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ENVIRONMENT AGENCY AUSTRIA

GHG PROJECTIONS AND ASSESSMENT OF POLICIES AND MEASURES IN AUSTRIA 2023

Reporting under Regulation (EU) 2018/1999
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REPORT
REP-DRAFT

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PREAMBLE

This report presents Austria's greenhouse gas emission projections until 2050.

The projections for the greenhouse gases and their development include a scenario 'with existing measures' (WEM former takes into account mitigation measures implemented by 1 January 2022.

Additional measures to meet the current 2030 target as well as the enhanced ambition for 2030 are currently under discussion and have therefore not be included in the modelling exercise. Therefore, a full update will be submitted later this year, together with additional policies and measures to comply with the national targets for 2030.

The emission projections provided in this report are based on economic scenarios for the period up to 2050. To calculate the scenarios, several models have been applied. The energy scenario is based on analyses of total energy demand and production conducted by an econometric input-output model (MIO-ES), supported by calculations for the building sector by Zentrum für Energiewirtschaft und Umwelt (e-think 2023) und transport by the University of Graz (HAUSBERGER &SCHWINGSHACKL 2023). For agricultural and waste additional models were used.

The sectoral structure of the emission scenario is based on the format for emission reporting under the UN Framework Convention on Climate Change (UNFCCC). The report is in compliance with the requirements for reporting according to Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, and with the UNFCCC Guidelines (Guidelines for the preparation of National, decision 6/CP.25) for national reports on climate change.

CONTENTS

SUMMARY

This summary provides an overview of the projections for the scenario "with existing measures" (WEM). The main results of the five CRF sectors (without LULUCF) and of all greenhouse gases are presented in CO_2 equivalent units. Trend graphs include GHG totals by category and by gas.

Total GHG emissions

Emissions (without LULUCF) decreased by 1.9% from 1990 to 2021, i.e. from 79.0 Mt of CO_2 equivalent in 1990 to 77.5 Mt in 2021. The "with existing measures" (WEM) scenario shows a decrease of 30% from 1990 to 2050, i.e. from 77.0 Mt of CO_2 equivalent in 1990 to 55.1 Mt of CO_2 equivalent in 2050.

Figure 1: Past trend and scenario (2022–2050): total GHG emissions (without LULUCF).

