Projections

1 Overview of emissions projections

As a member of the European Union, Latvia is obliged to report to the European Commission emission projections according to Article 8 of Directive (EU) 2016/2284 of the European Parliament and the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC or NEC directive.

The Informative inventory report submitted under the Convention on Long-Range Transboundary Air Pollution on 15.03.2018 has been used as a starting point for the projections and the year 2016 is used as a base year.

Emissions are projected for the scenario with current policies and existing measures (WM) and the scenario with additional measures (WAM). The emission projection is done using the macroeconomic indicators forecast for the year 2030 elaborated by the Ministry of Economics (Gross Domestic Product (GDP), Value Added (VA), private consumption and the number of population). The projections are calculated for NOx, NMVOC, SO_2, NH_3, $PM_{2,5}$ and BC emissions.

The submission contains:

1. Report on Projections of National Emissions in Latvia;
2. Emission projections reporting template (Annex IV).

Latvias projections for 2020, 2025 and 2030 is prepared in co-operation between Institute of Physical Energetics, Ltd "Latvian Environment, Geology and Meteorology Centre", Latvia University of Life Sciences and Technologies and sectoral ministries.

2 Emission reduction targets for 2020 and 2030

On 31 December 2016, Directive (EU) 2016/2284 of the European Parliament and the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC or NEC directive entered into force. The Directive sets out new emission reduction commitments for Latvia (see Table 0.1).

To ensure the legal framework for meeting the requirements for reaching the target of emission reduction, on 12 April 2018 amendments to the Law on Pollution[1] were adopted. The given amendments stipulate that Latvia shall have to reduce emissions of NO_x, NMVOC, SO_2, NH_3, $PM_{2,5}$ in different sectors of economy in the period 2020-2029 and the year 2030 onwards. The targets for reducing the mentioned emissions for the stated period and 2030 onwards were laid down in Cabinet Regulations No 614 of 2 October 2018 "Emissions reduction and accounting rules of gross air pollutants"[2] (hereinafter – Cabinet Regulations No 614).

Table 0.1 Emission reduction commitments for Latvia

Emission	For any year from 2020 to 2029	For any year from 2030
SO_2	8 %	46 %
NO_x	32 %	34 %
NMVOC	27%	38 %
NH_3	1 %	1 %
$PM_{2.5}$	16 %	43 %

Note: The reduction commitments have the year 2005 as base year

[1] Latvijas Republikas Saeima. Grozījumi Likumā "Par piesārņojumu". Pieņemti 2018.gada 12.aprīlī, stājās spēkā 2018.gada 10.maijā, https://likumi.lv/ta/id/298653

[2] MK 2018.gada 2.oktobra noteikumi Nr. 614 "Kopējo gaisu piesārņojošo vielu emisiju samazināšanas un uzskaites noteikumi"

3 Projected emissions with existing measures (WM) and with additional measures (WAM)

The scenarios underlying the emission projections in the 2019 submission incorporate new insights with regard to economic and demographic developments, sector developments, fossil fuel prices and policies when compared with the projection of 2017 submission.

National emission projections have been made for the years 2020, 2025 and 2030. The projections are based on the policies and measures approved by the Parliament of Latvia and government before the year 2018, which means that it is a projection "with measures" (WM).

Emission calculations incorporates also policies and measures that are included in the climate policy scenario developed under the climate and energy package for 2030.

In addition to this scenario, there are also projected emissions with planned policies and measures. They are principally announced by high-level strategic development documents elaborated but not yet adopted and still their implementation has not been elaborated in detail yet and legal regulations have not been adopted either but are expected to be adopted and implemented from the specific future year onwards. This is the "scenario with additional measures" (WAM).

In addition, sensitivity analysis regarding emissions projections has been carried out. GDP and population assumptions impacts on projected emissions (NOx, NMVOC, SO_2, $PM_{2,5}$) have been analysed in 1A1; 1A2; 1A3 and 1A4 NFR sectors.

3.1 NO_x

WM scenario

The gross NOx emission projections for 2030 reveal reduction against 2016 and are by 5.2% lower than those in 2016. The major emission sources in 2030 are the transport sector (36.5%), fuel combustion in the industry sector (10.6%), the energy industries sector (13.9%), service sector and households (18.9%), and agriculture (13.8%).

Analysing trends in changes of emission projections in different sectors in the period 2016-2030 it can be noted that increase is projected for emissions from fuel combustion in the industry sector (35.9%) and industrial processes. The main reason for the increase is the assumed future growth rate in the manufacturing industry. In the transport sector, as the major NOx emission source, the projected emissions are reduced by 17.4% in 2030 against 2016. The greatest reduction is projected in road transport due to changing the present vehicles by such which run on more effective fossil fuel and a wider entry of vehicles that use alternative fuels (compressed natural gas (CNG), liquid natural gas (LNG), plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV)).

It should be noted that the emission projections in the road transport sector is based on the information about currently available technologies and the respective environmental quality requirements (e.g., EURO6 and EURO6+, PEV, BEV, CNG).

The other greatest NOx emission reduction is projected for the service sector and households where the energy efficiency measures in residential and public buildings will provide reduction of energy consumption required for heating.

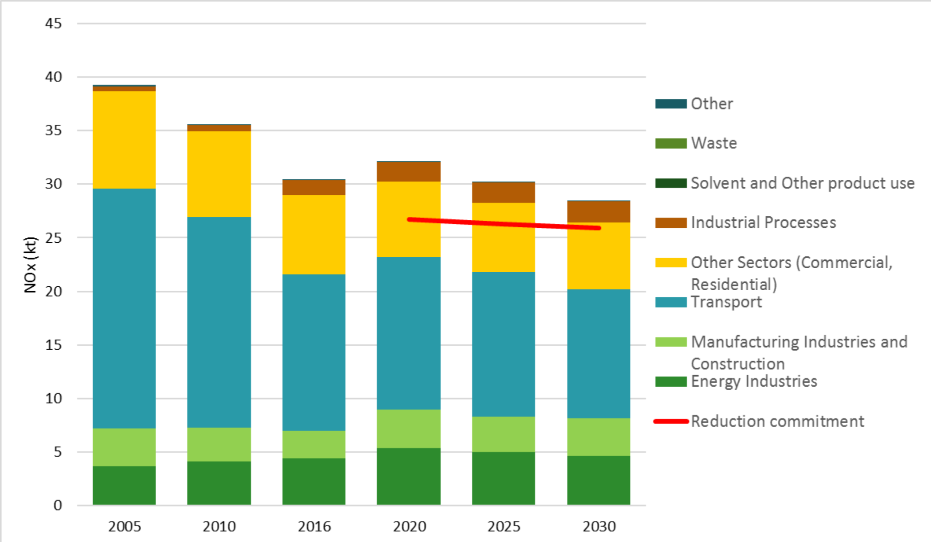

Figure 0.1 NO_x emissions according to the latest inventory (2005-2016) and the WM projections (up to 2030)

Note. Complying with Directive 2016/2284, Article 4, the projected emissions reduction does not include emissions from manure management and agricultural soils.

Figure 0.1 reveals that the NO_x emission projections in the WM scenario exceed the emission ceilings determined by the EU in 2020 by about 20%, but in 2030 they are by about 10% higher than the set target.

WAM scenario

In addition to the measures in the WM scenario, the WAM scenario encompasses three groups of measures for the projected emissions reduction from fuel combustion.

- Group 1 addresses energy consumption reduction by implementing energy efficiency measures. They are planned basically for the service sector and households.
- Group 2 refers to replacing the used combustion equipment by such that corresponds to the requirements of higher emission limit values.
- Group 3 is associated with transport sector. In road transport, first, the stock of passenger cars to be replaced with more environmentally friendly cars. It embraces both wider use of alternative fuels and electric vehicles and reduction in the number of cars running on diesel fuel. WAM scenario envisages railway electrification planned under the 2014-2020 Operational Programme “Growth and Employment” Priority 6.2. “Developing and restoration of comprehensive, quality and interoperable railway systems, and promoting noise reduction measures”.

