significant period at the end of the Neoproterozoic Era when the composition of oxygen in the Earth's atmosphere suddenly increased to its contemporary levels. The research programme was based on the pedogenic phases of the uniquely preserved Baltic paleosol: isotope research of clay minerals, oxyhydrates, carbonates and phosphate-sulphate minerals that enabled the quantitative evaluation of paleotemperatures, paleoprecipitation and the pCO_2 (partial pressure of CO_2) percentage in the atmosphere.

A SMEAR (Station for Measuring Ecosystem-Atmosphere Relations) station was built in the cooperation of the Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences, the Institute of Physics of the University of Tartu and the Tartu Observatory. The purpose of the station is to measure the concentrations and fluxes of the atmosphere-biosphere system.

8.2.2. Modelling and prediction, including general circulation models

In 2014, the ESTEA published the results of the analysis ***Estonia's future climate scenarios 2100***. The ESTEA's future climate modelling project presented the changes in air temperature, precipitation and some other meteorological indicators during the periods of 2041–2070 and 2071–2100 by using climate models to compare the climate of normals of 1971–2000 with respective modelled indicators. In this analysis, the 30-year average changes of future periods were calculated for months and seasons.

In 2016–2019, the ESTEA will be carrying out the project ***The Development of Meteorological and Hydrological Monitoring for Evaluating or Forecasting Climate Change*** (SEME) with the aim of increasing the capability of responding to emergencies caused by climate change and extensive pollution as well as increasing the proportion of the renewed monitoring network.

In 2015, the Institute of Agricultural and Environmental Sciences of the University of Life Sciences started the project ***Modelling of the metabolism and food web structure of Estonian lakes***. The aim of the project is to model the possible impact of climate change on the metabolic state of Estonian lakes and the carbon fluxes of lakes. The representative sample includes 11 lakes which make up 95% of the Estonian inland water volume.

8.2.3. Research on the impacts of climate change

The **EcolChange Centre of Excellence** is a synergistic network of expertise for developing global and local scenarios for terrestrial ecosystems in the context of global change, from molecular to biome-level responses.

The main research areas are:

- integrated studies of ecosystem functions, biodiversity and adaptability;
- integration of macroecological big data with genetic research and experimental approaches;
- incorporation of ecological knowledge into principles of adaptation to global change through sustainable ecosystem management;

- enhancement of ecologically sustainable economic growth via smart regional planning in forestry and agriculture: functionally diverse forests, cultivars for future climates, novel cereals and sustainable nutrient cycles.

The **BioClim** (climate change impact analysis, adaptation strategy and implementation plan for the natural environment and bioeconomy in Estonia) project combined input data in eleven areas of the natural environment and bioeconomy for the preparation of a climate change adaption strategy and implementation plan. From January to August 2015, the impact of climate change on biodiversity as well as on the terrestrial, freshwater and marine ecosystems (incl. the services of these ecosystems) and on six related bioeconomy sectors (agriculture, forestry, fishery, hunting, tourism and peat extraction) was mapped. The project identified priority themes for Estonia in the abovementioned areas; the impact of climate change and available adaption measures were analysed; suggestions were made for the development of a national adaption strategy and implementation plan. The analysed impacts of climate change and the adaption measures developed accordingly help Estonia fulfil its obligations under several relevant international agreements, and follow EU's and domestic policies.

Within the framework of the **Climate Smart Agriculture on Organic Soils** (CAOS) project, greenhouse gas (GHG) balance surveys are carried out in the Keressaare cut-over peatland in 2014–2017 as part of a restoration project. The project includes universities and institutions from Germany, the Netherlands, Denmark, Estonia, Finland and Sweden.

In 2015, the Tartu Observatory started the project ***Aerosols and greenhouse gases contribution to the climate change in the Baltic Sea region and in the Arctic***. This project researches climate change in the Baltic Sea region and in the Arctic. The purpose of this project is to detect causation between the temporal variability of temperature, the atmosphere's energy budget components, aerosols and GHGs. For the analyses, atmospheric reanalysis models BaltAn65+ and ERA-Interim and aerosols model SILAM are applied. The modelled products will be validated against measurement data (radiosondes, radiation meters, AERONET sunphotometer).

In 2013, the Marine Institute of the University of Tartu started the project ***Coastal ecosystems and rapid change: understanding and projecting effects of multiple stressors on marine biodiversity and functioning*** with the purpose of developing models that can forecast the developments in ecosystems and consider long-term climate change and significant anthropogenic pressures, such as eutrophication.

In 2017, the institute started the project ***Future marine climate and ecological risks in the Baltic Sea*** with the aim of studying extratropical cyclones of future climates, the combined effect of sea level rise and its acceleration, and storm surges in the Baltic Sea during the 21st century and future manifestations of storm-induced oceanic climate-related and ecological risks in the Baltic Sea.

In 2014, the Institute of Physics of the University of Tartu (the Laboratories of Environmental Physics and Atmospheric Physics) started the project ***Airborne nanoparticles and their role in meteorological processes***. By developing the experimental basis and theory of nanoparticle formation and growth, advanced physical and optical models of aerosols and cloud particles will be developed. The models will be applied to composing new radiative transfer blocks for numerical weather and climate models and applied in national (KESTA) and international (MACC) weather and climate programmes. The research is supported by the Estonian Science Infrastructure Roadmap Project *Estonian Environmental Observatory*, which includes the implementation of the SMEAR measure.

In 2016, the Department of Geography of the Institute of Ecology and Earth Sciences of the University of Tartu started a JPI Water project ***Improving Drought and Flood Early Warning, Forecasting and Mitigation using real-time hydroclimatic indicators***. The main objective of the project is to apply the knowledge gained from the project (based on fundamental research) and develop information tools built on server-based technologies that are needed for the management of the flood and drought risk. This will be done in close cooperation with stakeholders and end users to ensure the diligent commissioning of the new products. Spain, Portugal, South-Africa and Romania are taking part in the project.

8.2.4. Socio-economic analysis, including analysis of both the impacts of climate change and response options

The aim of the **ENERPO** (reduction of ambient air pollution through a more precise analysis of energy production and consumption via mobile positioning data) project is to reduce ambient air pollution by determining energy consumption spots at any given moment through mobile positioning of consumers and to notify transmission and distribution networks of the survey results so that they could increase network efficiency and prevent energy losses, thereby reducing the environmental impact of energy production.

The aim of the **SustainBaltic** project is to prepare spatial development plans for coastal areas that would combine the preservation of the natural environment with the need to develop the social and economic environment based on human needs in a harmonious way, and to ensure a smooth and well-planned use of the space between coastal and marine areas. Duration of the project is 30 months, the end date is 28 February 2019.

Within the framework of preparing the Estonian climate change adaptation strategy and implementation plan, the project ***Evaluation of the impact of climate change and the development of adaptation measures within the areas of planning, land use, human health and rescue capacity*** (KATI) was carried out. The aim of the project was to study topics related to the settlement system and humans for the Estonian national climate change adaptation strategy and action plan and to evaluate possible climate change adaptation measures. The project included topic-based analyses for planning and land use, coastal areas and land improvement, and health and rescue capacity, on the basis of which the current situation was mapped, the impacts of climate change were evaluated, the likelihood thereof in the abovementioned areas was analysed and adaptation measures with their estimated efficiency and cost were proposed.

Within the framework of developing the adaptation strategy and implementation plan, the study ***Adaptation to climate change in the areas of economy and the society*** was also carried out. The aim of the study was to make sure that the drafters of the Estonian climate change adaptation strategy and implementation plan are equipped with up-to-date material based on the best possible information in the areas of the economy and society.

In the areas of energy and infrastructure, the Tallinn Centre of the Stockholm Environment Institute and partners carried out the project ***Estonian Climate Adaptation Strategy for Infrastructure and Energy*** (ENFRA). The aim of the project was to ensure that climate change adaptation activities in Estonia are executed in a carefully planned and coordinated fashion.

8.2.5. Research and development on mitigation and adaptation technologies

Researchers of the Centre of Excellence in Environmental Adaptation ENVIRON studied the **adaptation of plants and ecosystems to environmental and biological stressors** with the aim of gaining a better understanding of the responses of the ecosystems in the temperate climate zone to global climate change. The project period was 2011–2015. Ecosystems have a high potency of adapting to environmental changes, but this is generally not considered when forecasting the impact of climate change. The centre of excellence conducted research based on interdisciplinary experiments and models that would allow a quantitative forecast of the response of ecosystems to global climate change based on knowledge of molecular stress mechanisms. The research results serve as a basis for the sustainable management of natural resources and long-term planning of land use in agriculture and forestry in Estonia and the Nordic countries. The publications of the centre of excellence are available here: *http://environ.emu.ee/teadusartiklid/*.

In July 2016, Tallinn University started a joint project of five countries ***Life Peat Restore***, which is supported by the climate sub-programme of EU's LIFE programme. Within the framework of the project, peatlands situated on the North European Plain that have been ruined by human activity are restored with the aim of reducing CO_2 emissions. The project partners include Germany's oldest nature protection organisation NABU, Poland's Ecological Club, Lithuanian Fund for Nature, University of Latvia and Tallinn University. In addition to the EU funds, the activities carried out in Estonia are also financed by the EIC and the Tallinn University. During the project, a restoration plan is prepared and implemented. Comprehensive prior research of water, peat, vegetation, wild birds and carbon fluxes is conducted to ensure that correct decisions are made; follow-up monitoring must last for 20 years as of the end of the restoration works. Measuring carbon fluxes is important, as it proves whether peatlands capture carbon or not. The measuring methods used in different countries are calibrated for gaining more accurate results.

8.2.6. Research in support of the national greenhouse gas inventory

Developments in the Waste sector

In 2016, the MoE concluded an agreement with the EERC for carrying out a waste sector research for compiling the GHG inventory. The project was funded by the EIC. The aim of the project was to improve the timeline of generated and deposited waste and make emission measurement of flared landfill gas.

Developments in the Land use, land-use change and forestry (LULUCF) sector

In 2016, the ESTEA started the project ***Greenhouse gas emissions inventory research for national reporting in the fields of litter and forest soil***, funded by the EIC. The project produced data on litter dynamics of different forest ecosystems that allow making approximate generalisations about the yearly litter volumes in Estonian forests.

In 2016, also a project was launched to estimate the impact of land-use change (Cropland converted to grassland and Grassland converted to cropland) to the organic carbon stocks in mineral soils and to derive country-specific emission factors for these subcategories. The project is conducted by the Estonian University of Life Sciences.

In 2017, the ESTEA started a project with the University of Life Sciences which will develop country specific biomass models for the above- and belowground tree components of Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and birch (*Betula sp.*).

Developments in the Energy sector

In 2017, the Institute of Physics of the University of Tartu (the Laboratory of Atmospheric Physics) started researching the **geographic correlation of wind on AS Elering's power lines** with the purpose of determining the extent of the cooling effect of wind on high-voltage power lines to optimise the capacity of power lines in a situation where new wind turbines are continuously built in Western Estonia.

Developments in the Agriculture sector

In 2014, the MoE concluded the agreement ***Developing a method for calculating greenhouse gas emissions from the production of crops grown for manufacturing biofuels and the calculation of average emissions*** with the Estonian University of Life Sciences. The aim of the project was to find the average value of the GHGs produced while raising different crops: rape, rye, wheat, barley and triticale and to calculate the average GHG emission values per each Estonian county.

8.3. Systematic observation

The national Environmental Monitoring Act entered into force in 1999, establishing the organisation of environmental monitoring, the procedure for processing and keeping the retrieved data and the relationship between the executors of environmental monitoring and the owners or possessors of immovable property. Environmental monitoring has been defined as the continuous surveillance of the status of the environment and the factors affecting thereof with the main purpose of forecasting environmental status and gaining data for preparing programmes, planning and development plans. The prioritisation of the environment in the society has increased the demand for environmental information, and the expectations on the quality and availability thereof.

The area of activity of the **ESTEA** is the execution of the national environmental monitoring programme, the organisation of national and international environmental data exchange, the collection and analysis of data, provision of evaluations of environmental status and provision of weather forecasts, warnings and necessary related monitoring data as a vital service. The

ESTEA also ensures the working order of monitoring networks and the maintenance and renewal of monitoring stations, tools and devices.

In 2014–2020, the ESTEA will carry out the project *Development of the monitoring of meteorological and hydrological indicators for evaluating or forecasting climate change*. Within the framework of the project, hydrometeorological stations are improved and necessary infrastructures are developed. In addition, the calibration laboratory of meteorological and hydrological sensors is renewed, and a new automatic radiosond station is purchased for observations and research in higher atmospheres.

The Air Quality Management Department of the **EERC** is responsible for air quality monitoring in Estonia in pursuant with European Directives and international conventions. The EERC is carrying out national ambient air quality monitoring in cities and rural areas. One important task is the development and management of the Estonian Air Quality Management System. The system combines the continuous air quality monitoring (data collection from national monitoring stations and from industrial monitoring stations), air pollution modelling, emission databases, calculation of the air quality index and other data related to air.

In addition to the ESTEA and the EERC, the Tartu Observatory, the Estonian Marine Institute of the University of Tartu and the Estonian Agricultural Research Centre also engage in environmental monitoring.

International cooperation

The **ESTEA** fulfils the following international obligations: carrying out the duties of the national contact point for the European Environment Agency and the UNEP/Info-terra network, exchanging information with the European Environment Agency, the EUROSTAT, the European Commission, the UN Environment Programme and other international and national institutions and compiling and delivering national and international reports to such institutions. The main goal of the ESTEA's environmental monitoring is to forecast (through continuous monitoring and evaluation of environmental factors and environmental status) changes in environmental factors and statuses via a developed indicator system and forecasting models. There are a total of 12 sub-programmes of environmental monitoring: biodiversity and landscape monitoring, radiation monitoring, integrated monitoring, meteorological and hydrological monitoring, forest monitoring, soil monitoring, groundwater monitoring, marine monitoring, seismic monitoring, inland water bodies monitoring, the support programme and ambient air monitoring. Most monitoring programmes also research climate change.