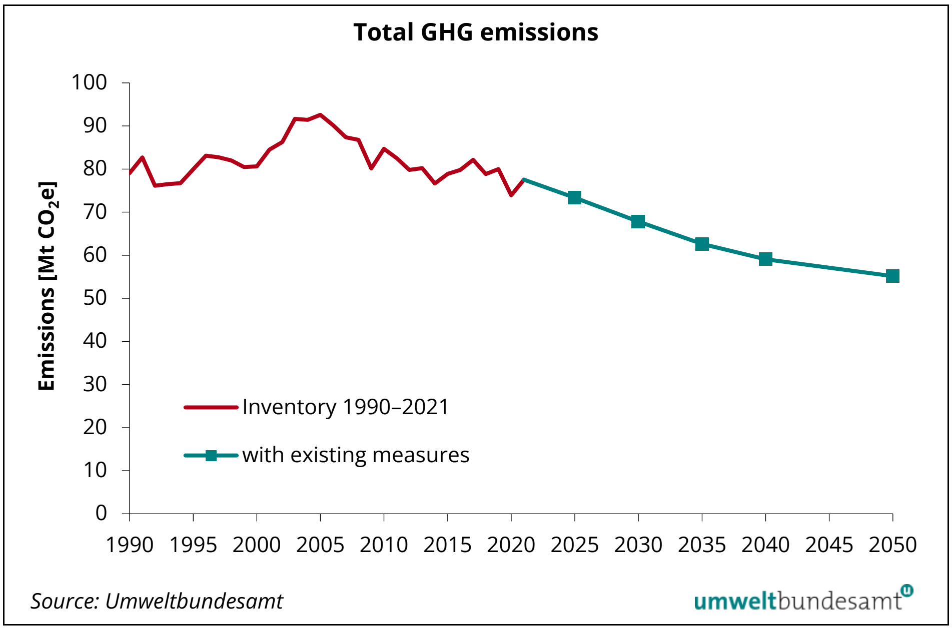


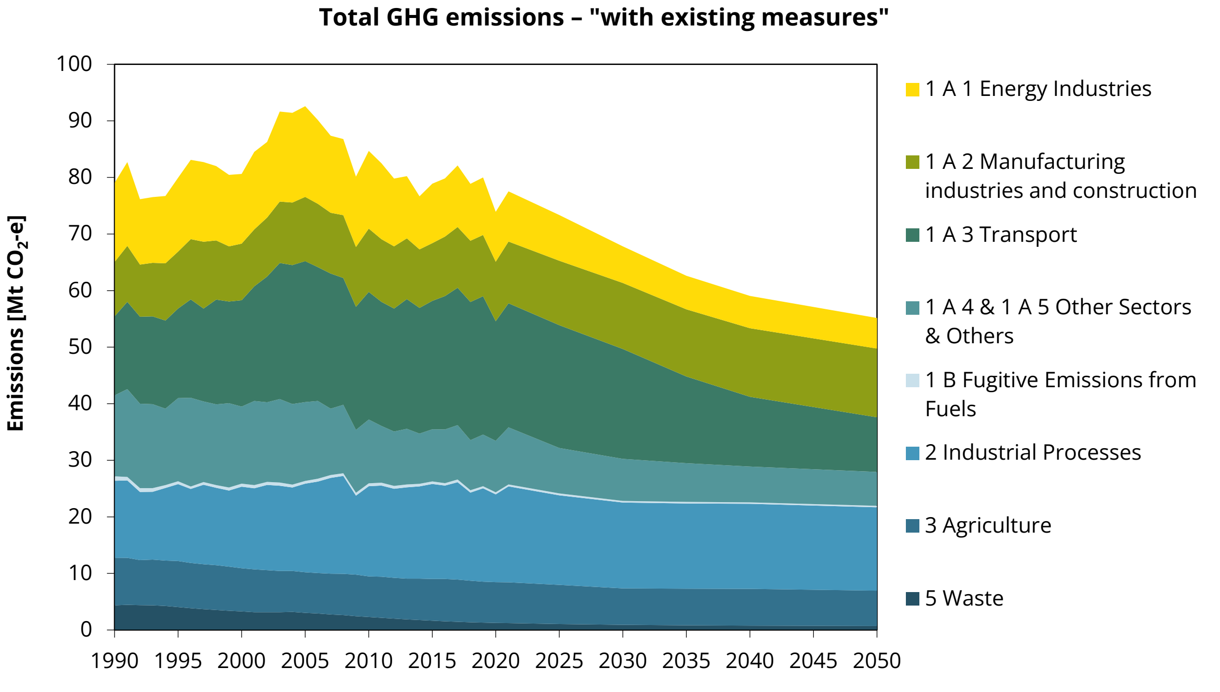
Table 1: Historical trends and projections (2025–2050): greenhouse gas emissions (without LULUCF) – scenario "with existing measures" (WEM). (Umweltbundesamt)

	Inventory trend [kt CO_2 eq]				Emissions 'with existing measures' [kt CO_2 eq]				
	1990	2005	2020	2021	2025	2030	2035	2040	2050
Total (without LULUCF)	79 047	92 589	73 911	77 532	73 358	67 809	62 620	59 044	55 147
1 Energy	52 665	66 715	49 930	52 142	49 546	45 274	40 248	36 735	33 455
2 Industrial Processes	13 615	15 652	15 524	16 959	15 845	15 170	15 059	15 024	14 741
3 Agriculture	8 400	7 181	7 197	7 221	6 923	6 462	6 493	6 520	6 248
5 Waste	4 367	3 041	1 259	1 211	1 045	903	819	765	704

The WEM scenario predicts a decrease in total GHG emissions of 29% or 22.4 Mt of CO_2 equivalent between 2021 and 2050.

This change is mainly driven by a decrease in the energy (minus 36% or 18.7 Mt of CO_2 equivalent) and industrial processes sector (minus 13 % or 2.2 Mt of CO_2 equivalent). Emissions from the agricultural sector are predicted to decrease by 13% or 1.0 Mt of CO_2 equivalent. Emissions in the waste sector are projected to decrease by 42% or 0.5 Mt of CO_2 equivalent. In the energy sector, emissions from the sub-sector 1.A.1 Energy industries are projected to decrease by 39% or 3.4 Mt of CO_2 equivalent and emissions from 1.A.2 Manufacturing industries and construction are projected to increase by 11% or 1.2 Mt of CO_2 equivalent. Emissions from the sub-sector 1.A.3 Transport are predicted to decrease by 56% or 12.3 Mt of CO_2 equivalent between 2021 and 2050, and emissions from the sub-sector 1.A.4 and 1.A.5 'Other sectors' are predicted to decrease by 41% or 4.1 Mt of CO_2 equivalent.