In the WAM scenario the impact of the first two groups is estimated not only for NO_x emissions, but also for NMVOC, SO_2 and $PM_{2,}$ emissions, while the impact of Group 3 – only for NO_x emissions.

When implementing all three groups of measures, the projected NO_x emissions in the WAM scenario for 2030 are by about 12% lower than in the WM scenario and as a result they are by 2% lower than the set target.

However it is projected that the target for 2020 will be exceeded. Given that planned measures to reduce NOx emissions are related to large investments in transport sector (electrification, development of alternative fuel infrastructure), as well as changes in consumer behaviour, implementation of measures is planned after 2020. 2020 target trajectory will be met before 2025.

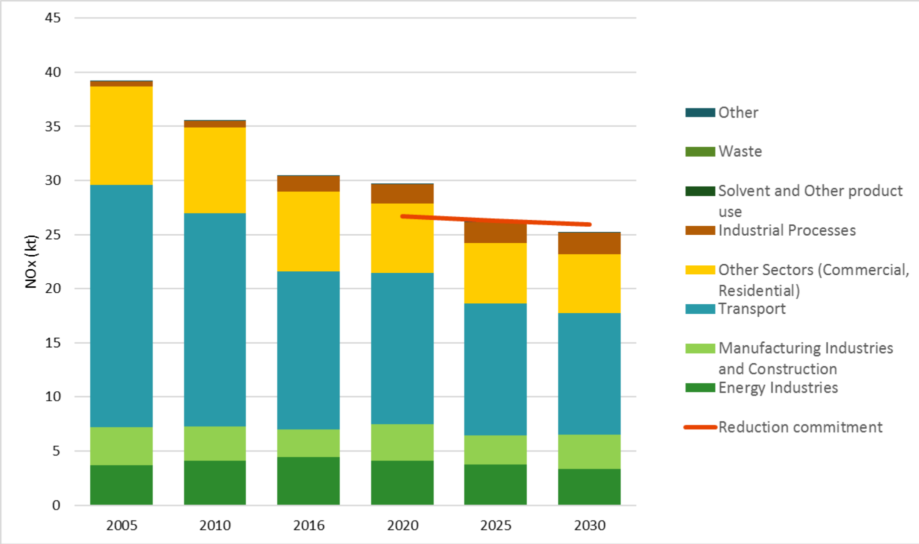

Figure 0.2 NO_x emissions according to the latest inventory (2005-2016) and the WAM projections (up to 2030)

3.2 SO_2

WM scenario

While in the period 2005-2016 the trend in SO_2 emissions revealed essential reduction, the WM scenario projects an increase of gross emissions before the year 2030 because of the projected fuel combustion in the industry sector and energy industries sector. Emissions increase in the energy conversion sector (energy industries) by 2020 is linked with replacing imported electricity with locally produced electricity; this assumption takes roots in the development of imported electricity prices by 2030. The major emission sources in 2030 are the energy conversion sector (28.3%), fuel combustion in industry (36.8%) and the service sector and households (31.7%). While in the energy conversion sector emission increase is due to replacing natural gas with biomass in boiler houses and combined heat power plants, in the industry sector it is due to the growth of fuel combustion determined by assumptions of increase in production volumes. Figure 0.3 below shows that according to the WM scenario SO_2 emissions are by 47.8% lower in 2020 and by 48.2% lower in 2030 than in the year 2005.

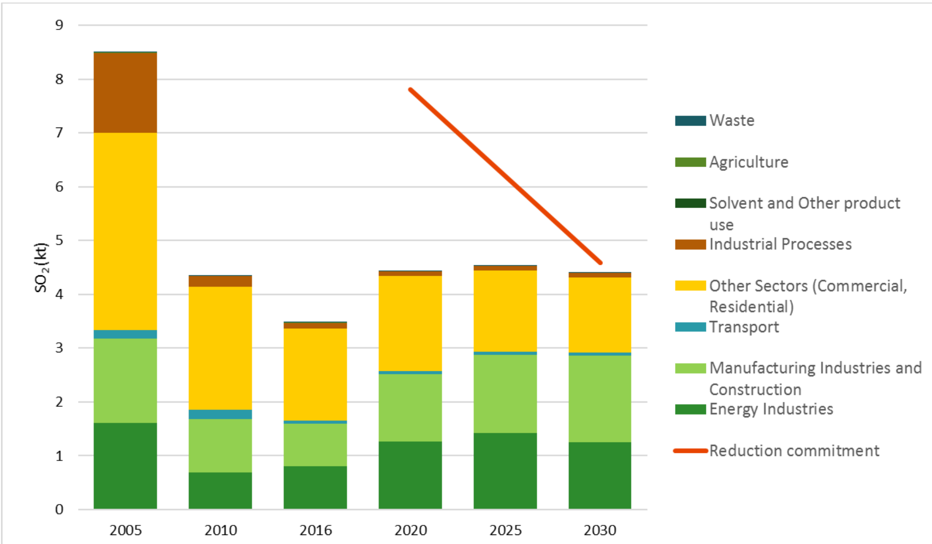

Figure 0.3 SO_2 emissions according to the latest inventory (2005-2016) and the WM projections (up to 2030)

Such emission trends provide reaching the set targets for the years 2020 and 2030. Emission projections for 2030 are by about 4% lower than the set emission target for 2030.

WAM scenario

Implementation of energy efficiency additional measures contributes also to SO_2 emissions reduction in the energy conversion sector, service sector and households, and fuel combustion in the industry sector.

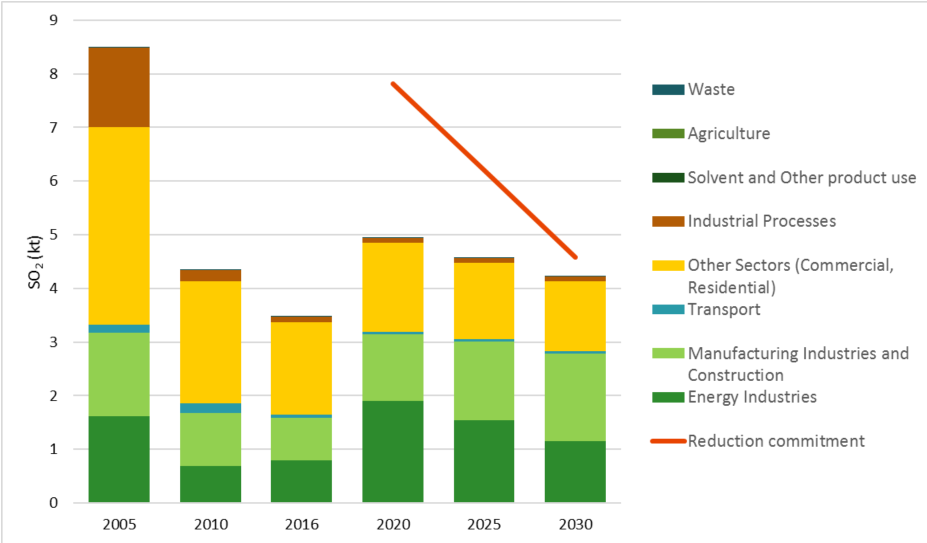

Figure 0.4 SO_2 emissions according to the latest inventory (2005-2016) and the WAM projections (up to 2030)

Implementation of energy efficiency measures reduces the projected SO_2 emissions in 2030 according to the WAM scenario by about 3.9% in comparison with the WM scenario. Consequently, the projected emissions are by 7.8% lower than the set target for 2030.

3.3 NMVOC

WM scenario

The results of the projected NMVOC emissions reveal that in the period up 2030 emissions might be reduced by 10.8% in comparison with 2016. The major emission sources in 2030 are use of solvents and other products (26.5%), fuel combustion in the service sector and households (18.8%), agriculture (24.0%) and fuel combustion in manufacturing industries (15.2%) and transport (5.9%).