The **ESTEA's weather service** participates in the work of many international organisations, being a cooperating member of the European Centre for Medium-Range Weather Forecasts (ECMWF) since 2005 and the cooperating member of the European Centre for the Exploitation of Meteorological Satellites (EUMETSAT) since 2006 and a full member of the latter since 2013. The ESTEA's weather service also participates in the work of the weather forecasting consortium HIRLAM (since 2007), the European Meteorological Services Network (EUMETNET) (since 2007), the Nordic Weather Radar Network (NORDRAD) (since 2010) and the NORDIC cooperation on Numerical Weather Prediction (NORDNWP) (since 2016). Estonian data is visible in the pan-European network for meteorological warnings (METEOALARM) since 2010. The ESTEA's weather service takes part in several climate-oriented programmes of the World Meteorological Organisation (WMO): the World Climate Programme (WCP), the GCOS, the Global Precipitation Climatology Centre (GPCC) and the work of the BSRN of the WCRP.

The European Monitoring and Evaluation Programme (EMEP) is a programme applying research-based policies to regulate international cooperation for solving cross-border problems with air pollution and operates based on the regulatory Convention on Long-Range Transboundary Air Pollution. Estonia started monitoring long-range air pollution in 1994 in the Vilsandi and Lahemaa stations; the Saarejärve monitoring station was established later. To develop research on the impact of pollutants and the international cooperation necessary for the monitoring thereof, a working group was compiled in 1980 within the framework of the Convention on Long-Range Transboundary Air Pollution with the first meeting held in 1981. The convention includes the UN Economic Commission for Europe, and its secretariat works with the Economic Commission for Europe.

The GCOS includes meteorological networks GCOS Surface Network (GSN) and GCOS Upper Air Network (GUAN), which provide information necessary for researching climate change. The Tartu-Tõravere station, a member of the GSN network, carries out actinometric measurements for researching the spread of solar radiation in the Earth's atmosphere and its refraction in the subsoil.

8.3.1. Monitoring atmospheric climate

Atmospheric monitoring is carried out by the **Tartu Observatory** which researches different links to climate change. Climate change research focuses on the causes of climate change in the Baltic Sea region and in the Arctic. The aim is to find causal relations between temperature, the components of the atmosphere's energy budget, aerosols and the temporary changes in GHGs; long-range relations between the Baltic Sea region and the Arctic climate are also researched. For the analyses, global atmospheric reanalysis models NCEP-CFSR and ERA-Interim, aerosols model SILAM and atmospheric radiative transfer model FUTBOLIN are applied. The model's data will be validated against measurement data (radiosondes, radiation meters, AERONET sunphotometer). One of the most important goals of the project is to evaluate the possible contribution of different climate parameters (water vapour, CO_2, aerosols) to climate change. The research project *Aerosols and greenhouse gases contribution to the climate change in the Baltic Sea region and in the Arctic* was launched in 2015.

The **EERC** is responsible for ambient air quality monitoring on the national level. Ambient air quality management entails the modelling of air quality by reducing the emission of pollutants through the application of relevant measures on the basis of air quality monitoring (measuring pollutant levels). The development of a national air quality management system was financed by the Phare aid project EuropeAid/114968/D/S/EE *Development of Estonian Air Quality Management System* and the system was created with the help of the Swedish Meteorological and Hydrological Institute. Currently, the system includes nine different air quality dispersion models, one odour model, one hydrological model and one noise model.

During hydrometeorological monitoring, data about air temperature, precipitation, wind direction and speed, water levels in water bodies and water temperatures are collected among other information. The data is collected, combined, processed and distributed by the **Estonian Weather Service** operating as part of the ESTEA. The ESTEA's network of permanent hydrometeorological monitoring stations covers the whole of continental Estonia, the coast and major Western Estonian islands relatively well. During the years 2013–2015, meteorological as well as hydrological observations were carried out in a total of about one hundred monitoring stations. The network of monitoring stations is mostly automated, which allows the continuous registration of measurement data and ensures operative distribution forwarding of data to the consumers.

8.3.2. Ocean climate monitoring

Marine monitoring

Marine monitoring is carried out by the **Estonian Marine Institute of the University of Tartu.** Within the framework of the national monitoring programme, the monitoring of Estonian coastal waters started in 1993–1994 – initially only in accordance with the HELCOM (Baltic Marine Environment Protection Commission – Helsinki Commission) requirements and as of 2006, also in accordance with the requirement of the EU's directives. Currently, marine monitoring includes the monitoring of water quality and biota of the coastal waters and open sea, as well as the percentage of harmful substances in fish to identify the impact of the main environmental problems of the Baltic Sea – eutrophication and contents of harmful substances – in the Estonian marine territory. Changes in beaches are monitored in 41 monitoring areas. The monitoring programme includes yearly evaluations of the status of coastal water bodies; a thorough evaluation of the environmental status of the entire Estonian marine territory is carried out periodically in accordance with the Marine Strategy Framework Directive. The latest of such evaluations was prepared in 2012 by the Estonian Marine Institute of the University of Tartu; the next status evaluation will be given in 2018.

Other hydrological monitoring

Hydrological monitoring is carried out by the **Hydrology Department of the ESTEA.** Monitoring is the execution of hydrological observations, during which data about water levels and water temperatures of water bodies is collected from automated measuring stations placed on rivers. Additionally, water levels in Estonian coastal waters are measured in observation points. Data regarding river discharges are important for calculating water balance and pollution load which allow evaluating the capacity of pollutants carried from the rivers to the coastal waters and lakes. A network of permanent monitoring stations and observation points covers the entire continental Estonia, the coastline and the major islands of Western Estonia relatively evenly. The network of monitoring stations is mostly automated, which allows the continuous registration of measurement data and ensures the operative forwarding of data to the consumers.

The outputs of this national monitoring programme are the operative availability of hydrological information for other sub-programmes of national monitoring; the preservation of an optimal amount of hydrological monitoring data rows in electronic databases, incl. the retrospective entering of data (data rows with length of up to 150 years); the general analysis of the hydrological monitoring data; and ensuring the availability of an optimal amount of data through the Internet.

8.3.3. Terrestrial monitoring

The Air Quality Management Department of the **EERC** is responsible for the management and execution of integrated monitoring within the framework of national environmental monitoring programme (International Cooperation Programme on Integrated Monitoring). The EERC is Estonia's leading institution in international integrated monitoring (ICP IM – International Cooperation Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems). Integrated monitoring is monitoring carried out on the basis of the Convention on Long-Range Transboundary Air Pollution (the Geneva Convention). The purpose of monitoring is to collect data about the status of small complete terrestrial ecosystems (mainly ecosystems with the catchment area of a natural water body) and to forecast changes that may occur in the ecosystems over time, first and foremost, considering the environmental impact of nitrogen and sulphur pollution (acidification) on the environment, incl. the climate. In Estonia, integrated monitoring is carried out on Saare lake (Jõgeva County) and in Vilsandi (Saare County) since 1994. Vilsandi (in addition to the Lahemaa background monitoring station) also participates in the EMEP programme, meaning that the air monitoring results of these areas are used for the preparation of pan-European air pollution models, which serve as a basis for modelling pollution loads and air quality.

In Estonia, the forest monitoring programme is currently carried out by the **ESTEA.** The purpose of monitoring forests and forest soil is to evaluate the status and increment of forests and to relate such data to the impact of biotic and abiotic factors. In the areas of intense monitoring, comprehensive monitoring of the impact of air pollution and climate change on more representative habitats and forest stands growing in more typical forest communities is carried out. Monitoring works result in the evaluations of the status and increment of Estonian forests and overviews of the occurred changes and regional differences.

The mandatory European forest monitoring method devised for carrying out the international ICP Forests programme is used for carrying out any research included in the forest monitoring complex.

The agricultural soils monitoring is carried out by the **Estonian Agricultural Research Centre**. In Estonia, systematic monitoring of agricultural soils has been carried out from 1983 and within the framework of national environmental monitoring as of 2001 on 30 selected reference areas with a 5-year rotation. In 2015, soil monitoring was carried out in four monitoring areas: in Rannu (Tartu County), Holtsi (Põlva County), Kiislimõisa (Jõgeva County, Palamuse Rural Municipality), and in Kuningmäe (Jõgeva County, Põltsamaa Rural Municipality). In Estonia, soils were generally favourably aerated, humus supply as well as the thickness of humus horizon are increasing, and soil conditions are usually stable. Decreasing trend of potassium content existed among the necessary plant nutrients for plant growth. Moreover, the trampling is slowly increasing which has to be considered when planning agrotechnology or buying new agricultural machines.

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IX

Education, training and public awareness

KEY DEVELOPMENTS

- **84–85% of the Estonian citizens deem it important to increase the share of renewable energy.**
- **Awareness of Estonians about climate change is increasing gradually.**
- **Reporting of climate-related issues in the media has increased in connection with the Paris Agreement, thus the information about climate change is more easily available among society.**
- **The running for the title of the European Green Capital of 2018 and 2019 has forced Tallinn to develop sustainable lifestyle and to inform citizenry about the possibilities to behave sustainably.**
- **In 2017, Let's Do It Foundation was awarded the European Citizen's Prize by the European Parliament. Now, the Foundation is organising the *Let's Do It* World Cleanup 2018 being one of the leading announcers of the waste problem in relation to the mapping of illegal dump sites.**

9.1. Introduction

This chapter provides an overview of activities that have been designed to increase the climate awareness and general trends of the Estonian public over the last five years. Estonia continues to contribute to the various climate education targets of the United Nations Framework Convention on Climate Change (UNFCCC), such as popularisation of climate education and increasing the awareness of the public about climate change. Awareness of the people about the environment, environmental protection, and climate change is increasing every year. This has become a general trend, which has in turn directed people's behavioural and consumption choices. Ecological lifestyles, organic farming, recycling, and the use of environmentally friendly energy sources and technologies are gaining popularity, but these measures are quite often not related to the fight against climate change. Studies show that the awareness of Estonians about climate change remains low, but is increasing year-by-year.

The general education policy of Estonia supports increasing of climate awareness. There have been numerous environmental and climate projects and training programmes implemented in Estonia over the last five years. Significant amounts have been invested in the environment and in education, which supports sustainable development, and the number of organisations providing informal education on nature and the environment is growing every year. In addition to educational institutions, most people receive information from the media. Reporting of climate-related issues in the media has increased in connection with the Paris Agreement.

Reducing of air pollution is an important issue all over Estonia. This is, for example, evident from the fact that energy efficiency is being taken into consideration in the designing and use of (educational) buildings. Tallinn, Tartu, Rakvere, Jõgeva, and Rõuge have joined the Covenant of Mayors for Climate & Energy, and thereby promised to reduce the greenhouse gas emissions resulting from their activities. Tallinn was also in the running for the title of the European Green Capital of 2018 and 2019.

9.2. General policy toward education, training and public awareness

9.2.1. Awareness of the public about the environment and climate change

The general environmental awareness of the people of Estonia was summarised by the **survey of environmental awareness of Estonian citizens** conducted in 2016, which garnered 1,003 respondents. The survey revealed that the people of Estonia were generally satisfied with the situation of various environmental fields and that the assessments had improved compared to a similar survey of 2012. Estonian citizens have become more attentive towards the environment and are more aware of how to preserve nature. People were most satisfied with nature trails and the possibilities for learning about nature independently, as well as with the availability of clean drinking water and environmental extracurricular education, and with the cleanliness of air. Dissatisfaction was highest in the case of cleanliness of the sea, sustainable use of natural resources, and extraction of mineral resources. Wind energy, wood, biomass, and natural gas were considered the most environmentally friendly energy sources. Oil shale and nuclear energy were deemed less-favoured sources of energy.

Estonians generally consider themselves environmentally aware; however, their awareness of climate change and the accompanying issues is quite low (Figure 9.1). The survey of environmental awareness revealed that 40% of the population believed that they were well-aware of the impacts of climate change on the Estonian environment and 52% of the respondents deemed themselves to be poorly informed. 74% had detected a decrease in snow cover in Estonia in their lifetime and 52% the higher frequency of severe storms. The increasing frequency of the heat waves, floods caused by sudden rising of the water level of the coastal sea or inland waterbodies and floods resulting from heavy rainfall had also been detected. 41% of the respondents deemed the impacts of climate change a serious problem for Estonia and 55% believed that climate change does not pose a significant threat for Estonia. Young people of the ages of 15–19 were most aware of the subject of climate change mitigation.

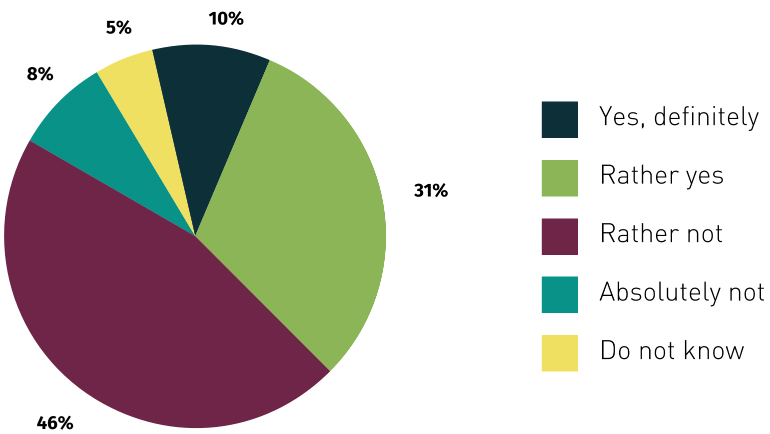

Figure 9.1. Responses of Estonian citizens to the multiple-choice question *Do the consequences of climate change pose a serious problem for Estonia?*, % of all respondents (Report of the Ministry of the Environment, *Environmental awareness of the population 2016*)

The **Eurobarometer survey on the attitudes of European citizens towards climate change** in 2015 showed that 70% of the 1,018 Estonians interviewed considered climate change to be a serious or very serious problem. This percentage remains the lowest among the EU Members States. Only 28% of the respondents said that they had personally implemented measures to combat climate change over the last six months. The most common measures implemented were sorting and recycling of waste (71%), reducing of the share of disposable products used (65%), and buying of local and seasonal food (54%) (Figure 9.2). 90% of the respondents agreed that the battle against climate change would only be efficient if all countries over the world worked together. The majority (85%) deemed it important for the Government to set the goals of increasing the share of renewable energy by 2030 and to support the increasing of energy efficiency. Compared to 2013, Estonian people were more aware of the importance of contributing to renewable energy. 59% agreed that combating climate change and more efficient use of energy may help support the economy and increase employment in the EU.