Figure 2: Past trend and scenario (2022–2050): total GHG emissions by sector) – scenario "with existing measures".



Source: Umweltbundesamt

According to the WEM scenario, the dominant GHG emitted in Austria will still be CO_2 with a minor increase between 2021 (85.1 %) and 2050 (84.5 %). Between 2021 and 2050, Austria's total CH_4 emissions and N_2O emissions (in CO_2 equivalent) are projected to increase from 12.0 % to 13.9 %, whereas the percentage of emissions of fluorinated gases (HFC, PFC, SF_6 and NF_3) is expected to decrease from 2.4 % in 2019 to 1.2 % in 2050.

Table 2: Past trend and scenario (2025–2050): GHG emissions by gas (without LULUCF) – scenario "with existing measures" (WEM). (Umweltbundesamt)

	Emission trend [kt CO_2 eq]				**Emissions 'with existing measures' [kt CO_2 eq]**				
	1990	**2005**	**2020**	**2021**	**2025**	**2030**	**2035**	**2040**	**2050**
CO_2	62 167	79 097	62 121	66 019	62 729	58 441	53 473	49 988	46 623
CH_4	10 106	7 602	5 806	5 803	5 373	4 895	4 815	4 759	4 538
N_2O	4 511	3 585	3 474	3 512	3 463	3 362	3 325	3 284	3 126
F gases	1 550	1 789	2 198	1 892	1 532	896	798	806	663
Total	79 047	92 589	73 911	77 532	73 358	67 809	62 620	59 044	55 147

An analysis of past trends and scenarios by sector is presented in chapter 2 'Sectoral Scenario Results'. Tables with detailed emissions by sub-sector and gas are included in the Annex. Specific sectoral assumptions and activities are given in the sub-chapters 3.1 to 3.5.

EU ETS/EU ESR emissions

GHG emissions covered by the EU's Emissions Trading Scheme (ETS) show a downward trend in the "with existing measures" scenario until 2050. The driving force is the energy sector with a projected decrease of about 20% from 2021 to 2050. A decrease is also projected for the industrial processes sector (-4%).

The EU's total GHG emissions under the Effort Sharing Regulation (ESR) are expected to decrease by 39% over the same period.

Table 3: EU ETS and EU ESR GHG emissions – scenario "with existing measures" (WEM). (Umweltbundesamt)

	with existing measures [kt CO_2 eq]						
EU ETS GHG emissions	**2020**	**2021**	**2025**	**2030**	**2035**	**2040**	**2050**
Total (without LULUCF)	27 034	28 703	27 334	26 078	25 662	25 522	25 120
1. Energy	14 158	14 419	13 440	12 231	11 830	11 736	11 469
2. Industrial Processes	12 876	14 284	13 894	13 846	13 832	13 786	13 651
EU ESR GHG emissions	**2020**	**2021**	**2025**	**2030**	**2035**	**2040**	**2050**
Total (without LULUCF)	46 853	48 805	45 983	41 685	36 910	33 474	29 979
1. Energy	35 749	37 699	36 065	32 996	28 370	24 951	21 938
2. Industrial Processes	2 648	2 675	1 951	1 323	1 227	1 238	1 090
3. Agriculture	7 197	7 221	6 923	6 462	6 493	6 520	6 248
5. Waste	1 259	1 211	1 045	903	819	765	704

1 GENERAL APPROACH

1.1 Guidelines and Provisions

The following regulations and guidelines are taken into account:

- **Regulation (EU) 2018/1999** of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action
  - Article 18 – Integrated reporting on greenhouse gas policies and measures and on projections
- **Commission Implementing Regulation (EU) 2020/1208** of 7 August 2020 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999 of the European Parliament and of the Council
  - Article 36 – Reporting on national systems for policies and measures and projections
  - Article 37 – Reporting on national policies and measures
  - Article 38 – Reporting on national projections

  The structure for reporting information on projected GHG data and policies and measures follows the structure of the templates provided in the Annex of the Regulation.
- The **Guidelines for the preparation of National Communications** by parties included in Annex I to the Convention (decision 6/CP.25).
- Commission guidance for reporting on GHG projections in 2023 under Art. 18 of the Regulation on the Governance of the Energy Union and Climate Action (European Commission, Version 5.0, 15.2.2023)
- Recommended parameters for reporting on GHG projections in 2023 (European Commission, May 2022)

1.2 Quality Assurance & Control

A questionnaire has been used for checking input data for compliance with the most important data quality requirements. The QA/AC strategy include several data consistency checks, e.g. through documentation of data inputs and changes to the calculation files. A standard data input form has been used for each sector.