In comparison with 2016 the projected NMVOC emissions in 2030 are lower by 22.1% in the transport sector as fuel consumption, petrol including, is reduced in the road transport, and household and commercial and service sector emissions decrease by 30.1% due to the implementation of energy efficiency measures in heating public and residential buildings. Emissions from the use of solvents and other products decline by 16.1% as their lower consumption is predicted. Emissions increase is forecasted only in manufacturing, as the predicted increase in production requires increase of energy consumption in the sector that mainly uses wood biomass and natural gas.

The figure below shows the projected NMVOC emissions up to 2030 considering, as stipulated by Directive 2016/2284, Article 4, that the gross emission reduction does not include emissions from manure management and agricultural soils. Figure 0.5 reveals that the projected emissions trajectory ensures reaching the targets in 2020 and 2030.

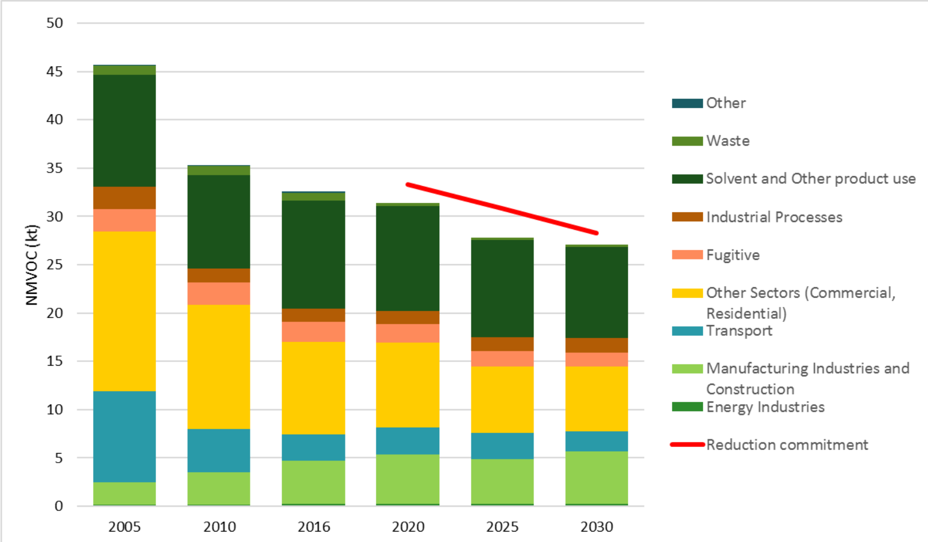

Figure 0.5 NMVOC emissions according to the latest inventory (2005-2016) and the WM projections (up to 2030)

The calculated NMVOC emissions are by about 4.3% lower than the set emissions reduction trajectory for the year 2030.

WAM scenario

The implementation of energy efficiency measures, basically aimed at renovation of public and residential buildings, make vital impact upon the NMVOC emissions projections. In the WAM scenario, they are by 2.6% lower than in the WM scenario in 2030 and the projected emissions are by 6.9% lower than the set target.

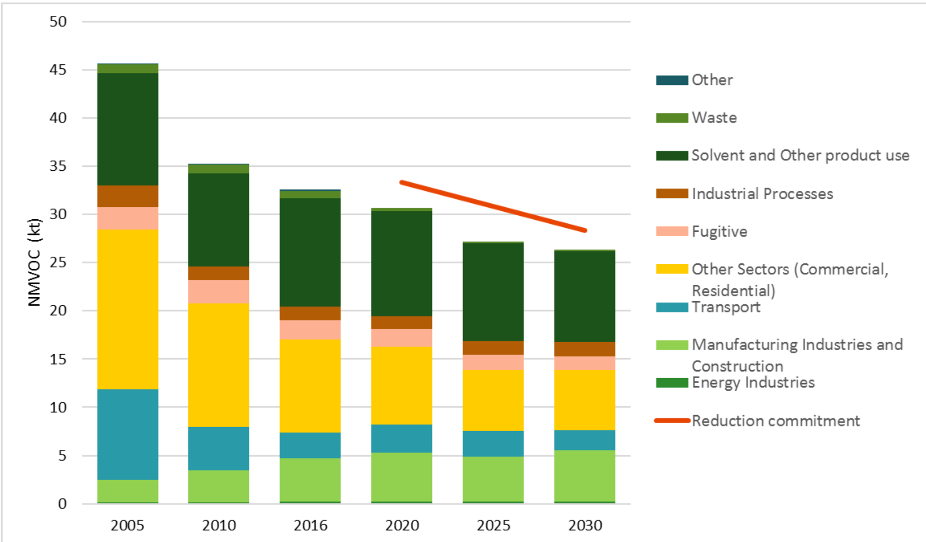

Figure 0.6 NMVOC emissions according to the latest inventory (2005-2016) and the WAM projections (up to 2030)

3.4 NH_3

WM scenario

The largest source of NH_3 emissions is agriculture and its share in the gross projected emissions for 2030 make about 89.3%. The projected gross ammonia emissions are by 8.6% higher in 2030 than in 2016 and by 18.4% than in 2005. The projected emissions in the agricultural sector are by 13% higher in 2030 than in 2016 and by 32.4% than in 2005. The major NH_3 emission sources in agriculture are manure management and use of synthetic fertilizers. The calculated emission projections predict increase in the share of NH_3

emissions from the use of synthetic ammonium fertilizers and manure in 2030 by about 18% points in comparison with 2016, making 52% in 2020 and 53% in 2030 from gross NH_3 emissions in agriculture.

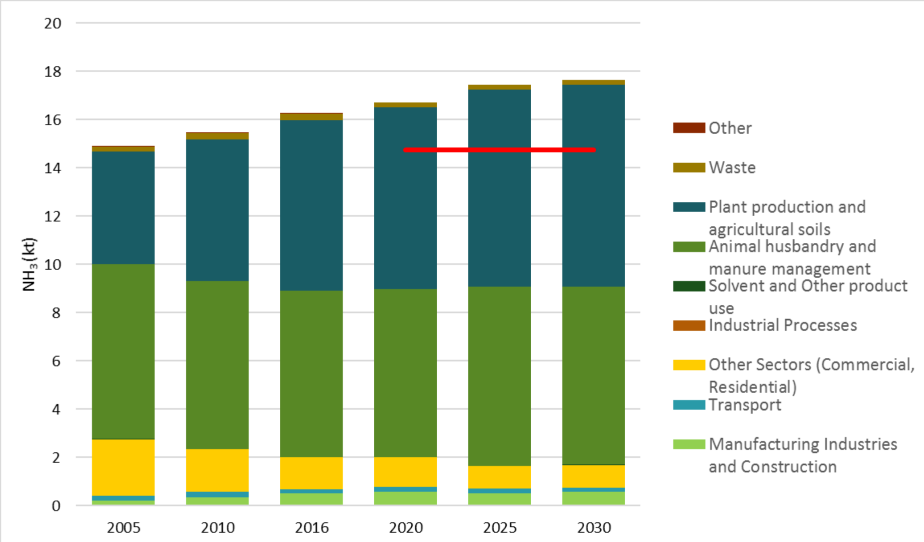

Figure 0.7 NH_3 emissions according to the latest inventory (2005-2016) and the WM projections (up to 2030)

Such emission projections exceed the national targets for 2020 and 2030 by 13.4% and 19.6% respectively.

In the WM scenario ammonia emission projections for 2030 indicate that without essential changes in the current practice of manure management and use of synthetic fertilizers ammonia emissions will increase and in 2030 they might be by 8.5% higher than in 2016.

WAM scenario

Implementation of additional policies and measures in agriculture plays a decisive role in the reduction of ammonia emissions in the WAM scenario. Additional measures include three groups of measures:

- Additional measures for reducing the use of mineral ammonium in crop production;
- Additional measures for reducing ammonia emissions from manure management;
- Additional measures for feeding management of cattle.