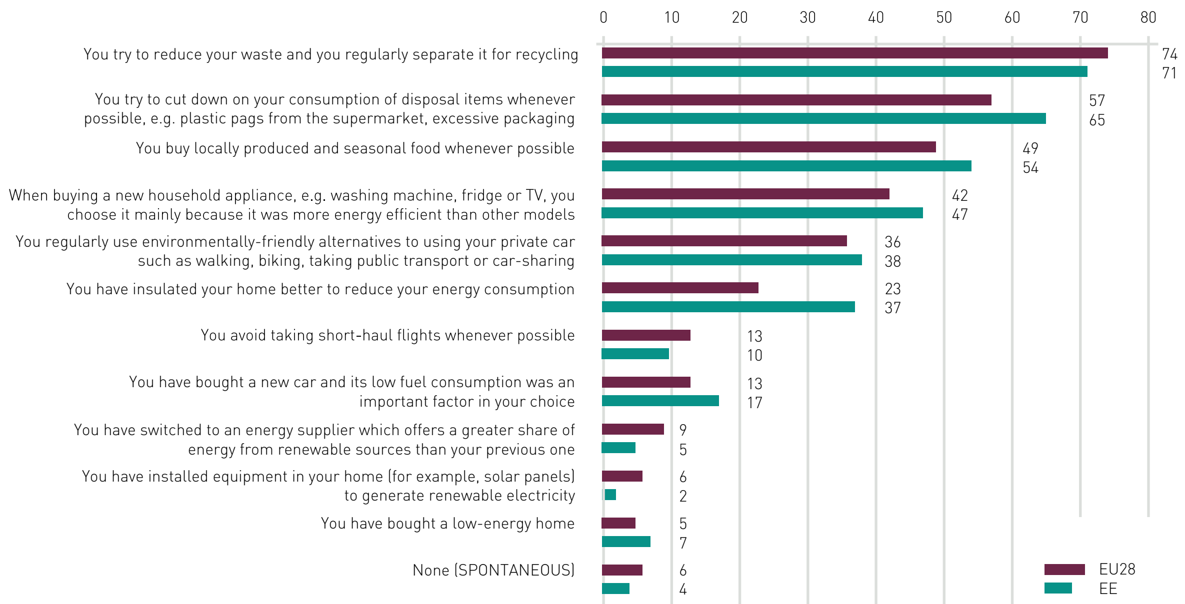

Figure 9.2. Responses of Estonian citizens to the question *Which of the following actions have you taken, if any?* (Special Eurobarometer 435 *Climate Change* survey, 2015)

The **survey on the values of the citizens of the Republic of Estonia** commissioned by NGO Ühiskonnauuringute Instituut (Institute of Social Research) and conducted by the market research company Turu-uuringute AS in 2017 revealed that 62% of the 795 people interviewed believed that the Estonian society had to do more to combat global environmental problems, such as climate change. 70% of the people were of the opinion that protection of the environment had to be prioritised even if it would somewhat hinder economic growth and lead to loss of jobs. 84% of the interviewees thought that Estonia should invest more in renewable energy and 24% believed that Estonia should stop using oil shale energy.

9.2.2. General environmental education policy and education in Estonia

In Estonian environmental education, sustainable development supporting education is becoming more and more important, incl. formation of environmentally friendly consumption habits, learning about nature in general, formation of values related to nature preservation, and understanding of ecosystem services. Promotion and shaping of education, which supports sustainable development, are some of the priorities for the Republic of Estonia. This approach to education is also highlighted in various international and domestic development documents: the UN Millennium Development Goals 2030, the UNESCO Global Action Programme on Education for Sustainable Development (2014) with the implementation guidelines, the national development plan Sustainable Estonia 21, Estonian Environmental Strategy 2030, Estonian Nature Conservation Development Plan until 2020, and the national curricula for basic schools and upper secondary schools.

Environmental education in Estonia is promoted in the cooperation of the Ministry of Education and Research (MoER) and the Ministry of the Environment (MoE). In 2017, the heads of the two ministries signed the third joint action memorandum, which sets the direction for future cooperation to promote education for sustainable development. Thereat, the MoE is focused on the long-term environmental goal of sustainable development, which includes sustainable use of natural resources, reducing of pollution, and preservation of biodiversity and natural areas. The role of the MoER includes popularisation and promotion of education for sustainable development, incl. more efficient implementation of the topic *Environment and sustainable development* in the national curricula and increasing of interest in the specialties and career choices, which are related to the areas of nature and exact science as well as technology.

In addition to formal education, several organisations all over Estonia are providing informal nature and environmental education. The problem here, however, is the lack of clearly established requirements for the study programmes provided in the field of environmental education and for the organisations providing the study programmes.

The MoER and the MoE believe that the progress of rethinking both formal and informal education as education for sustainable development is not fast enough. The deficiencies concern the areas of teachers' training, low awareness of the heads of schools, and lack of appropriate teaching aids. In the last few years, however, significant investments have been made in the environment and in education for sustainable development. In 2010, the Environmental Investment Centre (EIC) supported the project *Development of the environmental education infrastructure* for 13 environmental education infrastructures with 22.3 million euros. Now, the projects have been completed and several environmental training centres have been built or renovated (e.g. the Tallinn Zoo Environmental Education Centre, Särghaua learning centre of Tallinn University of Technology, learning centre of the Natural History Museum of University of Tartu).

In 2013–2015, refresher training on sustainable development was organised for informal environmental education specialists within the framework of the *Development of environmental education programme* launched by the Environmental Board and funded from the European Social Fund. The University of Tartu launched a training programme for kindergarten teachers and university lecturers whereas the Sustainable Development Education Centre of the Institute of Ecology of Tallinn University carried out a training programme for basic school, upper secondary school, and vocational school teachers as well as environmental education specialists. The training programmes also covered the topic of climate change. One of the aims of the programme was to create the prerequisites required for active participation in the education system, which supports sustainable development, and to provide support in the implementation of the recurring topic *Environment and sustainable development* in the national curriculum. 449 teachers, lecturers, and environmental education specialists completed the training programme.

9.3. Education

Topics of climate change are included in the content of teaching and learning outcomes of nature subjects included in the national curricula at various levels of education in Estonia. Even the national curriculum of preschool institutions includes a field *The environment and I*, in which the changes occurring in the nature is one of the topics. The national curriculum for basic schools and upper secondary schools adopted by the Government of the Republic in 2014 establishes the framework for implementation of all recurrent topics, incl. the compulsory cross-curricular topic of *Environment and sustainable development*.

The environment-related topics dominating the curriculum of the first stage of basic school include natural resources, biodiversity, and the human being as a biological creature. At the second stage of basic school, changing of the environment as a result of human activity, energy consumption, and recycling of materials are covered. The geography curriculum of the third stage of basic school includes a separate block of topics dedicated to climate; climate is also discussed under the topics of hydrography and biomes.

Based on the national curriculum for upper secondary schools, climate, the factors that shape climate, climate change, global environmental problems and the impacts thereof are discussed in depth in geography lessons. The selection of topics of the optional human geography course *Globalising world* includes: climate change and regional impacts thereof, the reasons for decreasing biodiversity and the accompanying problems. The optional course *Natural sciences, technology, and society* offers the following module: *Climate change: what is the future of Estonia like?*.

The MoER also supports participation of schoolchildren in various extracurricular environmental programmes and environmental research work competitions, as well as various environmental education projects for schoolchildren by targeted financing. The MoER supports participation of schools in international sustainable development promoting educational programmes within the framework of the general education programme of the Estonian lifelong learning strategy. Such supported programmes are, for example, GLOBE (Global Learning and Observations to Benefit the Environment) and the Baltic Sea Project. GLOBE is a global environmental education and research programme designed for primary, basic, and upper secondary school students, which offers learning through research and practical activities. By 2017, 86 Estonian schools had joined the programme. The Baltic Sea Project is focused on researching environmental problems in the Baltic Sea region and seeking solutions to the problems. Around 30 Estonian schools take part in the project.

The MoER also supports the Tartu Environmental Education Centre in organising a nationwide environmental research project competition for schoolchildren and in participation in the international research project competition INEPO (International Environmental Project Olympiad) aimed at schoolchildren.

There are no educational institutions, which teach separate specialities related to climate or climate change. Luua Forestry School and Räpina School of Horticulture are the vocational educational institutions, which cover the topic of sustainable development in Estonia. The institutions of applied higher education teaching climate change include the Tallinn University of Applied Sciences and EuroAcademy. At the level of higher education, the topics of climate change are represented in the programmes of various specialities taught at various universities. The more general topics of sustainable development are, however, covered more frequently. The universities providing climate-related knowledge include the University of Tartu, Tallinn University of Technology, Estonian University of Life Sciences, and University of Tallinn.

9.4. Public information campaigns

There are several climate-related environmental campaigns organised in Estonia, which are aimed at the public. The majority of those campaigns are directly focused on energy efficiency. The campaigns are often also related to healthy ways of mobility.

NGO Estonian Renewable Energy Association and NGO Estonian Green Movement (EGM) organised a **social campaign on climate and energy policies** in May 2014 in cooperation with European civil society organisations. The aim of the campaign was to focus on the energy security and independence of the EU and the Member States as well as on the fact that local fuels help reduce costs and the dependence on foreign energy resources.

In 2014, the EGM participated as a partner in the ***Generation Aware*** campaign organised by the European Commission, which was aimed at increasing the awareness of consumers about the connections between their consumption habits and the limits of natural resources, and thereby change their consumption habits and behaviours.

In September every year, the **environmentally friendly mobility month** is organised in Tallinn. The general aim of the campaign is to increase the awareness of the residents of Tallinn about the environment and mobility. Various authorities, city district governments, and other cooperation partners are involved to create a pleasant and safe environment in the city, in which it would be possible to travel sustainably, increase traffic safety on the streets, and promote the use of environmentally friendly and zero CO_2 emission vehicles and the advantages of environmentally friendly means of mobility. During the campaign, more extensive use of public transport and less extensive use of private cars is promoted and the people are encouraged to choose environmentally friendly means of mobility, such as walking or cycling.

The **European mobility week** promotes sustainable mobility on city streets and introduces environmentally friendlier methods of mobility. Five Estonian cities took part in the mobility week in 2016: Tallinn, Tartu, Pärnu, Narva, and Jõgeva.

The initiative ***Cyclicious Estonia*** was established with the aim to encourage people to use bikes as their daily vehicles of choice. One can travel by car, by foot, or by public transport, but it is especially convenient to move around one city by bicycle.

The aim of the **international Earth Day** (22 April) is to draw the attention of people to Earth-related environmental problems (climate warming, air pollution, excessive energy consumption, motorisation, etc.). In 2014, the tradition of planting trees in the yards of Tallinn schools on the International Earth Day was initiated.

9.5. Trainings and study programmes

More than 120 organisations in Estonia are providing informal environmental education study programmes for schoolchildren as well as others who are interested. These organisations include public authorities, institutions managed by local municipality governments, foundations, non-governmental organisations, private companies, as well as subdivisions of universities. The portal *www.keskkonnaharidus.ee* includes information about more than 900 study programmes. Many environmental issues discussed within the framework of the study programmes include climate change. The Environmental Board alone organised 128 climate change-related study programmes in the period of 2012–2016. The EIC is also funding numerous environmental awareness projects, which directly or indirectly cover the topics of climate change.

In 2015–2017, the NGO Peipsi Centre for Transboundary Cooperation (Peipsi CTC) took part in the global educational cooperation project ***S.A.M.E. WORLD – sustainability, awareness, mobilisation, environment in the Global Education for the European Year of Development Cooperation 2015***. The aim of the project was to increase the awareness of schoolchildren and teachers about the interdependence of Europe and developing countries, focusing on environmental justice and the related topics of climate change and environmental migration. Students discussed the connections between climate change and production and consumption of food products as well as the connection between climate change and different agricultural methods. 105 students from four schools took part in the learning programme in 2015 and 172 students from five schools in 2016.

In 2016–2017, the Peipsi CTC also conducted the project ***Global education in the Lake Peipus region schools – environmental justice and climate refugees*** with the support of the Ministry of Foreign Affairs. The aim was to increase awareness about the need for developmental cooperation and to demonstrate the connection of local issues with global problems. The schools in the Lake Peipus region learned about the subject *Environmental justice and climate refugees* and a poster competition was organised on the topic of climate change and climate refugees. In Tartu, a discussion evening entitled *Food and climate change* was organised.

Tallinn is participating in the ***Green School*** programme implemented by the Foundation for Environmental Education. One of the main topics of the Green School programme is climate change and the accompanying phenomena. At the beginning of 2017, a seminar on climate change was organised for the teachers who have joined the programme, with 20 teachers participating.

In 2015–2016, the ***C-YOU-2: Sharing NorLtic Way of Living*** project was organised in cooperation with the Tartu Environmental Education Centre for the schoolchildren of Tartu

County (11 schools), Denmark, Sweden, and Iceland, with the aim to increase awareness about climate problems and develop solutions. The project developed the cooperation and mutual understanding between Baltic and Nordic schoolchildren by sharing environmentally efficient practices for building schools with low CO_2 emissions.