In general, data quality checks similar to those applied to the Austrian Air Emission Inventory have been performed for each sector. Often the person who is responsible for the sectoral emissions is identical with the person who is also responsible for the relevant sectors in the inventory and most sectors use emission methods based on the verified inventory methods.

An output data check has been carried out involving a detailed comparison of sector results and checking the plausibility of emission trends.

The specific responsibilities for this report have been as follows:

- Coordination & general chapters ....Andreas Zechmeister
- Energy Industries & ....Michael Gössl, Thomas Krutzler,
  Manufacturing Industries Herbert Wiesenberger
- Transport ....Gudrun Stranner, Margarethe Staudner
- Other Energy Sectors ....Wolfgang Schieder
- Fugitive Emissions.............................Stephan Poupa
- Industrial Processes &......................Herbert Wiesenberger
  Product Use ....Maria Purzner, Manuela Wieser
- Agriculture ....Michael Anderl, Simone Mayer
- Waste...Katja Pazdernik, Michael Roll
  Stephan Poupa
- LULUCF..Peter Weiss, Merlin Mayer,
  ....Carmen Schmid

1.3 Description of General Methodology

1.3.1 Database and Historical Emission Data

The projections for greenhouse gases provided in this report are consistent with the historical GHG emission data from the Austrian Emission Inventory (submission March 2023) up to the year 2021.

1.3.2 Emission projections

The activity scenarios are based on the structure of the national inventory of greenhouse gases. The data structure for activities, input data, emission factors and emission calculations is based on SNAP categories (*Selected Nomenclature for sources of Air Pollution*). GHG output data are reported and aggregated in the Common Reporting Format (CRF) of the UNFCCC.

Emission projections are generally calculated by applying the same methodologies as those used for the national GHG inventory. These are described in Austria's National Inventory Report 2023 (Umweltbundesamt, 2023).

The emission factors used for the projection as well as the underlying parameters are detailed in the methodological approach described in sub-chapter 3 of this report.

1.3.3 Underlying Models and Measures

Emission projections are based on the following sectoral forecasts:

- Energy forecast (fuel combustion) are based on the National Energy Balance of (Statistik Austria, 2022a) and on an econometric input-output model (MIO-ES), supported by calculations carried out using the bottom-up models:
  - INVERT/EE-Lab (e-think energy research (e-think, 2023): domestic heating and hot water supply.
  - NEMO & GEORG (Schwingshackl & Rexeis 2022): energy demand and emissions of transport (incl. off-road).
- Forecasts of emissions from industrial processes and solvent emissions are based on Umweltbundesamt expert judgements and on projections for the respective gross value added (NACE code).
- For estimations of emissions for fluorinated gases results of the Austrian model are extrapolated considering EU legislation in force.
- In the agriculture sector the following models were used:
  - For activity data calculation (animal livestock, crop yields, mineral fertilizers, agriculture area) the PASMA model of the Austrian Institute of Economic Research (Wifo & Boku 2023) was used.
  - For the determination of the economic impact on the overall economy, the PASMA results were transferred into ADAGIO, WIFO's Input-Output-Model
  - For emission calculation, the agriculture model of the Austrian GHG inventory was used. Existing measures of agricultural practice projected for Austria were taken into account.
- Projections for waste (expert judgements on waste amounts and waste treatment World Model with econometrically estimated behavioural equations.) were prepared by Umweltbundesamt.
- Several models have been used for the different LULUCF subsectors:
  - For forest growth the model CALDIS was used, for soil organic carbon the YASSO 15 model;
  - for cropland and grassland the PASMA model model of the Austrian Institute of Economical Research;
  - expert judgements have been used for wetlands, settlements and other land;
  - the forest sector model FOHOW2 has been used for projections of harvested wood products.

For the submission in March only one scenario "with existing measures" was modelled, which includes all measures implemented by 1 January 2022. Later in the year also a scenario "with additional measures" will be available. This scenario will include planned policies and measures which were reported under the National Air Pollution Control Programme and in the Integrated National Energy and Climate Plan for Austria.

The status of the implementation of measures has been defined at expert level in consultation with the Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology. Information on national policies and measures included in the scenarios can be found in Chapter 4.