Each of the above groups is offered alternative measures. To be able to evaluate the impact of the selected measures upon reducing ammonia emissions, a general characterization of the measure was given, highlighting the essence of the measure implementation as well as its impact on ammonia emissions reduction that, in fact, has at its basis the Code of Good Agricultural Practice for Reducing Ammonia Emissions (UN, 2014). To be able to evaluate the potential of the selected measures for ammonia emissions reduction, farms were identified liable to execute the given measures.

Implementing the measures in the WAM scenario, the calculated emissions projections in 2030 are by 18% lower than in the WM scenario. Wherewith, the projected emissions are by 2.1% lower than the set target.

Even though it is projected that the emission target for 2020 will be exceeded the compliance with target for 2025 will be ensured.

Given that the planned measures to reduce NH_3 emissions are related to large investments int agriculture sector, implementation of these measures is planned after 2020. 2020 target trajectory will be met before 2025.

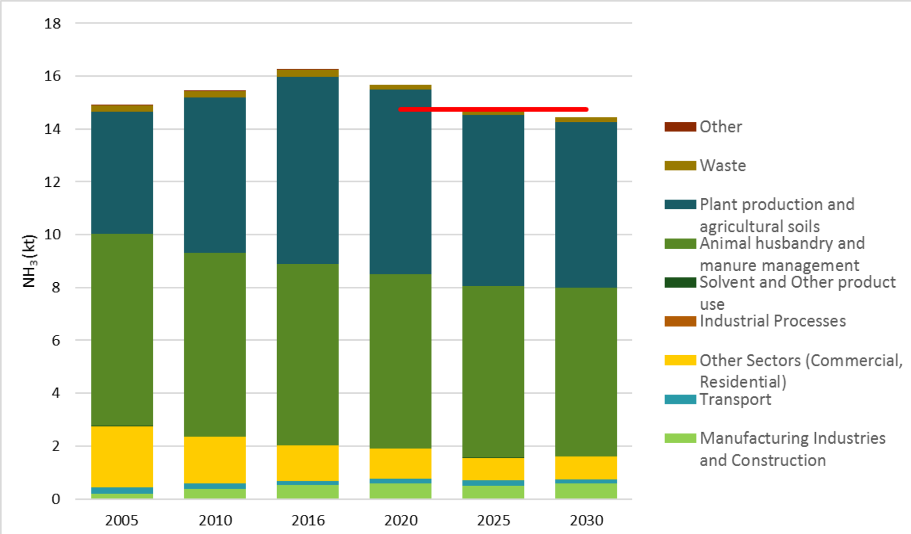

Figure 0.8 NH_3 emissions according to the latest inventory (2005-2016) and the WAM projections (up to 2030)

3.5 $PM_{2.5}$

WM scenario

Emissions projections of fine particulate matter $PM_{2,5}$ for 2020 and 2030 reveal their possible volume reduction by 5.1% and 13.7% respectively in comparison with the 2016 level. The major $PM_{2,5}$ emission sources in 2030 are the service sector and households (48.8%) which widely use biomass combustion equipment, the energy industries (energy conversion sector) (19.8%) with extensive use of biomass in central district heating plants and combined heat power plants and fuel combustion in the manufacturing sector (17.0%).

Emissions reduction in the transport sector and service sector and households is forecasted. In the transport sector emissions will reduce by 24.2% in 2030, compared with 2016, due to the increasing number of cars using alternative fuels and more environmentally friendly fossil fuels. In the service sector and households energy efficiency measures in public and residential buildings will enable reduction of fuel consumption, leading to the emission level be by 28.3% lower in 2030 than in 2016. At the same time emissions increase in the manufacturing sector due to increase of fuel consumption.

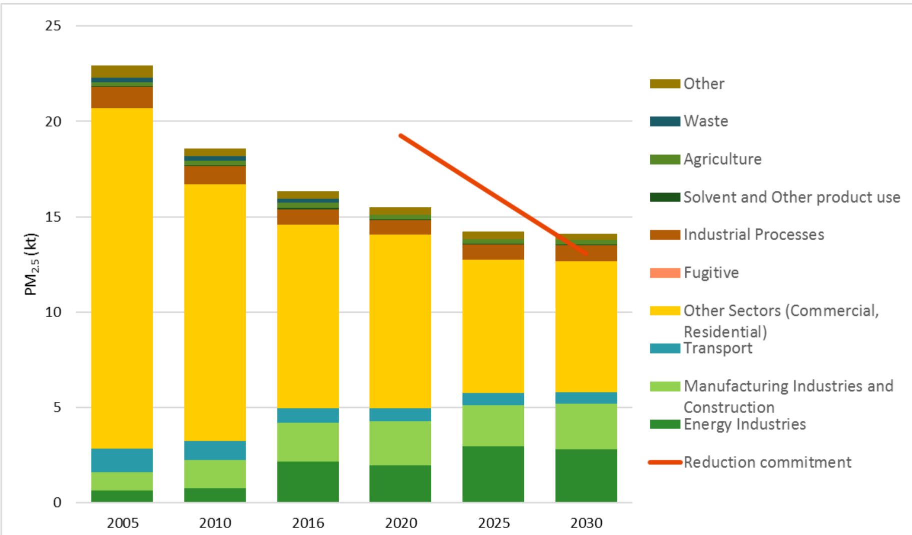

Figure 0.9 $PM_{2,5}$ emissions according to the latest inventory (2005-2016) and the WM projections (up to 2030)

Such emission trends do not provide reaching the EU set targets for 2030 emission limits. The emission projections exceed the set emission limits by about 8.1% in 2030.

WAM scenario

In the WAM scenario, a group of measures is aimed at reducing energy consumption by executing energy efficiency measures, resulting in reduction of emissions from fuel combustion. These mainly refer to renovation of public and residential buildings in the service sector and households. The second group relates to replacing the used combustion equipment by such that corresponds to the requirements of higher emission limit values.

The major impact upon $PM_{2,5}$ emission reduction is from replacing the used combustion equipment by such that corresponds to the requirements of higher emission limit values. Implementation of energy efficiency measures results in lower emission reduction.

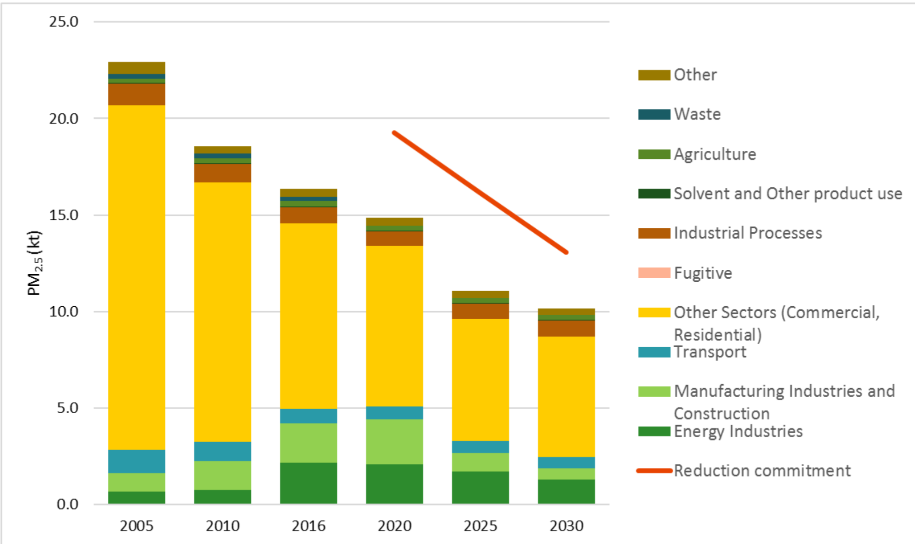

Figure 0.10 $PM_{2,5}$ emissions according to the latest inventory (2005-2016) and the WAM projections (up to 2030)

Implementation of the above two groups of measures enables $PM_{2,5}$ emission reduction according to the WAM scenario by about 28% against the WM scenario. It together with additional measures in 2030 results in $PM_{2,5}$ emissions be by 22% lower than the set target.