In 2016, Tallinn Secondary School of Science with the support of NGO Loov Eesti (Creative Estonia) and the Swedish Institute took part in an international project involving Baltic Sea countries, ***Art/Mosphere,*** which binds together culture and increasing awareness on climate change by way of topics related to the sea. In the course of the project, participants learned how climate change has impacted Estonian coastal areas and thereby the daily life.

In 2014, NGO HeadEst first conducted the ***Fresh ideas for Europe*** project, which helped the organisation fulfil its mission of supporting young people in becoming independent in the modern world. Within the framework of the project, a project week was organised at Saku Gymnasium with 25 students from grades 9 and 11 participating. The youths developed their own opinions on the future of Europe in the areas of energy and climate policy.

In 2012–2014, Tartu Kivilinna School took part in the Comenius project ***Air pollution studies***, which was organised with the aim to increase the awareness of schoolchildren and teachers about global climate change, as well as to provide knowledge on science, math, and information and communications technology. Problems related to air pollution were studied at the local as well as global level.

9.5.1. Conferences

Conferences and lecture series related to the environment are organised in various places all over Estonia, which are open for everyone interested. The Environmental Board has organised a total of ten nature evenings or learning days for the public (29 March 2012 – 25 May 2016), which were focused on climate change.

The Environment Agency organises annual conferences to celebrate the **global day of meteorology**. The conferences are open to specialists of relevant fields as well as to the wider public. In 2014, the focus was on young people and the involvement of youths in climate-related activities, the topic of 2015 was *Turning climate-related knowledge into action*, and in 2016, the conference focused on the impacts of climate change on various fields of life.

In April 2015, **Pathways to the Future** was a conference dedicated to the rapidly evolving field of Education for Sustainable Development. The event provided an opportunity to share ideas and experiences and to discuss the future of education which could support sustainable development. The event took place in 22–24 April 2015 in Tallinn University.

In November 2015, the Riigikogu held a public seminar entitled ***The Paris Climate Change Conference – an opportunity to some, a challenge to others?*** discussing whether and how transfer to a cleaner economy could contribute to economic growth and benefit the countries that are leading the fight against climate change.

The **Opinion Festival** is an annual meeting place for inspiring ideas, interesting thoughts, and new initiatives. The aim of the festival is to develop the opinion culture and citizen education. In 2015, the Estonian Fund for Nature (EFN) organised a climate change-related opinion stage at the Opinion Festival in order to draw attention to the problems arising from the extraction of fossil fuels. In the Energy Sector of the Opinion Festival of 2016, several discussions were held on topics ranging from new technologies to energy security and from oil shale to renewable energy. The topic of *Climate policy 2050 – is Estonia in the boat* was also discussed. In 2017, the Energy Turning Sector held discussions on stepping out of the oil shale energy sector, the opportunities offered by renewable energy sources and nearly zero-energy buildings.

The **Sustainable Energy Forum** is a discussion conference focused on the issues of the environment, economy, and society. In 2016, the aim of the forum was increasing awareness about the interdependence of food production and consumption and climate change as well as the possibilities for mitigating the impacts of climate change. Three companies and organisations operating in the food industry, whose activities helped protect the climate and adapt to climate change, were also awarded the titles of *Climate Friend 2016*.

A conference ***Challenges of environmental education in the changing World*** which recurrent topic was climate change was held in Jäneda in 25–26 October 2017. The presentations were from the Estonian leading experts of their field, like Tarmo Soomere and Urmas Kõljalg. Besides, environmental education centres conducted eight different climate change related workshops.

The **Green Drinks Evenings** is a series of environmental discussion evenings where respective topics are introduced by experts of the field. Several topics, which are directly or indirectly related to climate, have been discussed in the lectures. Similar lectures are also being given within the framework of the Estonian Green Movement ***Living in a sustainable world*** project (2015–2018). The aim of the project is to increase the awareness of people about the overlapping points of environmental issues and developing countries – introducing global problems, e.g. climate change and consumption.

Climate researcher Ain Kallis has taken part in the ***Night Owl Academy*** nature evenings to talk about climate change. Ain Kallis was awarded the title of the Friend of Academic Journalism in 2014, as he has published hundreds of popular science articles, explaining weather phenomena, climate and its change to the wider public.

At the event series ***Evenings with a life scientist*** held at the Natural History Museum of the University of Tartu, people get to meet various life scientists who speak about their daily work and fresh knowledge on nature. On several occasions, climate change related topics have been discussed.

The 7th conference of ***Human impact on the environment of Tallinn*** organised at the Tallinn Botanic Gardens in January 2016, the topic of which was *Green cities today and tomorrow*, was focused on the title of the Green Capital of Europe and the challenges faced by Estonian cities in connection with adaption to climate change. The potential problems posed to Estonian cities and to the residents of the cities by the end of this century were discussed, as well as solutions on how to adapt to the new conditions.

9.6. Resource or information centres

9.6.1. Educational centres

Several centres have been opened or reopened in Estonia in the last few years where children can take part in climate-related study programmes. Some of the centres also provide information on climate change to adults.

The **Särghaua earth science and environmental technology learning centre of the Tallinn University of Technology** (opened in 2014) organises climate-related learning days and educational programmes, which introduce how climate is researched, what the causes and impacts of climate change are, and what could the climate be like in the future.

The **Ice Age Centre** (opened in 2012) organises environmental educational activities and programmes, which are related to the exhibits of the centre. The topic of climate change is discussed within the framework of various study programmes. Overviews are provided about the development of the Earth as well as about climate change; additionally, various climate periods and the impacts of climate change in the Estonian territory are introduced.

The **Tallinn Botanic Garden** offers a weather and climate-related study programme, which includes observations at a weather station, research activities, and discussions of global problems.

The climate change workshop at the **Energy Discovery Centre** (reopened in 2014) seeks for answers to the questions of why the average temperature on Earth is increasingly growing and what the consequences of this increase are. Experiments are conducted to study the connections between greenhouse gases and temperature changes in the atmosphere of the Earth.

The **Museum of the University of Tartu** includes the Mad Scientist's office (opened in 2013), a discovery room, in which children as well as adults get to experiment. The *What is weather and what is climate?* programme introduces the work of weather and climate researchers and observes various weather phenomena.

The **Tallinn Zoo Environmental Education Centre** (opened in 2014) is primarily focused on promoting environmental education in and around Tallinn. The centre in cooperation with other competent institutions and organisations enables assuring that various different target groups have access to diverse environmental education, including teaching of sustainable lifestyles.

The aim of the **Tartu Environmental Education Centre** (reopened in 2013) is to provide educational training, increase the awareness of people, and create a functioning model for environmentally aware behaviour. The study programmes offered by the Tartu Environmental Education Centre also complement the topic of climate change in the curricula of general education schools.

9.6.2. Sources of information

Official national climate information is shared on the website of the **MoE** at *http:// www.envir.ee/et/kliima*. The website explains the meanings of climate, climate change, the greenhouse effect, and greenhouse gases, as well as discusses adaption to climate change and the climate policy. The website also includes the development plan for adaption to climate change and information on the international battle against climate change. The website of the Estonian Environmental Research Centre (*http://www.klab.ee/kohanemine/*) also introduces the possibilities for adapting to climate change and provides a list of which fields of life are affected by climate change in Estonia. Both websites include numerous references to various climate-related materials.

However, the wider public are mainly informed on climate-related issues through the media. In the autumn of 2015 at the time of the Paris Climate Change Conference, there was special focus on climate-related topics in the media. For example, Delfi, the largest news portal in Estonia, launched a special subsite *Estonian weather 2100* before the Paris Climate Change Conference, which includes news on climate and climate change. The journey of the Climate Bus was also reported in the blog of the project team as well as in the wider media (e.g. in the newspapers Eesti Päevaleht and Müürileht). The aim of the **Climate Bus** was to drive to the international climate policy negotiations in Paris within the framework of citizen activism for the first time, take part in the events in Paris and bring the events on the streets of Paris directly to the homes of Estonian people. The Climate Bus took a delegation of journalists, and citizen and environmental activists to the conference with the aim to report the news of the most important official as well as unofficial events (events on the street), which would not have been shown in Estonian media otherwise.

The **Estonian Public Broadcasting** (ERR) reports climate issues over the radio and television and online. The programmes "Osoon", "AegRuum" and "Teaduspalavik" produced by the national TV channel ETV have covered various climate change-related topics. The ETV2 channel of the ERR celebrates the environment month in May each year by showing various documentaries on the topic of the environment, including climate change. Ecological and climate change-related issues have been covered in the "Zelenaja sreda" section of the "Kofe+" programme produced by ERR's Russian-language TV-channel ETV+. The environment and climate change are also often discussed in the morning programme of the Raadio 4 radio channel and in the programmes "Üksikasjad" and "Elukeskkond" (2014–2015). The Vikerraadio radio channel has covered these topics in the programmes "Ökoskoop", "Reporteritund", "Uudis+", and "Huvitaja". A science news channel produced in the cooperation of the University of Tartu and the ERR is focused on introducing science and scientists (available at *http://novaator.err.ee/l/loodus*).

In 2016, the **EFN** established an informative website *www.kliimamuutused.ee*, which is available in Estonian as well as Russian, and a Facebook page of the same name. The website publishes information on climate change, incl. 12 articles (during approximately one year in operation), which introduce different aspects of climate change and were also published in the national media in addition to the kliimamuutused.ee website.

In 2017, the EFN organised the adaption of 14 video clips on the reasons and impacts of climate change and the possibilities for halting climate change for Estonian viewers. The clips provide an overview of the origin of fossil fuels, the history of the use thereof, the carbon cycle and footprint. The impacts of climate change on biodiversity, the sea level, the average temperature on Earth, and weather conditions are explained. Advice is given on how to support the deceleration of the process of climate change and how to adapt to the new conditions. The clips have also been translated into Russian. The clips were broadcast on several different channels, including on ETV2 during the environment month.

NGO **Mondo** administers a global education and training centre portal *http://www.maailmakool.ee*, which includes global education materials for schools, teachers, and youth workers, which have been produced in Estonia or translated into Estonian. The website includes plenty of information on climate change, which can be used as teaching aids, such as clips, comics, and ideas, which facilitate teaching.

In 2015, a set of environmental educational learning clips with supporting worksheets and a teacher's manual were published, commissioned by the Environmental Board and supported by the ***Development of environmental education*** programme of the European Social Fund. One of the subtopics included is *Weather and climate*, which consists of four clips: *Climate change and people, Climate change in the history of the Earth, Changes over 24 hours, and Seasons and weather*. The clips can be found at *www.keskkonnaharidus.ee* and are freely accessible and usable.

The journals **Eesti Loodus, Horisont**, and **Eesti Mets** have published over 30 climate-related articles in the last five years.

9.7. Involvement of the public and non-governmental organisations

The non-governmental organisations actively involved in the field of climate-related issues are generally the same as the ones listed along with the aims of their activities in the previous climate report, such as the EGM and the EFN in the field of environmental protection; the NGO Estonian Renewable Energy Association, Estonian Wind Power Association, and the Tartu Regional Energy Agency which promote sustainable energy consumption; Archimedes Foundation, which is involved with educational and research projects; the Estonian Environmental Law Centre in the field of law, and the Baltic Environmental Forum and the Tallinn Centre of the Stockholm Environmental Institute, which take part in international programmes. In addition to those mentioned above, there are other NGOs, which are worthy of a mention.

NGO **Mondo** is a leading Estonian global education, developmental cooperation, and humanitarian aid organisation, which provides the people of Estonia an opportunity to make the world better and offers documentaries on global issues to schools and other interested parties, among other things. In cooperation with the EFN and Estonian National Commission for UNESCO, a climate campaign for the youth was organised in 2015 with the aim to enable young people to take part in the formation of the Estonian climate policy. The youths also participated in a climate-related social advertisement competition, in a seminar organised by the Riigikogu, and the most active ones got a chance to take part in the Paris Climate Change Conference.

The aim of the NGO **Peipsi CTC** is to provide knowledge-based support to the balanced development of the region of Lake Peipus and the bordering areas of the European Union. The contribution of the centre to the field of climate is discussed in Chapter 9.4 on trainings and study programmes.

NGO **Tervikring** operates in the field of promotion of environmentally friendly solutions with the aim to decrease waste generation at public events and from retailing, thereby also promoting reuse. The main initiatives include replacement of deposable plastic cups with reusable cups. The waste-free reusable cup solution for festivals offered by the NGO was among the six finalists in the innovation competition organised by the Estonian Quality Association.

9.8. Participation in international activities

In addition to participation in the international projects for schoolchildren discussed above (such as GLOBE, the Baltic Sea Project) and taking part in the activities of the international environment days, climate change-related environmental topics are also discussed at a more general international level. Currently, a second World Cleanup Day *Let's Do It!* is planned on the initiative of Estonians and will be held on 8 September 2018.

Figure 9.3. *Let's Do It!* European Citizen's Prize of 2017 (European Parliament, 2017)

The aim of the ***Let's Do It!* World Cleanup Day** is to achieve a clean world. In order to organise such an event, national leaders for organising the cleanup action were sought in 2016. To prepare for the World Cleanup Day, an international World Cleanup conference *Connecting Heroes* was held in Estonia in January 2017, in which leaders of the cleanup action from 64 countries took part. In 2017, a global campaign to map the sites of illegal waste dumping was organised, whereat any interested smartphone owner could download a free application and take part. The *Let's Do It!* World Cleanup is a non-political citizen movement and an official member of the UN Environmental Programme. The *Let's Do It World* Cleanup is coordinated by the Let's Do It Foundation (Teeme Ära Sihtasutus). Let's Do It! was also involved in the *World Cleanup 2015* project, which was aimed at developing IT solutions: development of a waste map, online updating of a country-based database of waste flows, country-based connection of the waste map with websites of the countries, development of a new website / information system for *Let's Do It World*, and regular IT-related consulting of the countries included in the network. In 2015, Let's Do It Foundation helped organise the first cleanup action in Afghanistan. In 2017, Let's Do It Foundation was awarded the

European Citizen's Prize by the European Parliament (Figure 9.3), which is awarded to the people or organisations, which contribute to the integration of the society or develop cross-border cooperation in the European Union.