1.3.4 Key Underlying Assumptions

The key factors used for the scenarios "with existing measures" are as follows:

Table 4: Key input parameters for emission projections

Year	Scenario	2020	2021	2025	2030	2035	2040	2050
GDP [billion € 2020]	WEM	381	402	439	466	497	533	599
GDP real growth rate [%]	WEM	-6.5	5.9	1.6	1.1	1.6	1.4	1.1
Population [1 000]	WEM	8 917	8 961	9 114	9 251	9 360	9 470	9 626
Stock of dwellings [1 000]	WEM	3 982	4 008	4 112	4 207	4 295	4 380	4 497
Heating degree days	WEM	3 311	3 301	3 260	3 210	3 160	3 110	3 010
Exchange rate [US$/€]	WEM	1.2	1.2	1.2	1.2	1.2	1.2	1.2
International coal price [€ 2020/GJ]	WEM	1.6	3.7	3.1	3.1	3.1	3.3	3.7
International oil price [€ 2020/GJ]	WEM	6.4	10.5	15.4	15.4	15.4	16.2	19.7
International natural gas price [€ 2020/GJ]	WEM	3.1	15.1	13.2	11.3	11.3	11.3	11.8
CO_2 certificate price [€ 2020/t CO_2]	WEM	24.0	54.0	80.0	80.0	82.0	85.0	160.0

Other underlying assumptions are included in the sectoral methodology (Chapter 3) and in the Annex.

1.4 Sensitivity Analysis

Scenarios are usually based on specific assumptions which provide the direction for future developments. These sensitive key drivers (e.g. GDP) can be varied in order to verify the robustness or sensitivity of the models and projections.

This chapter presents sensitivity assessments for specific areas, analysing increases and decreases in key parameters (or a combination of key parameters). The sensitivity assessment in the energy sector is based on the influence of economic growth and price variations on GHG emissions from transport, energy industries and manufacturing industries and construction. It is important to note that, in general, emission results and changes in an input factor are not linearly dependent. This is the reason why the presented sensitivity data cannot be seen as a functional dependency with varied parameters. The emission effect can only be seen in the specific values of the given parameters.

For the energy sector, four sensitivities (with different assumptions about economic growth and energy prices) have been calculated:

- WEM sensitivity 1: high GDP
- WEM sensitivity 2: low GDP
- WEM sensitivity 3: high energy prices
- WEM sensitivity 4: low energy prices

The main input variables are summarised in Table 5.

Table 5: Basic parameters for sensitivity analysis modelling (Umweltbundesamt)

Parameter WEM sensitivity 1	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
GDP real growth rate [%]	-6.7%	2.4%	2.0%	2.4%	2.3%	2.1%	2.0%
GDP [billion € 2020]	342	401	444	495	555	619	684
Parameter WEM sensitivity 2	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
GDP real growth rate [%]	-6.7%	1.1%	0.7%	1.0%	0.9%	0.8%	0.7%
GDP [billion € 2020]	342	387	401	418	437	457	474
Parameter WEM sensitivity 3	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
GDP real growth rate [%]	-6.7%	1.1%	1.1%	2.0%	0.8%	1.2%	1.1%
GDP [billion € 2020]	342	390	414	445	474	506	535
International coal price [€ 2020/GJ]	1.6	6.1	6.2	6.3	6.6	7.0	7.3
International oil price [€ 2020/GJ]	6.4	23.0	23.0	23.0	24.4	26.4	29.5
International natural gas price [€ 2020/GJ]	3.1	26.5	22.6	22.6	22.6	22.6	23.6
Parameter WEM sensitivity 4	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
GDP real growth rate [%]	-6.7%	1.7%	1.2%	1.3%	1.6%	1.2%	1.1%
GDP [billion € 2020]	342	393	417	444	477	508	537
International coal price [€ 2020/GJ]	1.6	2.4	2.5	2.5	2.7	2.8	2.9
International oil price [€ 2020/GJ]	6.4	12.3	12.3	12.3	13.0	14.1	15.7
International natural gas price [€ 2020/GJ]	3.1	10.6	9.0	9.0	9.0	9.0	9.4

The following charts show an analysis of the trends in Austria's total GHG emissions and the two sensitivity analyses. In addition, the results are presented separately for ETS (Directive 2003/87/EC) and ESR (Regulation (EU) 2018/842).

Figure 3: Trend and projections (2025–2050): total GHG emissions for different sensitivities.