3.6 BC

Black carbon emissions depend directly upon $PM_{2,5}$ emissions volume. Thus, the calculated projections have the same main development trends. The projected emissions according to the WM scenario are by 19.2% lower in 2030 compared with 2016 and by 41% lower than in 2005. The major emission sources are the service sector and households (52.9%), fuel combustion in the manufacturing sector (31.5%) and transport (9.5%).

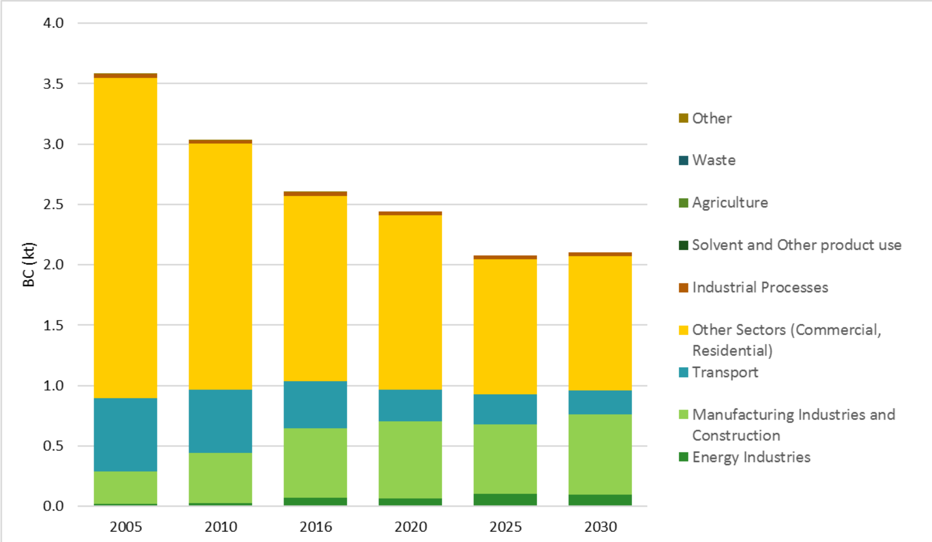

Figure 0.11 BC emissions according to the latest inventory (2005-2016) and the WM projections (up to 2030)

4 Sensitivity analysis

The alternative scenario assumes that in 2030 the GDP is about 20% higher than in the WM scenario and the number of population – by about 12%.

The figure below reveals that assumptions about higher GDP growth rate and stabilizing or stopping the population decline increase the projected final energy consumption in 2030 by 10% in comparison with the WM scenario, but final energy consumption in separate sectors according to the alternative scenario increases within the range of 5-17% in comparison with the WM scenario. The greatest impact is on households where increase in the population number results in increase of final energy consumption in 2030 by 16.9% against the WM scenario. In the transport sector, final energy consumption increases by 14.2% in comparison with the WM scenario.

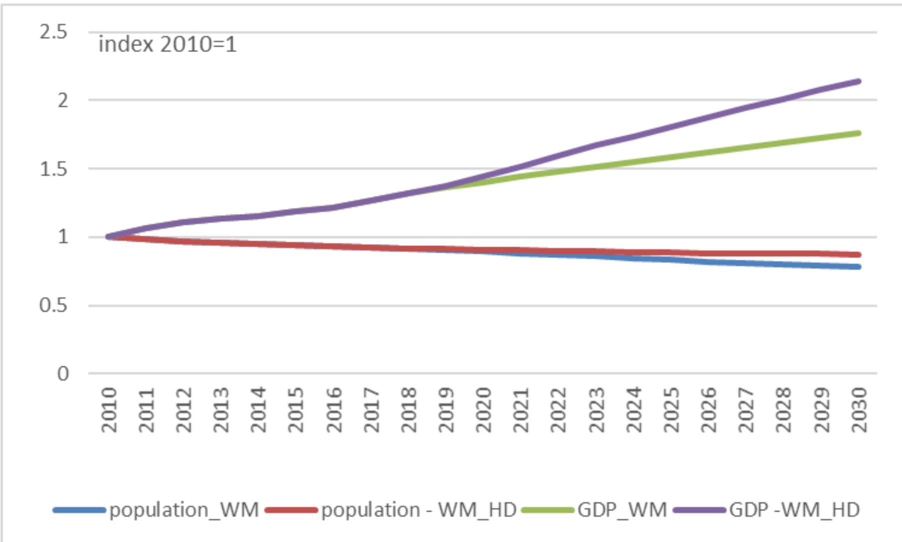

Figure 0.12 Comparison of the used macroeconomic indices in the modelled scenarios

Greater final energy consumption results in emissions growth under the provision of not implementing additional policies aimed at emission reduction.

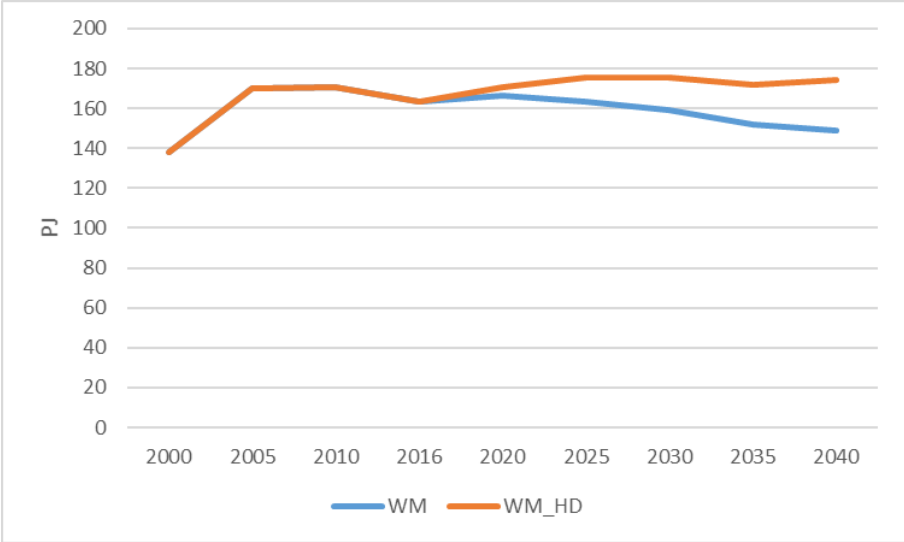

Figure 0.13 Projected final energy consumption in the WM and alternative scenarios

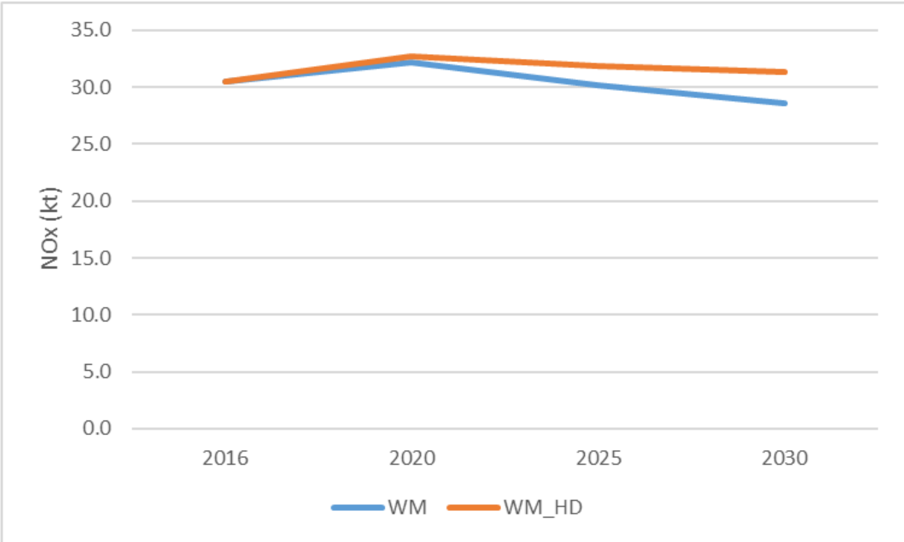

Figure 0.14 Projected NO_x emissions in the WM and alternative scenarios

Growth of final energy consumption and, thus, of gross primary energy consumption results in higher NO_x emissions. In the alternative scenario, the projected NO_x emissions in 2030 are by 9.8% higher than in the WM scenario. The greatest emissions increase compared with the WM scenario affects the energy conversion sector and transport (13%), and industry (10%).