Tallinn reached the stage of the five **finalists** in the running for the **European Green Capital 2019** awarded by the European Commission, improving on the result achieved in the same competition the year before. The aim of the initiative is to improve the living environment in European cities and, above all, to acknowledge and reward the efforts made by cities to improve the environment and the quality of life. The title is awarded to the city, which has improved the urban environment as a whole through various activities, such as introduction of sustainable ways of mobility, creation and expansion of parks and other green and recreational areas, modernisation of waste management, taking into use of renewable energy sources, noise reduction, implementation of innovative solutions, environmental management of the city government, cooperation between the authorities, residents, businesses, and other parties in the city with the aim to develop and improve the living conditions in the city. Tallinn has contributed to global mitigation of and adapting to climate change by implementing the *Fixing the facades* support scheme for energy efficient buildings in the city, continuing to offer free public transport services to the residents of Tallinn, and taking part in the Covenant of Mayors with the aim to decrease greenhouse gas emissions by 40% by 2030. The Tallinn Energy Agency, however, is working on increasing the awareness of the population about issues related to energy and greenhouse gases.

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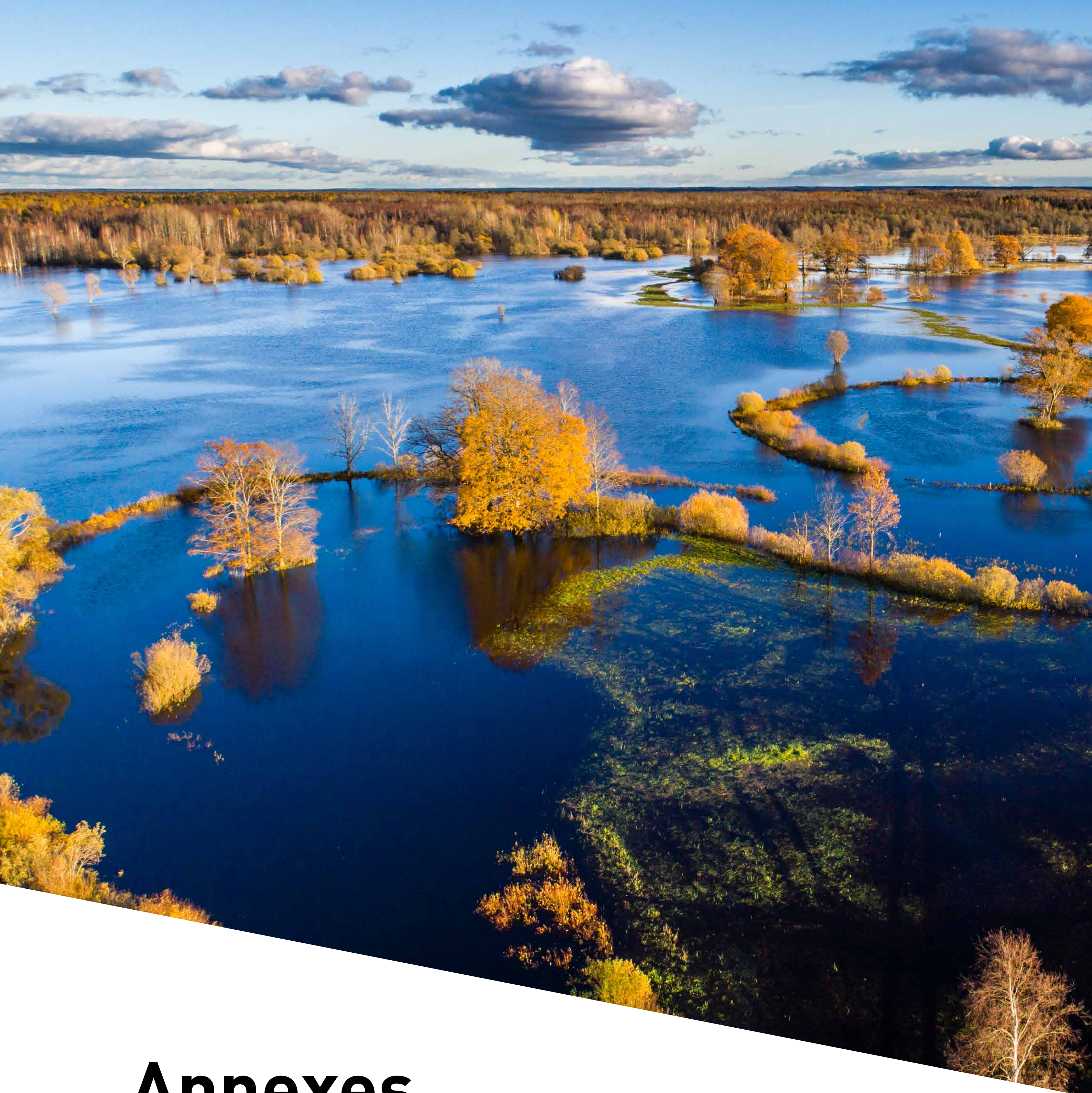

Annexes

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES
(Sheet 1 of 3)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs(1)	PFCs(1)	Unspecified mix of HFCs and PFCs(1)	SF_6	NF_3	NOx	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	13,519.36	42.37	2.95	222.82	NO	NO	0.0001	NO	37.80	110.70	25.58	24.39
1. Energy	15,589.07	6.30	0.39						36.20	110.41	13.08	24.25
A. Fuel combustion Reference approach (2)	16,144.17											
Sectoral approach (2)	15,589.05	5.68	0.39						36.20	110.41	13.08	24.25
1. Energy industries	12,188.33	0.63	0.11						15.06	5.98	3.55	22.24
2. Manufacturing industries and construction	489.79	0.12	0.02						0.93	2.20	0.20	0.93
3. Transport	2,293.13	0.15	0.09						9.29	20.04	4.13	0.20
4. Other sectors	591.01	4.77	0.18						10.62	81.65	5.09	0.88
5. Other	26.78	0.001	0.001						0.29	0.54	0.11	0.0005
B. Fugitive emissions from fuels	0.03	0.62	NO						NO	NO	NO	NO
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.03	0.62	NO						NO	NO	NO	NO
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	284.06	NO	0.01	222.82	NO	NO	0.0001	NO	0.06	0.29	7.89	0.13
A. Mineral industry	262.66								NO	NO	NO	0.07
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	21.40	NO	NO						NO	0.11	7.23	NO
E. Electronic industry				NO	NO	NO	NO	NO				
F. Product uses as substitutes for ODS				222.82								
G. Other product manufacture and use	NO	NO	0.01	NO	NO	NO	0.00	NO	NO	NO	NO	NO
H. Other (3)	NO	NO	NO	NO	NO	NO	NO	NO	0.06	0.18	0.66	0.06

Note: All footnotes for this table are given at the end of the table on sheet 3.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

(Sheet 2 of 3)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs [1]	SF_6	NF_3	NOx	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
3. Agriculture	11.24	24.74	2.38						1.54	NO	4.61	NO
A. Enteric fermentation		21.62										
B. Manure management		3.12	0.21								4.61	
C. Rice cultivation		NO									NO	
D. Agricultural soils		NO	2.17						1.54	NO	NE,NO	
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		NO	NO						NO	NO	NO	
G. Liming	8.29											
H. Urea application	2.95											
I. Carbon-containingt	NO											
J. Other	NO	NO	NO						NO	NO	NO	NO
4. Land use, land-use change and forestry [4]	-2,366.01	0.002	0.02						NO,NE	NO,NE	NO,NE	NO
A. Forest land [4]	-2,475.37	0.0001	0.000001						NE	NE	NE	
B. Cropland [4]	119.79	NO,NA	0.02						NE	NE	NE	
C. Grassland [4]	37.56	0.00	0.00						NE	NE	NE	
D. Wetlands [4]	794.73	0.00	0.00						NE	NE	NE	
E. Settlements [4]	214.08	NO,NE,NA	NO,NE,NA						NE	NE	NE	
F. Other land [4]	23.41	NO	NO,NE						NE	NE	NE	
G. Harvested wood products	-1,080.21											
H. Other [4]	NO	NO	NO						NO	NO	NO	NO
5. Waste	0.99	11.33	0.14						0.01	0.002	0.0001	0.01
A. Solid waste disposal [5]	NO,NA	7.49							NO	NO	NO	
B. Biological treatment of solid waste [5]		0.60	0.04						NO	NO	NO	
C. Incineration and open burning of waste [5]	0.99	0.02	0.0003						0.01	0.002	0.0001	0.01
D. Wastewater treatment and discharge		2.36	0.10						NO	NO	NO	
E. Other [5]	NA	0.86	0.003						NO	NO	NO	NO
6. Other *(please specify)* [6]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on sheet 3.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A) (Sheet 3 of 3)

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs [1]	PFCs [1]	Unspecified mix of HFCs and PFCs [1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Memo items: [7]												
International bunkers	958.40	0.09	0.03						23.01	2.93	0.81	5.75
Aviation	73.72	0.002	0.002						0.28	0.81	0.04	0.02
Navigation	884.68	0.08	0.02						22.73	2.12	0.77	5.73
Multilateral operations	NO	NO	NO						NO	NO	NO	NO
CO_2 emissions from biomass	3,898.29											
CO_2 captured	NO											
Long-term storage of C in waste disposal sites	3,356.28											
Indirect N_2O			NO,NE									
Indirect CO_2	NO,NE,IE											

(1) The emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), unspecified mix of HFCs and PFCs and other fluorinated gases are to be expressed as carbon dioxide (CO_2) equivalent emissions.

(2) For verification purposes, Parties are requested to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in the documentation box to table 1.A(c). For estimating national total emissions, the results from the Sectoral approach should be used.

(3) 2.H. Other includes pulp and paper and food and beverages industry.

(4) For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(5) CO_2 from categories solid waste disposal on land and waste incineration should only be included if it stems from non-biogenic or inorganic waste streams. Only emissions from waste incineration without energy recovery are to be reported in the waste sector, whereas emissions from incineration with energy recovery are to be reported in the energy sector.

(6) If reporting any country-specific category under sector "6. Other", detailed explanations should be provided in Chapter 8: Other (CRF sector 6) of the national inventory report (NIR).

(7) Parties are asked to report emissions from international aviation and international navigation and multilateral operations, as well as CO_2 emissions from biomass and CO_2 captured, under Memo Items. These emissions should not be included in the national total emissions from the energy sector. Amounts of biomass used as fuel are included in the national energy consumption but the corresponding CO_2 emissions are not included in the national total as it is assumed that the biomass is produced in a sustainable manner. If the biomass is harvested at an unsustainable rate, net CO_2 emissions are accounted for as a loss of

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SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) (1)	13,519.36	1,059.15	877.68	222.82	NO	2.25	NO	NO	15,681.26
1. Energy	15,589.07	157.43	117.36						15,863.86
A. Fuel combustion (sectoral approach)	15,589.05	141.92	117.36						15,848.33
1. Energy industries	12,188.33	15.87	33.04						12,237.23
2. Manufacturing industries and construction	489.79	2.96	4.87						497.63
3. Transport	2,293.13	3.84	26.85						2,323.82
4. Other sectors	591.01	119.22	52.16						762.39
5. Other	26.78	0.04	0.44						27.26
B. Fugitive emissions from fuels	0.03	15.51	NO						15.53
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	0.03	15.51	NO						15.53
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	284.06	NO	3.79	222.82	NO	2.25	NO	NO	512.92
A. Mineral industry	262.66								262.66
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	21.40	NO	NO						21.40
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				222.82					222.82
G. Other product manufacture and use	NO	NO	3.79	NO	NO	2.25	NO	NO	6.04
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	11.24	618.50	707.88						1,337.62
A. Enteric fermentation		540.51							540.51
B. Manure management		77.99	61.76						139.75
C. Rice cultivation		NO							NO
D. Agricultural soils		NO	646.12						646.12
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		NO	NO						NO
G. Liming	8.29								8.29
H. Urea application	2.95								2.95
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO

Note: All footnotes for this table are given at the end of the table on sheet 2.