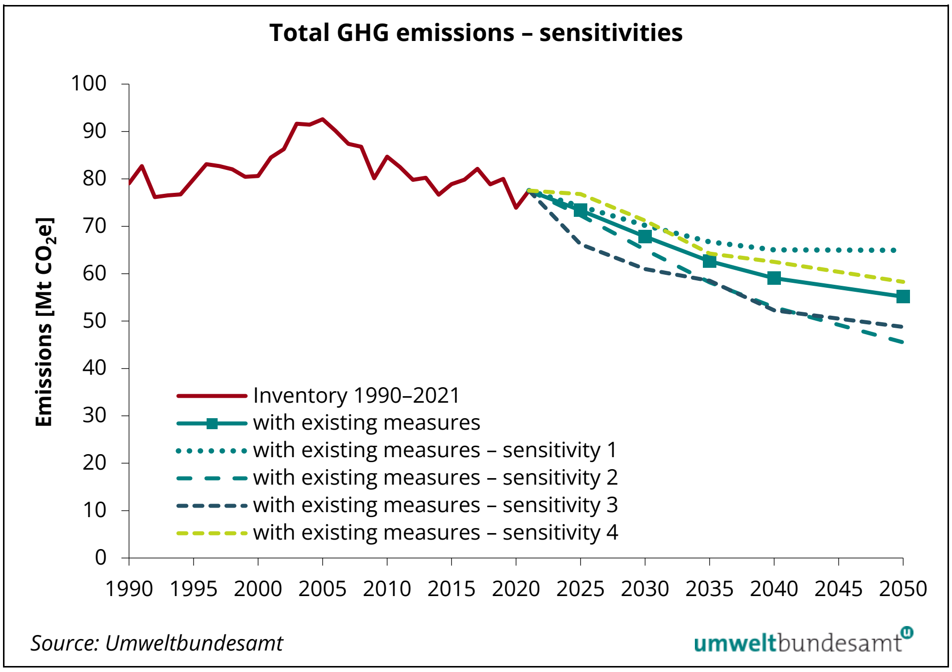
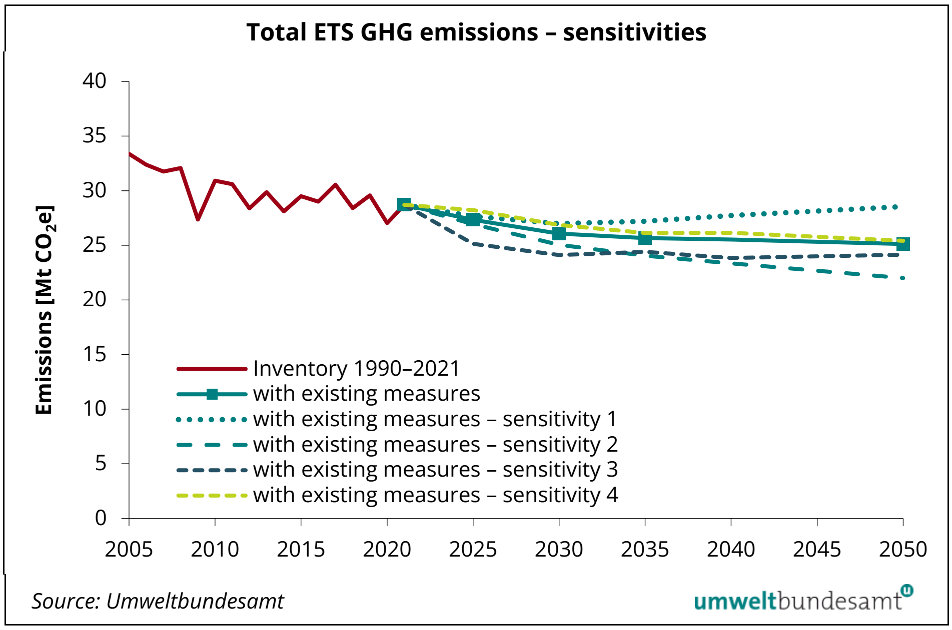


Figure 4: Trend and projections (2025–2050): total ETS GHG emissions for the different sensitivities.