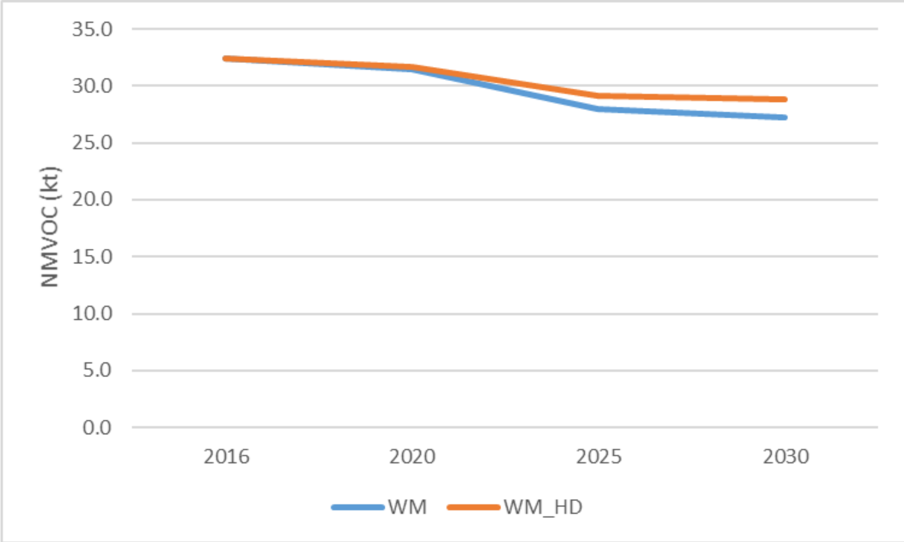

Figure 0.15 Projected NMVOC emissions in the WM and alternative scenarios

As combustion of solid fuels used for heating and different types of motor fuels is the cause of about 45% of gross NMVOC emissions, their impact is smaller than that of other pollutants upon the projected gross NMVOC emissions in the alternative scenario, compared with the WM scenario. In the alternative scenario, emission level in 2030 is by 5.9% higher than in the WM scenario. The greatest growth, compared the WM scenario, is in the energy conversion sector and manufacturing sector (12%), also in the service sector and transport sector (10%).

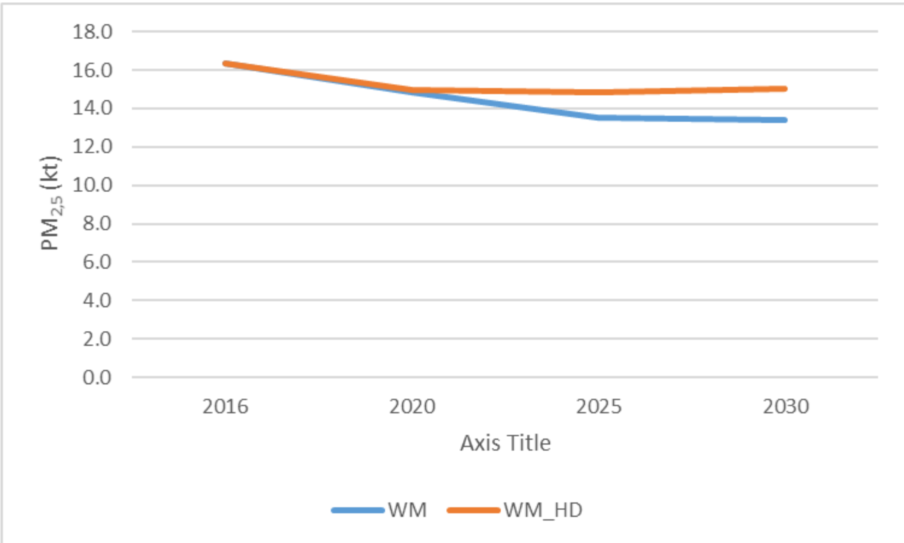

Figure 0.16 Projected $PM_{2,5}$ emissions in the WM and alternative scenarios

As combustion of solid fuels used for heating and different types of motor fuels causes about 95% of gross $PM_{2,5}$ emissions and biomass has a considerable share of the consumed fuels, in the alternative scenario, which is characterized by greater FEC and GPEC, emissions increase in 2030, in comparison with the WM scenario is by 12.2%. The greatest growth, compared with the WM scenario, is in manufacturing sector (21%), the transport and energy conversion sectors (13%).

NH_3 emissions from composting are projected according to the amount of composted waste. One of the main parameters determining NH_3 emissions in the composting sector is the national population. The parameter used to prepare the sensitivity analysis is the national population projections used in the previous projection cycle (2017), which predicted a much slower population decline than the latest macroeconomic projections. The population is taken into account when calculating NH_3 emissions from household composted waste quantities.

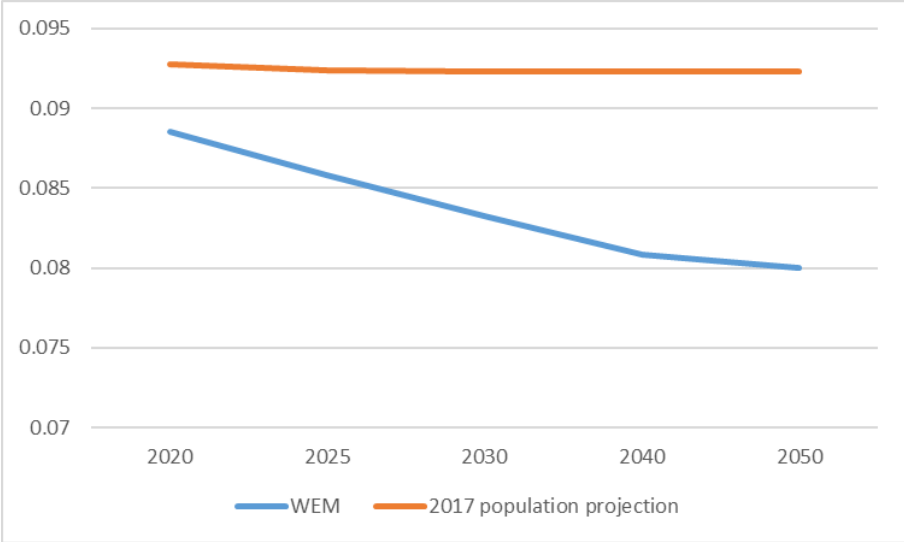

Figure 0.17 NH_3 emissions (kt)

5 Methodology

5.1 Energy

<u>Macroeconomic framework</u>

Emissions projections are calculated taking as basis long-term macroeconomic forecasts for the year 2030, developed by the Ministry of Economics in 2018. The projected macroeconomic indicators are based on conservative assumptions and by assessing internal and external risks. The major growth drive is revenue from export and export capacity expansion. The development rate of economy in the baseline scenario is also affected by negative demographic trends.