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SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
4. Land use, land-use change and forestry (1)	-2,366.01	0.06	6.72						-2,359.23
A. Forest land	-2,475.37	0.003	0.0003						-2,475.37
B. Cropland	119.79	NO,NA	5.42						125.21
C. Grassland	37.56	0.00	0.00						37.56
D. Wetlands	794.73	0.06	1.28						796.06
E. Settlements	214.08	NO,NE,NA	NO,NE,NA						214.08
F. Other land	23.41	NO	NO,NE						23.41
G. Harvested wood products	-1,080.21								-1,080.21
H. Other	NO	NO	NO						NO
5. Waste	0.99	283.16	41.93						326.08
A. Solid waste disposal	NO,NA	187.28							187.28
B. Biological treatment of solid waste		15.00	10.73						25.73
C. Incineration and open burning of waste	0.99	0.46	0.09						1.54
D. Waste water treatment and discharge		58.96	30.10						89.06
E. Other	NA	21.46	1.01						22.47
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items: (2)									
International bunkers	958.40	2.16	7.83						968.39
Aviation	73.72	0.04	0.61						74.37
Navigation	884.68	2.12	7.22						894.03
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	3,898.29								3,898.29
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	3,356.28								3,356.28
Indirect N_2O			NO,NE						
Indirect CO_2 (3)	NO,NE,IE								
Total CO_2 equivalent emissions without land use, land-use change and forestry									18,040.48
Total CO_2 equivalent emissions with land use, land-use change and forestry									15,681.26
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									NA

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-)

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

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TABLE 10 EMISSION TRENDS
CO_2
(Sheet 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year [1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(kt)													
1. Energy	36,093.57	36,093.57	33,061.27	23,955.14	18,732.22	19,325.25	17,597.06	18,309.77	17,820.21	16,186.47	15,079.26	14,731.50	15,057.35	14,763.22
A. Fuel combustion (sectoral approach)	36,093.48	36,093.48	33,061.18	23,955.08	18,732.19	19,325.21	17,597.02	18,309.73	17,820.17	16,186.43	15,079.21	14,731.45	15,057.30	14,763.18
1. Energy industries	29,256.08	29,256.08	26,695.29	20,211.06	15,919.06	16,189.54	14,637.41	15,164.80	14,742.38	13,141.10	12,560.22	12,126.43	11,935.38	11,655.33
2. Manufacturing industries and construction	2,497.61	2,497.61	2,356.37	1,590.05	749.56	1,054.86	894.12	968.02	886.12	832.05	479.61	577.48	701.35	487.02
3. Transport	2,415.74	2,415.74	2,198.49	1,135.62	1,255.62	1,572.42	1,536.00	1,597.94	1,704.78	1,763.81	1,641.44	1,626.26	1,935.17	2,065.86
4. Other sectors	1,880.64	1,880.64	1,757.84	984.24	797.18	497.44	500.72	562.70	473.19	432.27	380.75	384.41	466.93	540.33
5. Other	43.40	43.40	53.19	34.12	10.78	10.95	28.77	16.27	13.68	17.20	17.18	16.87	18.48	14.65
B. Fugitive emissions from fuels	0.09	0.09	0.09	0.05	0.03	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.05	0.04
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.09	0.09	0.09	0.05	0.03	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.05	0.04
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	960.28	960.28	962.43	554.19	329.32	570.85	600.54	610.26	655.02	697.07	620.88	608.39	627.73	449.06
A. Mineral industry	614.26	614.26	622.20	380.13	246.17	347.22	364.62	377.50	414.49	437.03	388.36	400.99	408.45	391.94
B. Chemical industry	307.73	307.73	301.22	145.43	57.88	194.24	207.83	202.81	211.40	228.44	203.12	180.78	195.35	31.33
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	38.29	38.29	39.01	28.62	25.28	29.40	28.10	29.94	29.13	31.60	29.40	26.62	23.93	25.79
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	13.11	13.11	12.10	3.09	2.58	2.81	4.23	4.24	6.24	25.31	26.30	19.85	21.28	19.11
A. Enteric fermentation														
B. Manure management														
C. Rice cultivation														
D. Agricultural soils														
E. Prescribed burning of savannas														
F. Field burning of agricultural residues														
G. Liming	12.11	12.11	11.17	2.60	2.38	2.16	3.59	3.65	5.76	24.95	25.84	19.41	20.83	18.83
H. Urea application	1.00	1.00	0.93	0.49	0.20	0.66	0.64	0.59	0.48	0.36	0.46	0.43	0.45	0.28
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry [2]	-1,736.51	-1,736,51	-1,812.94	-1,299.97	-2,151.83	-1,517.27	-1,808.99	-1,832.09	-2,216.90	-2,952.34	-3,230.56	-3,399.38	-1,510.79	-2,026.66
A. Forest land	-2,977.04	-2,977.04	-2,979.91	-2,990.33	-2,997.00	-3,024.52	-3,012.04	-3,053.10	-3,072.55	-3,088.67	-4,063.95	-3,475.74	-1,531.00	-2,769.89
B. Cropland	100.92	100.92	84.55	69.77	45.67	27.26	11.63	1.66	-14.22	-9.73	-2.22	5.55	24.56	46.47
C. Grassland	60.01	60.01	62.60	79.41	100.98	130.20	151.54	166.61	172.56	186.00	169.86	161.81	135.10	108.38
D. Wetlands	1,079.60	1,079.60	1,018.04	1,428.12	631.33	1,319.33	1,091.29	1,199.60	1,149.46	422.66	1,332.46	835.24	914.60	1,562.72
E. Settlements	NO,NE	NO,NE	1.78	2.70	3.61	7.7	8.82	8.42	10.04	11.21	9.07	11.24	41.31	72.66
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO,IE
G. Harvested wood products	NE	NE	NE	110.35	63.58	22.69	-60.22	-155.29	-462.18	-473.82	-675.78	-937.47	-1,095.36	-1,046.99
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	2.25	2.25	2.25	2.45	2.21	2.60	2.99	2.46	2.58	2.65	2.81	2.82	2.21	2.38
A. Solid waste disposal	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
B. Biological treatment of solid waste														
C. Incineration and open burning of waste	2.25	2.25	2.25	2.45	2.21	2.60	2.99	2.46	2.58	2.65	2.81	2.82	2.21	2.38
D. Waste water treatment and discharge														
E. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:														
International bunkers	659.15	659.15	683.35	415.17	516.79	434.99	321.46	329.60	368.24	368.46	405.63	385.63	353.71	417.33
Aviation	106.75	106.75	109.21	35.89	53.52	43.92	50.49	46.76	65.33	46.38	65.53	63.58	47.28	54.82
Navigation	552.40	552.40	574.14	379.28	463.26	391.08	270.97	282.84	302.91	322.07	340.10	322.05	306.44	362.51
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	962.15	962.15	944.34	903.24	861.24	1,398.59	2,269.46	2,699.30	2,764.45	2,355.60	2,365.03	2,383.56	2,509.34	2,538.14
CO_2 captured	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Long-term storage of C in waste disposal sites	1,751.44	1,751.44	1,761.65	1,843.53	1,871.01	2,094.59	2,259.90	2,285.33	2,384.17	2,159.77	1,849.46	2,008.01	2,053.53	2,130.25
Indirect N_2O														
Indirect CO_2 [3]	NE,NO,IE	NE,NO,IE	NE,NO,IE	NO,NE,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE
Total CO_2 equivalent emissions without land use, land-use change and forestry	37,069.22	37,069.22	34,038.05	24,514.86	19,066.33	19,901.52	18,204.82	18,926.73	18,484.06	16,911.51	15,729.24	15,362.56	15,708.57	15,233.77
Total CO_2 equivalent emissions with land use, land-use change and forestry	35,332.70	35,332.70	32,225.10	23,214.88	16,914.49	18,384.25	16,395.84	17,094.64	16,267.16	13,959.17	12,498.68	11,963.18	14,197.77	13,207.11
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 10 EMISSION TRENDS
CO_2
(Sheet 2 of 2)

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GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
														%
1. Energy	16,576.95	16,656.55	16,535.03	15,821.42	19,275.66	17,053.33	14,293.81	18,649.23	18,620.44	17,222.18	18,905.24	18,413.57	15,589.07	-56.81
A. Fuel combustion (sectoral approach)	16,576.91	16,656.49	16,534.97	15,821.36	19,275.61	17,053.27	14,293.77	18,649.19	18,620.41	17,222.14	18,905.20	18,413.54	15,589.05	-56.81
1. Energy industries	13,494.90	13,391.81	13,177.78	12,360.46	15,198.96	13,194.11	11,116.63	15,391.87	15,146.85	13,681.32	15,423.76	14,889.90	12,188.33	-58.34
2. Manufacturing industries and construction	555.47	664.59	720.91	714.37	1,183.16	1,082.54	588.94	508.50	721.00	766.96	736.11	698,32	489.79	-80.39
3. Transport	1,984.55	2,031.49	2,102.95	2,267.15	2,392.41	2,275.78	2,098.39	2,220.12	2,234.99	2,261.36	2,208.19	2,234.70	2,293.13	-5.08
4. Other sectors	523.04	540.91	498.60	447.84	470.53	490.10	460.77	487.88	497.80	491.04	504.92	558,03	591.01	-68.57
5. Other	18.96	27.68	34.72	31.54	30.55	10.75	29.05	40.81	19.77	21.47	32.23	32,60	26.78	-38.29
B. Fugitive emissions from fuels	0.05	0.06	0.06	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0,03	0.03	-69.10
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	0.05	0.06	0.06	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0,03	0.03	-69.10
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial processes	491.04	615.11	584.50	603,35	781.88	807.91	312.74	355.69	470.66	705.15	782.79	484,91	284.06	-70.42
A. Mineral industry	373.24	405.94	413.96	461.34	646.27	644.40	281.27	338.65	452.71	669.35	694.51	464,46	262.66	-57.24
B. Chemical industry	92.17	184.47	146.36	117.58	110.64	141.62	14.19	NO	NO	16.62	68.63	NO	NO	
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	25.62	24.69	24.19	24.43	24.97	21.89	17.28	17.04	17.95	19.18	19.65	20,45	21.40	-44.11
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	17.24	13.08	14.84	13.00	13.45	9.74	1.42	9.37	5.06	9.74	6.47	10.76	11.24	-14.26
A. Enteric fermentation														
B. Manure management														
C. Rice cultivation														
D. Agricultural soils														
E. Prescribed burning of savannas														
F. Field burning of agricultural residues														
G. Liming	16.85	12.43	13.44	12.24	11.90	9.56	1.20	9.37	3.93	6.98	6.11	8.29	8.29	-31.53
H. Urea application	0.39	0.65	1.41	0.76	1.55	0.18	0.22	0.01	1.13	2.75	0.37	2.47	2.95	195.53
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry (2)	-2,371.61	-2,476.09	-2,693.14	-2,562.67	-2,981.32	-2,768.38	-2,781.08	-1,930.43	-2,084.96	-2,090.20	-1,494.01	-1,761.74	-2,366.01	36.25
A. Forest land	-2,792.12	-2,895.23	-3,540.54	-4,027.14	-4,296.45	-3,943.76	-3,967.73	-2,630.11	-2,761.67	-2,535.77	-2,157.21	-2,183.47	-2,475.37	-16.85
B. Cropland	52.41	59.04	79.39	104.06	129.16	152.00	174.27	167.61	153.62	146.78	146.18	133.42	119.79	18.70
C. Grassland	69.95	75.20	44.05	53.77	68.52	71.98	35.00	34.80	19.10	11.36	-16.29	6.70	37.56	-37.41
D. Wetlands	1,078.84	836.88	1,138.53	1,334.57	989.58	802.29	955.34	1,045.54	951.53	730.79	1,082.13	905.70	794.73	-26.39
E. Settlements	145.54	184.42	241.95	304.32	341.95	341.00	366.14	357.17	327.52	306.34	266.13	235.05	214.08	100.00
F. Other land	NO,IE	9.63	30.59	91.11	96.07	108.15	103.44	86.98	30.18	30.45	23.41	23.41	23.41	100.00
G. Harvested wood products	-926.23	-746.03	-687.09	-423.35	-310.15	-300.03	-447.55	-992.42	-805.25	-780.15	-838.36	-882.55	-1,080.21	100.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	2.64	1.39	1.46	0.69	0.66	1.10	0.94	0.84	0.80	0.86	1.04	0.97	0.99	-55.85
A. Solid waste disposal	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
B. Biological treatment of solid waste														
C. Incineration and open burning of waste	2.64	1.39	1.46	0.69	0.66	1.10	0.94	0.84	0.80	0.86	1.04	0.97	0.99	-55.85
D. Waste water treatment and discharge														
E. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Memo items:														
International bunkers	399.01	542.88	510.28	740.79	896.25	843.13	777.77	778.76	674.83	1,331.45	1,363.98	1,101.26	958.40	45.40
Aviation	54.33	86.07	144.59	95.85	150.70	83.95	99.09	111.39	101.71	112.22	86.47	122.27	73.72	-30.94
Navigation	344.68	456.81	365.69	644.94	745.55	759.18	678.68	667.37	573.12	1,219.23	1,277.51	978.99	884.68	60.15
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass	2,673.02	2,775.54	2,713.02	2,433.30	2,754.49	2,965.20	3,260.65	3,857.17	3,732.23	3,800.77	3,733.21	3,731.23	3,898.29	305.16
CO_2 captured	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Long-term storage of C in waste disposal sites	2,633.60	2,538.32	2,540.89	2,380.26	2,615.46	2,628.61	2,338.40	3,193.40	2,541.05	2,232.79	2,936.98	3,738.69	3,356.28	91.63
Indirect N_2O														
Indirect CO_2 (3)	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NE,NO,IE	NO,NE,IE	0.00
Total CO_2 equivalent emissions without land use, land-use change and forestry	17,087.88	17,286.13	17,135.83	16,438.47	20,071.65	17,872.08	14,608.91	19,015.14	19,096.97	17,937.93	19,695.55	18,910.21	15,885.37	-57.15
Total CO_2 equivalent emissions with land use, land-use change and forestry	14,716.27	14,810.04	14,442.69	13,875.80	17,090.33	15,103.69	11,827.83	17,084.71	17,012.01	15,847.73	18,201.54	17,148.47	13,519.36	-61.74
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

Note: All footnotes for this table are given at the end of the table on page 251.