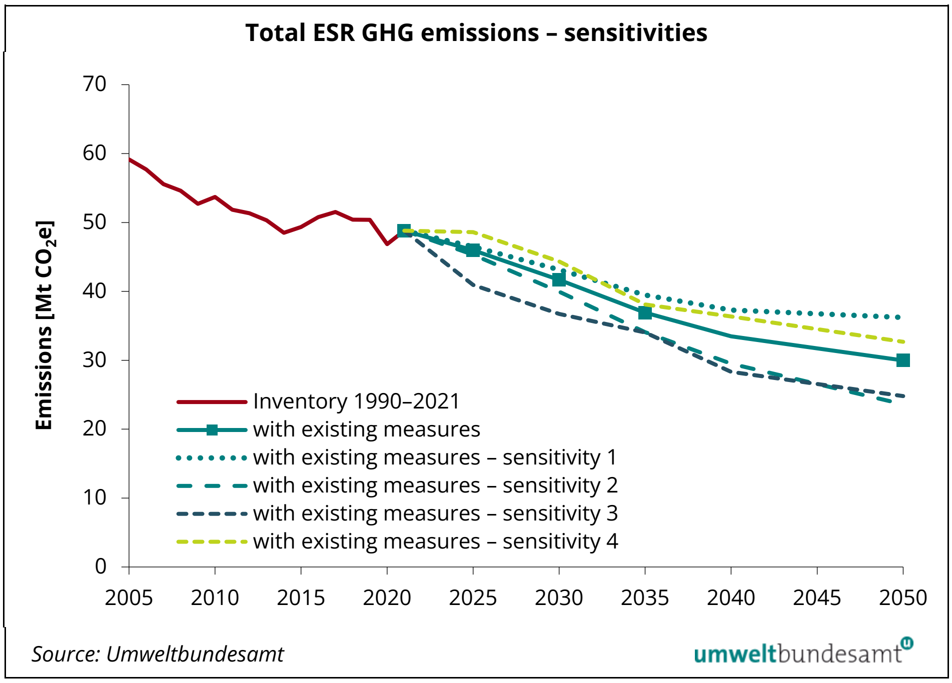


Figure 5: Trend and projections (2025–2050): total ESR GHG emissions for the different sensitivities

The sectoral conclusions and the results of the sensitivity analysis can be summarised as follows:

The sensitivity analysis for the **energy and industry** sectors (Heat and Power Generation (1.A.1) and Manufacturing Industries and Construction (1.A.2)) shows a relatively strong dependence on GDP growth, where a significant increase/decrease in emissions (± 14 % in 2050 compared to WEM) is expected as a lower/higher GDP growth rate is assumed. Price seems to have lesser influcence in the industry sectory as sensitivty 3 and 4 only leads to a of few percentage points change in 2050.

The **Transport sector (1.A.3)** is the one, which is most sensitive to a variation in price or GDP. A higher annual GDP growth rate results in an increase in total GHG emissions (+24% in 2050). This is mainly caused by intensified economic activities between Austria and its neighbouring countries and increased export quotas, leading to an increase in road freight transport by heavy duty diesel vehicles. GHG emissions are expected to rise accordingly. The results for the sensitivity scenario 2 show that a lower annual GDP growth rate results in a decrease in the total GHG emissions (–23% in 2050) from this sector. Price sensitivities are at a similar range on the downside (-21% in 2050, with high prices), but only limited in the upside (+11% 2050, low prices), compared to WEM.

GDP and price variations do not have a huge effect on emissions in **Other Sectors (1.A.4)**, as the variation in GHG emissions is below ± 6 % for all sensitivities in 2050. Increased economic growth leads to an increase in fossil energy demand compared to the WEM scenario. In WEM sensitivity with higher GDP or lower price, total fuel demand for heating is also higher than in the WEM scenario due to smaller investments in renovation measures. The reduction in the use of fuel oil is less noticeable in the WEM sensitivity with higher prices.

In the sensitivity analysis for sector **Agriculture (3)**, the focus was placed on investment costs, as these are subject to a high degree of uncertainty. Several variants of investment costs were used and compared in the PASMA model. The final assumptions for the cost increase were determined according to the stakeholder dialogue assuming higher construction costs than observed in the past. As a result, animal husbandry became more expensive whereas other activities like e.g. plant production became more profitable for farmers.

Overall, the PASMA results for Austria in 2030 are in line with the expectations of the OECD (OECD-FAO 2022) and the European Union (EC 2022). However, the development of milk production in Austria deviates from the generally expected developments due to the comparative advantage of dairy production in Austria compared to other countries.

1.5 Uncertainty in Projections

For most recent inventory submissions, a complete uncertainty assessment was performed (see UMWELTBUNDESAMT, 2023). The uncertainty of the GHG totals in Austria's GHG Inventory is estimated to be about 5 percent for the last inventory year. As fuel combustion is a major source of emissions, it is a sector (with a relatively small uncertainty) that also determines the overall uncertainty. Uncertainties tend to be higher for some sources and can vary significantly between individual sources.