<u>Trends in sectoral development</u>

In the baseline scenario for long-term and medium-term the manufacturing industry retains more rapid growth rate than average in economy. A relatively high growth rate is also forecasted in the major sector of the manufacturing industry – wood processing. Sectors mainly oriented towards internal market (e.g., the food industry, printing industry) will be considerably affected by the dynamics of internal demand. The sector of manufacturing non-metallic mineral products will be closely linked with trends in the construction industry.

The baseline scenario does not forecast essential changes in the sectoral structure of economy up to 2030, if compared with the current situation. It will remain close to the present one. The ratio of commercial services might increase by 1 percentage point up to 2030 alongside with increase also in such sectors as IT, the construction industry and different industrial sectors while the ratio of agriculture, the transport industry, financial services and communal services might slightly decrease.

Table 0.2 The main macro economic indices applied for projecting emissions

	2017	2020	2025	2030
Population, millions	1.986	1.884	1.759	1.638
Private consumption, constant (2010) prices, billions EUR	13.266	16.158	18.386	20.339
GDP, constant (2010) prices, billions EUR	21.328	25.230	28.564	31.599

The energy – economy – climate model MARKAL-Latvia (Institute of Physical Energetics) is used for calculating emission projections in energy industries (power and heat generation), transport, fuel consumption in the manufacturing and service sectors and households; it enables linking the economy development with energy consumption, generation and emission calculation.

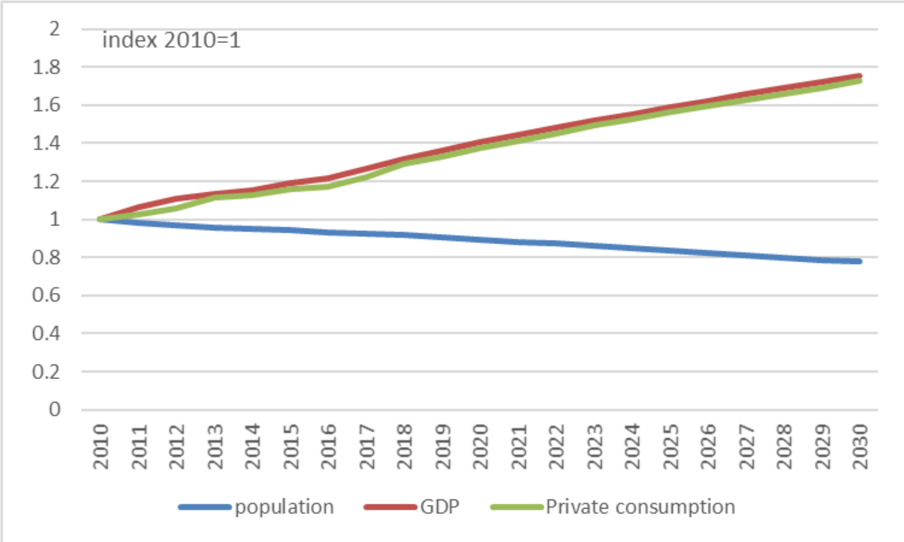

Figure 0.18 Used macroeconomic indices in the WM scenario

By applying the macroeconomic forecast and the above modelling method for the energy sector final energy consumption up to 2040 has been forecast (see Figure below). The major impacting policies upon the energy scenario are RES (renewable energy sources) policy and energy efficiency policy. The WM scenario forecasts the implementation of a set of measures for repealing the component of the mandatory procurement and development of electricity market, promotion of using local RES in district heating and execution of different support instruments for raising energy efficiency in the process of implementing the said measures.

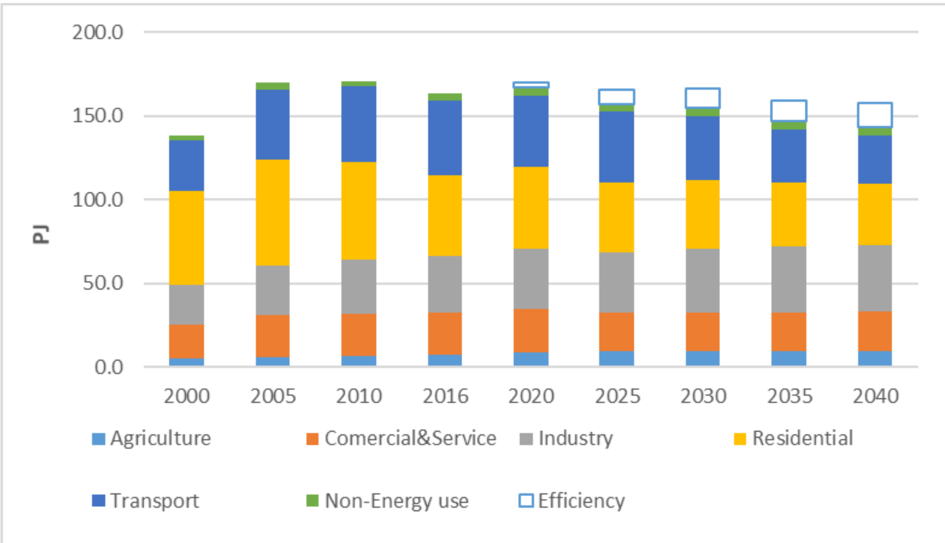

Figure 0.19 Final energy consumption development in sectors under the WM scenario

The calculated final energy consumption projections forecast the major energy consumption sectors in 2030 to be transport and industry, consuming 25.0% and 25.3% respectively of the final energy consumption. The share of households will be 24.7% and the service sector 15.4%, while the rest will go for the needs of agriculture and non-energy purposes.

The final energy consumption projections forecast essential increase of energy consumption in 2030 against 2016 in the industry sector (3.8 PJ), determined by the assumption of increase in annual value added tax rate in the whole period. At the same time, in other sectors, except agriculture, decrease in final energy consumption is forecasted. This trend rests on the assumptions about implementation of energy efficiency policy and forecasts about population number in the years 2030 and 2050. The final energy consumption in 2030 is by 5.6% lower than in 2016.

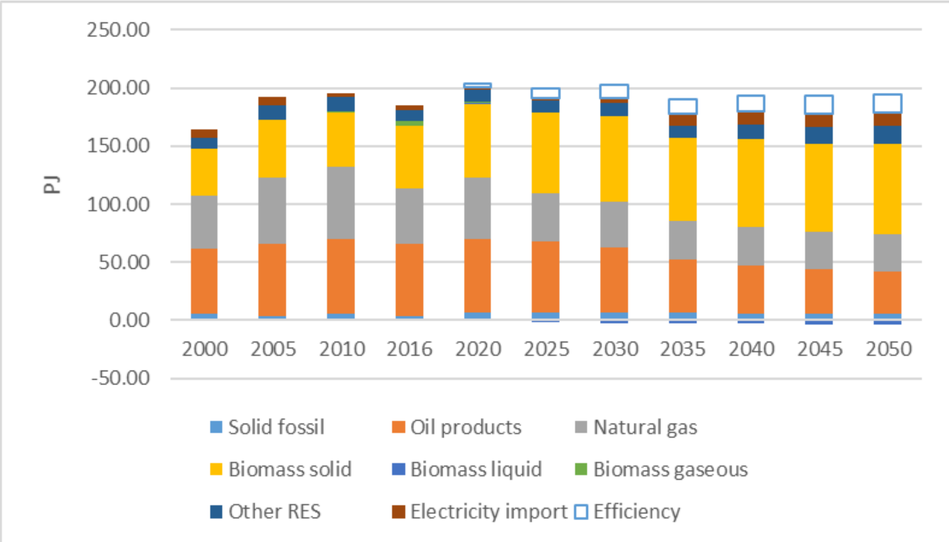

Figure 0.20 Gross primary energy consumption development under the WM scenario

Based on the finally generated energy consumption projections calculated in the model, the optimization model finds an optimal solution for primary resources balance in the WM scenario (minimum total costs of the system) up to 2050.