TABLE 10 EMISSION TRENDS
CH_4
(Sheet 1 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	(kt)																						
1. Energy	7.50	7.50	7.27	4.76	3.72	4.62	7.08	8.12	8.15	6.52	6.46	6.50	6.57	6.33	6.54	6.87	6.28	6.07	7.07	7.10	6.91	7.25	6.51
A. Fuel combustion (sectoral approach)	5.49	5.49	5.26	3.58	3.13	3.78	6.13	7.07	7.12	5.54	5.51	5.41	5.40	5.35	5.46	5.59	4.97	4.74	5.75	5.84	6.05	6.33	5.67
1. Energy industries	0.30	0.30	0.29	0.19	0.18	0.22	0.23	0.25	0.26	0.27	0.27	0.25	0.29	0.29	0.29	0.32	0.36	0.28	0.25	0.31	0.37	0.51	0.56
2. Manufacturing industries and construction	0.13	0.13	0.12	0.09	0.04	0.06	0.05	0.06	0.04	0.05	0.03	0.04	0.06	0.04	0.05	0.06	0.06	0.07	0.13	0.11	0.06	0.06	0.09
3. Transport	0.92	0.92	0.86	0.40	0.44	0.53	0.50	0.50	0.57	0.43	0.51	0.46	0.53	0.47	0.41	0.38	0.37	0.37	0.35	0.31	0.26	0.23	0.21
4. Other sectors	4.14	4.14	3.99	2.89	2.48	2.97	5.35	6.26	6.25	4.79	4.70	4.65	4.52	4.55	4.70	4.83	4.17	4.03	5.02	5.12	5.36	5.52	4.82
5. Other	0.002	0.002	0.003	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.002	0.002	0.001
B. Fugitive emissions from fuels	2.01	2.01	2.01	1.18	0.58	0.84	0.96	1.05	1.02	0.97	0.95	1.09	1.17	0.98	1.08	1.27	1.31	1.33	1.32	1.27	0.86	0.92	0.83
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	2.01	2.01	2.01	1.18	0.58	0.84	0.96	1.05	1.02	0.97	0.95	1.09	1.17	0.98	1.08	1.27	1.31	1.33	1.32	1.27	0.86	0.92	0.83
C. CO_2 transport and storage																							
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry																							
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry																							
F. Product uses as ODS substitutes																							
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	55.75	55.75	52.24	44.60	35.15	32.57	29.07	26.97	26.78	25.90	22.26	21.92	22.90	21.95	22.39	22.69	22.98	23.15	23.20	23.06	22.91	23.47	23.59
A. Enteric fermentation	49.88	49.88	46.85	40.61	32.02	29.45	26.14	24.76	24.51	23.59	20.18	19.81	20.62	19.56	19.80	20.05	20.22	20.31	20.09	20.02	19.80	20.21	20.34
B. Manure management	5.87	5.87	5.39	3.99	3.13	3.12	2.92	2.21	2.27	2.32	2.08	2.11	2.28	2.38	2.59	2.64	2.76	2.85	3.11	3.05	3.11	3.26	3.26
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming																							
H. Urea application																							
I. Other carbon-containing fertilizers																							
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	0.01	0.01	0.01	0.10	0.04	0.03	0.01	0.04	0.07	0.01	0.04	0.05	0.01	0.11	0.02	0.03	0.01	0.25	0.01	0.04	0.01	0.00	0.00
A. Forest land	0.01	0.01	0.00	0.10	0.04	0.03	0.01	0.03	0.07	0.00	0.03	0.05	0.01	0.10	0.01	0.03	0.01	0.25	0.01	0.03	0.00	0.00	0.00
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C. Grassland	0.0001	0.0001	0.00003	0.001	0.0004	0.0003	0.0001	0.0004	0.001	0.0000	0.002	0.0004	0.00002	0.003	0.0002	0.0003	0.00005	0.003	0.001	0.005	0.0001	0.00002	0,00002
D. Wetlands	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0,002
E. Settlements	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products																							
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	13.13	13.13	13.65	14.11	14.96	14.91	14.41	15.98	18.30	19.03	19.29	21.14	21.49	20.95	20.36	20.25	19.07	18.48	17.95	17.30	16.82	17.13	14.98
A. Solid waste disposal	8.55	8.55	9.14	9.68	10.59	10.60	10.15	11.88	14.25	15.54	15.80	17.50	17.90	17.60	16.82	16.89	15.54	14.81	13.97	13.71	12.30	12.79	11.03
B. Biological treatment of solid waste	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.02	0.04	0.01	0.03	0.08	0.07	0.07	0.27	0.26	0.37	0.39	0.77	0.72	0.82	0.78	0.53
C. Incineration and open burning of waste	0.05	0.05	0.05	0.05	0.05	0.06	0.07	0.07	0.07	0.07	0.09	0.08	0.05	0.06	0.06	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01
D. Waste water treatment and discharge	4.51	4.51	4.43	4.35	4.29	4.21	4.15	4.00	3.94	3.41	3.37	3.48	3.46	3.22	3.22	3.06	3.13	3.26	3.20	2.86	2.84	2.70	2.55
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.85	0.85	0.85
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH_4 emissions without CH_4 from LULUCF	76.38	76.38	73.16	63.46	53.83	52.10	50.55	51.07	53.23	51.45	48.01	49.55	50.96	49.23	49.30	49.80	48.33	47.70	48.22	47.47	46.64	47.85	45.08
Total CH_4 emissions with CH_4 from LULUCF	76.40	76.40	73.17	63.57	53.87	52.13	50.57	51.10	53.30	51.45	48.05	49.60	50.96	49.34	49.31	49.83	48.34	47.95	48.22	47.51	46.64	47.85	45.09
Memo items:																							
International bunkers	0.05	0.05	0.06	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.06	0.07	0.07	0.07	0.07	0.06
Aviation	0.001	0.001	0.001	0.0004	0.0004	0.0004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.002
Navigation	0.05	0.05	0.06	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.06	0.07	0.07	0.06	0.06	0.05
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass																							
CO_2 captured																							
Long-term storage of C in waste disposal sites																							
Indirect N_2O																							
Indirect CO_2 (3)																							

TABLE 10 EMISSION TRENDS
CH_4
(Sheet 2 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2012	2013	2014	2015	Change from base to latest reported year
	(kt)				%
1. Energy	6.77	6.74	6.48	6.30	-16.02
A. Fuel combustion (sectoral approach)	5.90	5.84	5.78	5.68	3.38
1. Energy industries	0.55	0.56	0.60	0.63	108.89
2. Manufacturing industries and construction	0.10	0.12	0.12	0.12	-6.23
3. Transport	0.19	0.17	0.16	0.15	-83.27
4. Other sectors	5.07	4.99	4.91	4.77	15.19
5. Other	0.001	0.002	0.002	0.001	-38.28
B. Fugitive emissions from fuels	0.87	0.89	0.70	0.62	-69.10
1. Solid fuels	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	0.87	0.89	0.70	0.62	-69.10
C. CO_2 transport and storage					
2. Industrial processes	NO	NO	NO	NO	0.00
A. Mineral industry					
B. Chemical industry	NO	NO	NO	NO	0.00
C. Metal industry	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	0.00
E. Electronic industry					
F. Product uses as ODS substitutes					
G. Other product manufacture and use	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	0.00
3. Agriculture	24.41	25.59	25.83	24.74	-55.63
A. Enteric fermentation	21.07	22.21	22.41	21.62	-56.66
B. Manure management	3.34	3.39	3.42	3.12	-46.84
C. Rice cultivation	NO	NO	NO	NO	0.00
D. Agricultural soils	NO	NO	NO	NO	0.00
E. Prescribed burning of savannas	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO	NO	NO	NO	0.00
G. Liming					
H. Urea application					
I. Other carbon-containing fertilizers					
J. Other	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry	0.00	0.00	0.00	0.00	-82.17
A. Forest land	0.00	0.00	0.00	0.00	-98.98
B. Cropland	NA,NO	NA,NO	NA,NO	NO,NA	0.00
C. Grassland	0.0001	0.00001	0.00003	0.000003	-96.77
D. Wetlands	0.002	0.002	0.002	0.002	-10.73
E. Settlements	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	0.00
F. Other land	NO	NO	NO	NO	0.00
G. Harvested wood products					
H. Other	NO	NO	NO	NO	0.00
5. Waste	14.67	13.20	11.95	11.33	-13.75
A. Solid waste disposal	10.45	8.97	8.05	7.49	-12.37
B. Biological treatment of solid waste	0.59	0.73	0.51	0.60	2113.79
C. Incineration and open burning of waste	0.02	0.02	0.02	0.02	-62.40
D. Waste water treatment and discharge	2.76	2.57	2.46	2.36	-47.68
E. Other	0.85	0.91	0.92	0.86	100.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	0.00
Total CH_4 emissions without CH_4 from LULUCF	45.85	45.52	44.26	42.36	-44.54
Total CH_4 emissions with CH_4 from LULUCF	45.85	45.53	44.26	42.37	-44.55
Memo items:					
International bunkers	0.12	0.12	0.10	0.09	59.88
Aviation	0.002	0.002	0.002	0.002	39.46
Navigation	0.12	0.12	0.09	0.08	60.33
Multilateral operations	NO	NO	NO	NO	0.00
CO_2 emissions from biomass					
CO_2 captured					
Long-term storage of C in waste disposal sites					
Indirect N_2O					
Indirect CO_2 [(3)]					

Note: All footnotes for this table are given at the end of the table on page 251.

TABLE 10 EMISSION TRENDS
N_2O
(Sheet 1 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(kt)																				
1. Energy	0.39	0.39	0.37	0.26	0.24	0.24	0.27	0.31	0.30	0.28	0.26	0.27	0.33	0.36	0.30	0.32	0.32	0.30	0.31	0.30	0.32
A. Fuel combustion (sectoral approach)	0.39	0.39	0.37	0.26	0.24	0.24	0.27	0.31	0.30	0.28	0.26	0.27	0.33	0.36	0.30	0.32	0.32	0.30	0.31	0.30	0.32
1. Energy industries	0.06	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.07	0.06	0.06	0.07	0.07
2. Manufacturing industries and construction	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
3. Transport	0.13	0.13	0.12	0.07	0.08	0.11	0.12	0.14	0.13	0.13	0.14	0.15	0.20	0.22	0.13	0.13	0.13	0.12	0.11	0.10	0.10
4. Other sectors	0.18	0.18	0.18	0.13	0.12	0.08	0.10	0.12	0.12	0.10	0.08	0.08	0.07	0.09	0.12	0.12	0.11	0.11	0.12	0.12	0.14
5. Other	0.002	0.002	0.003	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.002
B. Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. CO_2 transport and storage																					
2. Industrial processes	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
A. Mineral industry																					
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry																					
F. Product uses as ODS substitutes																					
G. Other product manufacture and use	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	4.24	4.24	4.09	3.41	2.57	2.27	2.00	1.83	1.87	1.94	1.67	1.71	1.67	1.55	1.69	1.82	1.81	1.78	1.97	2.18	2.01
A. Enteric fermentation																					
B. Manure management	0.45	0.45	0.43	0.36	0.29	0.27	0.24	0.21	0.21	0.20	0.19	0.17	0.20	0.19	0.20	0.20	0.20	0.20	0.20	0.20	0.20
C. Rice cultivation																					
D. Agricultural soils	3.79	3.79	3.66	3.05	2.28	2.00	1.76	1.62	1.66	1.74	1.48	1.54	1.47	1.36	1.50	1.62	1.61	1.59	1.77	1.98	1.81
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming																					
H. Urea application																					
I. Other carbon containing fertlizers																					
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.004	0.006	0.004	0.005	0.007	0.012	0.012	0.016	0.018
A. Forest land	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.002	0.000	0.000	0.000
B. Cropland	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO,NA	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
C. Grassland	0.00001	0.00001	0.000003	0.0001	0.00004	0.00003	0.00001	0.00004	0.0001	0.000004	0.0001	0.00004	0.00000	0.0003	0.00002	0.00003	0.000004	0.0003	0.0001	0.0005	0.00001
D. Wetlands	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
E. Settlements	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO
F. Other land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE.NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Harvested wood products																					
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.11	0.10	0.11	0.10	0.10	0.12	0.11	0.12	0.12	0.15	0.14	0.15
A. Solid waste disposal																					
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.05	0.04	0.05
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.13	0.13	0.13	0.13	0.12	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other ***(as specified in summary 1.A)***	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N_2O emissions without N_2O from LULUCF	4.78	4.78	4.61	3.81	2.95	2.65	2.40	2.27	2.30	2.35	2.05	2.11	2.12	2.04	2.13	2.27	2.27	2.22	2.44	2.64	2.50
Total direct N_2O emissions with N_2O from LULUCF	4.78	4.78	4.62	3.82	2.95	2.65	2.41	2.28	2.30	2.36	2.06	2.12	2.13	2.04	2.14	2.27	2.28	2.23	2.45	2.66	2.51
Memo items:																					
International bunkers	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Aviation	0.003	0.003	0.003	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.002	0.004	0.003	0.004	0.002	0.003
Navigation	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass																					
CO_2 captured																					
Long-term storage of C in waste disposal sites																					
Indirect N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Indirect CO_2 (3)																					

Note: All footnotes for this table are given at the end of the table on page 251.

TABLE 10 EMISSION TRENDS
N_2O
(Sheet 2 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)						%
1. Energy	0.37	0.35	0.35	0.36	0.39	0.39	0.86
A. Fuel combustion (sectoral approach)	0.37	0.35	0.35	0.36	0.39	0.39	0.86
1. Energy industries	0.09	0.10	0.09	0.10	0.10	0.11	85.60
2. Manufacturing industries and construction	0.01	0.01	0.01	0.02	0.02	0.02	-16.72
3. Transport	0.12	0.10	0.10	0.09	0.09	0.09	-30.23
4. Other sectors	0.14	0.14	0.15	0.15	0.18	0.18	-2.48
5. Other	0.002	0.001	0.001	0.002	0.002	0.001	-40.52
B. Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NO	NO	NO	0.00
C. CO_2 transport and storage							
2. Industrial processes	0.02	0.02	0.01	0.01	0.01	0.01	-30.47
A. Mineral industry							
B. Chemical industry	NO	NO	NO	NO	NO	NO	0.00
C. Metal industry	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	0.00
E. Electronic industry							
F. Product uses as ODS substitutes							
G. Other product manufacture and use	0.02	0.02	0.01	0.01	0.01	0.01	-30.47
H. Other	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	2.00	2.09	2.31	2.21	2.30	2.38	-43.94
A. Enteric fermentation							
B. Manure management	0.20	0.20	0.21	0.21	0.22	0.21	-54.01
C. Rice cultivation							
D. Agricultural soils	1.80	1.89	2.10	1.99	2.08	2.17	-42.74
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	0.00
G. Liming							
H. Urea application							
I. Other carbon containing fertlizers							
J. Other	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry	0.020	0.021	0.022	0.022	0.022	0,023	358.32
A. Forest land	0.000	0.000	0.000	0.000	0.000	0,000	-98.98
B. Cropland	0.02	0.02	0.02	0.02	0.02	0,02	100.00
C. Grassland	0.000002	0.000002	0.000006	0.000001	0.000003	0,0000003	-96.77
D. Wetlands	0.004	0.004	0.004	0.004	0.004	0,004	-10.73
E. Settlements	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NE,NA,NO	NO,NE,NA	0.00
F. Other land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO,NE	0.00
G. Harvested wood products							
H. Other	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.15	0.14	0.14	0.15	0.14	0.14	6.58
A. Solid waste disposal							
B. Biological treatment of solid waste	0.05	0.03	0.04	0.04	0.03	0.04	2113.79
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	-59.40
D. Waste water treatment and discharge	0.10	0.10	0.10	0.10	0.10	0.10	-22.08
E. Other	0.00	0.00	0.00	0.00	0.00	0.00	100.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	0.00
Total direct N_2O emissions without N_2O from LULUCF	2.53	2.60	2.81	2.73	2,84	2,92	-38.83
Total direct N_2O emissions with N_2O from LULUCF	2.55	2.62	2.84	2.75	2,86	2,95	-38.43
Memo items:							
International bunkers	0.02	0.02	0.04	0.04	0,03	0,03	45.24
Aviation	0.003	0.003	0.003	0.002	0,003	0,002	-31.40
Navigation	0.02	0.02	0.03	0.03	0,03	0,02	60.33
Multilateral operations	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass							
CO_2 captured							
Long-term storage of C in waste disposal sites							
Indirect N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO,NE	0.00
Indirect CO_2 [(3)]							

Note: All footnotes for this table are given at the end of the table on page 251.