The projected primary energy consumption in 2030 is by about 1.8% higher than in 2016. The major cause of the increase is decrease in energy import in 2030 and its replacement by locally generated energy;

In the baseline scenario no essential changes are forecasted concerning the structure of the types of primary energy in 2030, compared with 2016. The share of solid fossil fuel, natural gas and oil products decreases in the final energy consumption, while the share of solid biomass increases.

Based on the projected activity data and considering the valid policies, emission projections in the WM scenario have been calculated using the year 2016 as the base year. The calculation rests on the latest available emission factors in the national inventory. Appendix contains the numeric values of parameters used for emission projections.

Methods and model

To model the complex development of the Latvian energy system and perform calculation of emission projections there is used internationally widely-applied partial equilibrium, bottom-up, dynamic, linear programming optimisation model MARKAL code for the energy-environmental system optimisation which we have adapted to Latvia's circumstances since 1995 by creating the MARKAL-Latvia country model and applying it for the national level studies.

The MARKAL model is driven by useful energy demands, expressed in energy units or energy demands expressed as energy services in other units (e.g., lumen hours for lighting). The model integrates the end-use sectors and the supply side, holding descriptions of different energy sources and carriers that pass through the energy system's stages – transformation and distribution processes, energy end-use processes in all economic sectors, including a set of technological and energy efficiency options as well as associated emissions. The model is based on the minimization of the long-term discounted cost of all modelled energy-environmental system. The system's cost includes investment and operation, and maintenance costs for all technologies, plus costs of all fuels, minus the revenue from exported fuels, minus the salvage value of all residual technologies at the end of the modelled horizon. The model covers 11 periods of 5 years each, so that the modelled horizon covers 2000 to 2050, inclusive.

In the MARKAL-Latvia model the energy demand is divided in five main sectors – industry, residential, agriculture, commercial & service and transport – and further divided in subgroups or subsectors, e.g., energy consumption in the residential sector is divided into space heating and hot water in single or multifamily houses, the use of particular electrical appliances. The projection is calculated for each of these subsectors by linking directly or indirectly via elasticities and/or other indicators (e.g., energy intensities or specific consumption and changes in them, the number of households, persons per households, household area, etc.) to the economic development scenario (GDP, value added, private consumption, population). In the years 2000, 2005, 2010, 2015 and 2016, the actual installed capacities and activity levels of technologies (energy balance and emissions) are imposed, thus providing that the model results exactly represent the real system being modelled.

Additionally, the road transport model COPERT 5 is applied for the calculation of the used in the MARKAL model average emissions factors for road transport forecasting and technology distribution in the future.

MARKAL determines future investments and activity of technologies in each period, while ensuring demands, emission caps and sets of other different constraints.

Projection on prices of energy resources, as well as useful energy demand (energy service demand) or other secondary parameters, like the area of heated premises of buildings or mileage of cars that reflect the required amount of energy are needed as the input data in the MARKAL model. Consumption of electricity and district heating is calculated internally within the model.

The model structure is adapted so that emissions can be calculated not only by the type of fuel, but also by sector and corresponding type of technologies.

Demand for energy is directly linked with economic development, thus, the projected changes of consumption of useful energy are related to the long-term macroeconomic projections. For developing the energy demand scenario, the long-term macroeconomic projection up to the year 2030 developed by the MoE, has been used. This projection has been applied in projecting electricity consumption, heat consumption, as well as fuel consumption in individual sectors.

Price projection of imported energy resources (oil products, natural gas, coal) have been developed based upon information from the International Energy Agency World Energy Outlook (IEA WEO 2017, Existing Policy scenario). Prices of local energy resources depend on the geographical location of usage; therefore, the price may differ. Projection of average prices of these fuels have been developed based upon available statistics, various studies, taking into account the projection price trends of imported energy resources. Solid biomass (wood) is split into four price groups with different available amounts of sources. Actual prices of energy resources are projected without taking into account taxes. All implemented taxes in Latvia are further added in the model.

5.2 Industrial processes and solvent use

Emission projections calculation is based on MS Excel top-down accounting model. The structure and emission calculation is performed according to EMEP/EEA 2016 Guidebook and adjusted for projection estimation incorporating parameters according to macroeconomic forecast.

NMVOC emissions projections in the solvent use sector are calculated using top-down accounting model essentially based on the number of inhabitants. The structure and emission calculation is performed according to EMEP/EEA 2016 Guidebook.

5.3 Agriculture

Projections of emissions are based on primary activity data provided by the Ministry of Agriculture in collaboration with the Latvia University of Life Science and Technologies (LULST). The econometric scenario based model *Latvian Agricultural Sector Analysis Model* (LASAM) is used for the activity data generation of Latvian agriculture. LASAM provides an outlook for animal husbandry, producing forecasts in dairy, beef, sheep, goat, pig, poultry and horse farming and crop farming based on regression analysis principles. LASAM estimates a forecast of the utilised agricultural area (UAA) and the structure of UAA enables calculation of the use of fertilisers in the agriculture sector. The source data for the calculations within the model are gathered from CSB, EUROSTAT, domestic use balance sheets and the Farm Accountancy Data Network (FADN). The exogenous price forecasts until 2025 are gathered from the DG AGRI of the European Commission and Food and Agriculture Organization of the United Nations, further projected by the team of Latvia University of Life Science and Technologies. The macroeconomic forecasts are integrated from the forecasted values of the Ministry of Economics of Latvia.

Secondary data projections including manure management system distribution, nitrogen excretion of livestock, use of organic nitrogen fertilizers and nitrogen content in crop residues are made by experts of Latvia University of Life Science and Technologies based on the results of the pre-defined project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections" under 2009–2014 EEA Grants Programme National Climate Policy. Methodological approach used for manure management distribution projections are available in scientific literature[3,4].

EMEP/EEA 2016 Guidebook has been used for the calculation of emission forecasts, which is in line with the methodology used for preparing the latest inventory report. NH_3 and NOx emission calculation for the category of manure management was done corresponding to Tier 2 methodology and for crop farming – to Tier 1 and Tier 2.

5.4 Waste

NMVOC and particulate matters emissions from waste disposal are calculated according to EMEP/EEA guidelines 2016. Disposed amount multiplied with EF. Projected amount of disposed waste is estimated according to Latvia "Waste management plan 2013-2020".

Projected NH_3 emissions from composting are calculated according to EMEP/EEA guidelines 2016. Emission factors are multiplied with composted waste amounts. Composted waste amount in households is projected according to changes in population, but industrially composted amounts are projected according to time series from 2003 till 2017. From year 2020 increase of industrially composted amounts (about 100 000 tonnes) is projected due to information about direct investments in Latvia waste companies.

Projected NH_3 and NMVOC emissions from waste water handling are calculated according to EMEP/EEA guidelines 2016. Activity data (population using latrines and amount of treated waste water) are multiplied with corresponding emission factors. Activity data for projections are estimated according to existing trends in a sector.

[3] Cabinet of Ministers Regulations No.848 (20.12.2016) Regarding Development of Environmentally Friendly Public Transport (Buses) Infrastructure co-financed by the EU Cohesion Fund (Noteikumi "Darbības programmas "Izaugsme un nodarbinātība" 4.5.1.specifiskā atbalsta mērķa "Attīstīt videi draudzīgu sabiedriskā transporta infrastruktūru" 4.5.1.2.pasākuma "Attīstīt videi draudzīgu sabiedriskā transporta infrastruktūru (autobusi)" īstenošanas noteikumi), in force 24.12.2016, in Latvian, available at http://likumi.lv/doc.php?id=2876

[4] J. Priekulis, A. Aboltins, A. Laurs, L.Melece (2015)Research in manure management in Latvia / 14th International scientific conference "Engineering for rural development" : proceedings, Jelgava, Latvia, May 20 - 22, 2015 Latvia University of Agriculture. Faculty of Engineering. - Jelgava, 2015. - Vol.14, p.88-93. Available: http://tf.llu.lv/conference/proceedings2015/Papers/015_Laurs.pdf