TABLE 10 EMISSION TRENDS
HFCs, PFCs, SF6, and NF3
(Sheet 1 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year [1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	(kt)																		
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	NO	NO	NO	17.51	20.02	22.91	28.45	34.56	41.31	52.25	63.39	79.15	97.19	98.83	104.87	119.33	134.96	154.66	170.44
Emissions of HFCs - (kt CO_2 equivalent)	NO	NO	NO	17.51	20.02	22.91	28.45	34.56	41.31	52.25	63.39	79.15	97.19	98.83	104.87	119.33	134.96	154.57	170.37
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00002	0.00002	0.00002
HFC-32	NO	NO	NO	NO	NO	NO	0.0000003	0.0000	0.0000	0.0002	0.0003	0.0005	0,0007	0.0008	0.001	0.001	0.001	0,.002	0.002
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	0.000	0.000	0.001	0.001	0.002	0.002	0.003	0.004	0,005	0.01	0.01	0.01	0.01	0.01	0.01
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NO	NO	NO	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06	0.06
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	NO	0.000	0.000	0.001	0.001	0.002	0.003	0.003	0.004	0.004	0.01	0.01	0.01	0.01	0.01	0.01
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00003	0.00003	0.00003	0.003	0.003	0.003	0.003	0.02
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00001	0.00003	0.00007	0,0001	0.0002	0.0002	0.0003	0.0003
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00002	0.00003	0.00010	0.00009
Unspecified mix of HFCs[4] - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	0.1	0.1
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_3F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	0.00001	0.00001
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
$c-C_4F_8$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
$C_{10}F_{18}$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
$c-C_3F_6$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs[4] - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF_6 - (kt CO_2 equivalent)	NO	NO	0.05	0.09	1.39	2.97	3.07	3.33	2.85	2.85	2.88	2.61	1,67	1.38	1.27	1.04	1.03	1.10	0.92
SF_6	NO	NO	0.000002	0.000004	0.00006	0.00013	0.00013	0.00015	0.00013	0.00012	0.00013	0.00011	0.00007	0.00006	0.00006	0.00005	0.00005	0.00005	0.00004
Emissions of NF_3 - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on page 251.

TABLE 10 EMISSION TRENDS
HFCs, PFCs, SF6, and NF3
(Sheet 2 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)								%
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	150.44	157.53	175.54	183.32	193.21	207.26	217.52	222.82	100.00
Emissions of HFCs - (kt CO_2 equivalent)	150.39	157.53	175.54	183.32	193.21	207.26	217.52	222.82	100.00
HFC-23	0.00003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	100.00
HFC-32	0.002	0.003	0.003	0.004	0.004	0.005	0.005	0.01	100.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	100.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	100.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	100.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-152a	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	100.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-227ea	0.0003	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005	100.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-365mfc	0.00009	0.00003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	100.00
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of PFCs - (kt CO_2 equivalent)	0.05	NO	NO	NO	NO	NO	NO	NO	0.00
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_3F_8	0.00001	NO	NO	NO	NO	NO	NO	NO	0.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	0.00
$c-C_4F_8$	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	0.00
$C_{10}F_{18}$	NO	NO	NO	NO	NO	NO	NO	NO	0.00
$c-C_3F_6$	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of SF_6 - (kt CO_2 equivalent)	1.29	1.38	1.73	1.77	1.88	2.03	2.10	2.25	100.00
SF_6	0.00006	0.00006	0.00008	0.00008	0.00008	0.00009	0.00009	0.0001	100.00
Emissions of NF_3 - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.00
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	0.00

Note: All footnotes for this table are given at the end of the table on page 251.

TABLE 10 EMISSION TRENDS
SUMMARY
(Sheet 1 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS EMISSIONS	Base year [1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	CO_2 equivalent (kt)															
CO_2 emissions without net CO_2 from LULUCF	37,069.22	37,069.22	34,038.05	24,514.86	19,066.33	19,901.52	18,204.82	18,926.73	18,484.06	16,911.51	15,729.24	15,362.56	15,708.57	15,233.77	17,087.88	17,286.13
CO_2 emissions with net CO_2 from LULUCF	35,332.70	35,332.70	32,225.10	23,214.88	16,914.49	18,384.25	16,395.84	17,094.64	16,267.16	13,959.17	12,498.68	11,963.18	14,197.77	13,207.11	14,716.27	14,810.04
CH_4 emissions without CH_4 from LULUCF	1,909.61	1,909.61	1,829.09	1,586.57	1,345.72	1,302.45	1,263.80	1,276.71	1,330.66	1,286.17	1,200.21	1,238.80	1,273.90	1,230.69	1,232.44	1,244.99
CH_4 emissions with CH_4 from LULUCF	1,909.95	1,909.95	1,829.24	1,589.18	1,346.71	1,303.17	1,264.13	1,277.61	1,332.39	1,286.31	1,201.18	1,240.05	1,274.09	1,233.39	1,232.82	1,245.78
N_2O emissions without N_2O from LULUCF	1,423.92	1,423.92	1,375.21	1,135.28	878.20	788.78	716.25	677.65	685.07	700.46	611.85	630.15	632.51	606.55	634.92	675.28
N_2O emissions with N_2O from LULUCF	1,425.38	1,425.38	1,376.65	1,137.04	879.75	790.28	717.70	679.15	686.66	701.82	613.31	631.59	633.80	608.19	636.26	676.85
HFCs	NO	NO	NO	17.51	20.02	22.91	28.45	34.56	41.31	52.25	63.39	79.15	97.19	98.83	104.87	119.33
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	NO	NO	0.05	0.09	1.39	2.97	3.07	3.33	2.85	2.85	2.88	2.61	1.67	1.38	1.27	1.04
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	40,402.74	40,402.74	37,242.40	27,254.31	21,311.66	22,018.63	20,216.40	20,918.98	20,543.94	18,953.24	17,607.58	17,313.27	17,713.83	17,171.21	19,061.38	19,326.77
Total (with LULUCF)	38,668.03	38,668.03	35,431.05	25,958.70	19,162.36	20,503.59	18,409.19	19,089.29	18,330.37	16,002.39	14,379.45	13,916.58	16,204.51	15,148.90	16,691.48	16,853.04
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year(1)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	CO2 equivalent (kt)															
1. Energy	36,397.39	36,397.39	33,354.40	24,150.07	18,896.48	19,512.18	17,855.16	18,605.73	18,113.36	16,432.66	15,318.70	14,974.85	15,319.57	15,029.59	16,830.73	16,922.06
2. Industrial processes and product use	965.73	965.73	968.27	576.26	355.35	601.80	637.43	653.81	705.15	758.43	694.01	697.60	733.10	555.08	603.01	741.41
3. Agriculture	2,669.72	2,669.72	2,536.99	2,133.81	1,647.88	1,493.58	1,326.10	1,223.66	1,232.17	1,252.50	1,079.50	1,078.02	1,090.55	1,029.38	1,081.34	1,121.78
4. Land use, land-use change and forestry [5]	-1,734.71	-1,734.71	-1,811.36	-1,295.61	-2,149.30	-1,515.05	-1,807.21	-1,829.68	-2,213.57	-2,950.84	-3,228.14	-3,396.68	-1,509.32	-2,022.31	-2,369.90	-2,473.73
5. Waste	369.90	369.90	382.75	394.18	411.96	411.06	397.71	435.77	493.26	509.66	515.39	562.80	570.61	557.16	546.29	541.52
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF) [5]	38,668.03	38,668.03	35,431.05	25,958.70	19,162.36	20,503.59	18,409.19	19,089.29	18,330.37	16,002.39	14,379.45	13,916.58	16,204.51	15,148.90	16,691.48	16,853.04

(1) The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

(2) Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(3) In accordance with the UNFCCC reporting guidelines, for Parties that decide to report indirect CO_2 the national totals shall be provided with and without indirect CO_2.

(4) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

(5) Includes net CO_2, CH_4 and N_2O from LULUCF.

TABLE 10 EMISSION TRENDS
SUMMARY
(Sheet 2 of 2)

Inventory 2015
Submission 2017 v3
ESTONIA

GREENHOUSE GAS EMISSIONS	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
												(%)
CO_2 emissions without net CO_2 from LULUCF	17,135.83	16,438.47	20,071.65	17,872.08	14,608.91	19,015.14	19,096.97	17,937.93	19,695.55	18,910.21	15,885.37	-57.15
CO_2 emissions with net CO_2 from LULUCF	14,442.69	13,875.80	17,090.33	15,103.69	11,827.83	17,084.71	17,012.01	15,847.73	18,201.54	17,148.47	13,519.36	-61.74
CH_4 emissions without CH_4 from LULUCF	1,208.32	1,192.56	1,205.38	1,186.79	1,165.96	1,196.23	1,127.04	1,146.17	1,138.10	1,106.43	1,059.09	-44.54
CH_4 emissions with CH_4 from LULUCF	1,208.56	1,198.82	1,205.62	1,187.83	1,166.12	1,196.33	1,127.14	1,146.23	1,138.16	1,106.53	1,059.15	-44.55
N_2O emissions without N_2O from LULUCF	676.61	661.94	727.81	787.79	744.11	754.82	773.57	838.87	813.33	844.86	870.96	-38.83
N_2O emissions with N_2O from LULUCF	678.60	665.43	731.41	792.50	749.47	760.76	779.85	845.38	819.99	851.56	877.68	-38.43
HFCs	134.96	154.57	170.37	150.39	157.53	175.54	183.32	193.21	207.26	217.52	222.82	100.00
PFCs	NA,NO	0.09	0.08	0.05	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
SF_6	1.03	1.10	0.92	1.29	1.38	1.73	1.77	1.88	2.03	2.10	2.25	100.00
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (without LULUCF)	19,156.75	18,448.72	22,176.21	19,998.39	16,677.89	21,143.45	21,182.67	20,118.05	21,856.28	21,081.13	18,040.48	-55.35
Total (with LULUCF)	16,465.84	15,895.80	19,198.73	17,235.75	13,902.32	19,219.06	19,104.08	18,034.42	20,368.99	19,326.18	15,681.26	-59.45
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
												(%)
1. Energy	16,787.35	16,062.45	19,545.92	17,321.41	14,561.39	18,939.30	18,887.78	17,496.63	19,181.24	18,691.23	15,863.86	-56.41
2. Industrial processes and product use	726.42	764.25	957.72	964.34	475.91	537.58	660.46	904.44	996.01	707.69	512.92	-46.89
3. Agriculture	1,129.09	1,123.75	1,179.45	1,236.16	1,173.28	1,192.37	1,218.35	1,307.40	1,303.52	1,341.93	1,337.62	-49.90
4. Land use, land-use change and forestry [5]	-2,690.91	-2,552.92	-2,977.48	-2,762.64	-2,775.58	-1,924.39	-2,078.59	-2,083.63	-1,487.29	-1,754.94	-2,359.23	-36.00
5. Waste	513.89	498.27	493.12	476.48	467.32	474.20	416.08	409.58	375.50	340.27	326.08	-11.85
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF) [5]	16,465.84	15, 895.80	19,198.73	17,235.75	13,902.32	19,219.06	19,104.08	18,034.42	20,368.99	19,326.18	15,681.26	-59.45

[1] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[2] Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[3] In accordance with the UNFCCC reporting guidelines, for Parties that decide to report indirect CO_2 the national totals shall be provided with and without indirect CO_2.

[4] In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

[5] Includes net CO_2, CH_4 and N_2O from LULUCF.

Documentation box:	
• Parties should provide detailed explanations on emissions trends in chapter 2: Trends in Greenhouse Gas Emissions and, as appropriate, in the corresponding Chapters 3 - 8 of the national inventory report (NIR). Use this documentation box to provide references to relevant sections of the NIR if any additional information and further details are needed to understand the content of this table. • Use the documentation box to provide explanations if potential emissions are reported.	
Documentation box	

Annex II Summary of reporting of supplementary information under Article 7, paragraph 2 of the Kyoto protocol in the 7th National Communication

Information reported under Article 7, paragraph 2	**Chapter of the 7th National Communication**
National systems in accordance with Article 5, paragraph 1	**3.3**
National registries	**3.4**
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17	**5.4**
Policies and measures in accordance with Article 2	**4.2; 4.3**
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures	**4.2**
Information under Article 10	
Article 10a	**3.3; 8.2.6**
Article 10b	**4.2; 6.5.1**
Article 10c	**7.2**
Article 10d	**8**
Article 10e	**9.8**
Financial resources	**7**