The development of GHG scenarios adds another layer of uncertainty. In general, the uncertainty associated with projected activity data is considerably higher, while the uncertainty in the emission factors might be in a range similar to that of the uncertainty levels in the inventory.

Overall, there are different types of uncertainty that can be identified in emission projections:

- Inaccuracy of the base data (uncertainty in the GHG inventory, energy balance and key statistic/surveys)
- Assumptions on economic activities and key drivers (GDP, energy prices, population …),
- Impacts of policies and measures,
- Weather conditions (especially in some years),
- Global developments like pandemics and conflicts.

The main uncertainty factors are described for each sector in the following.

Energy Industries (1.A.1), Manufacturing Industries and Construction (1.A.2) and Industrial Processes & Product Use (CRF Source Categories 2)

Economic development (gross value added) directly influences energy demand and has been identified as the most important parameter. As can be seen in the sensitivity analysis, a decrease in GDP growth significantly reduces the energy demand.

Another very important parameter is the global oil price along with developments in energy prices. How much power the Austrian plants will produce for the international market also depends on the international price for electricity.

The third important parameter is the number of existing and prospective heat and power plants in Austria. Any long-term decisions on whether or not to build new gas-fired power plants in Austria strongly depend on the gas and electricity prices and on national and international policies.

For the wood and the pulp and paper industries, the availability of biomass and the costs involved are also a key parameter.

Less uncertainty is associated with population growth in Austria.

For halocarbons and SF6

Projections are mainly based on the pre-set quotas for the EU FC phase down. However, while EU Regulation 517/2014 specifies rules for the quotas of F gases which may be placed on the European market, the percentage applicable for Austria is unclear, which introduces an intrinsic uncertainty in estimated emissions. Furthermore, the expected decrease in leakage rates due to technical developments as well as the side effects of implemented measures have not yet been fully accounted for in the model.

For 2.D solvent use

Projections of CO_2 emissions in the sub-sector 2.D 'Non-Energy Products from Fuels and Solvent Use' are mainly based on economic growth data for sectors in which solvents are used. However, a possible decoupling of solvent use from economic growth through continuous technical improvement has not been fully considered.

Transport (CRF Source Category 1.A.3)

Numerous exogenous factors have an influence on projections such as: population growth, motorization level, fuel price trend, fuel export trend (fuel purchased in Austria and consumed abroad because of lower fuel prices in Austria compared to neighboring countries), fuel efficiency trends in newly registered vehicles as well as yearly trends in new registrations of electric vehicles and the share of BEVs (battery electric vehicles) and PHEVs (plug-in electric vehicles).

Other Sectors (CRF Source Category 1.A.4 & 1.A.5)

The sensitivity analysis shows that variations in assumptions for GDP slightly influence emission projections (see previous chapter).

Some uncertainty is associated with the implementation and acceptance of measures which influence overall heating demand, e.g. the renovation rate and the boiler exchange rate.

Economic development (gross value added), especially in the commercial sector, directly influences energy demand. Furthermore, specific economic conditions may inhibit or postpone the implementation of renovation measures, which may result in smaller reductions of greenhouse gas emissions.

Less uncertainty is associated with population growth in Austria, and with permanently occupied dwellings and the number of buildings.

Fugitive Emissions from Fuels (1.B)

The uncertainty in the projections for fugitive emissions is closely linked to the uncertainty in the energy industries sector. A higher level of uncertainty has to be expected when predicting CO_2 emissions from natural gas refineries since they depend on the composition of the explored natural gas.

Agriculture (CRF Source Category 3)

Future projections are fraught with a range of uncertainties which need to be kept in mind when considering the results of this analysis:

- **Model uncertainty:** The first uncertainty factor is related to the type of model. The PASMA model (WIFO & BOKU 2023) is static by design and adjustments to future situations are calculated in discrete steps which are based on exogenous assumptions (prices, costs, technical coefficients) and model-endogenous coefficients (marginal costs) based on observations in the reference period. Investment costs are not considered in the model as it is based on gross margin calculations. The model assumes a swift adaptation of land uses and management and an efficient use of resources. In practice, such adaptations may be over-optimistic because farmers are not able or willing to adjust in the way the model suggests.
- **Market uncertainty:** A comparison of different OECD-FAO projections suggests that there is a considerable difference between them. The range of such uncertainties is discussed in more detail in the relevant OECD-FAO report (2022).
- **Policy uncertainty:** Policies affect the decisions of farmers and other market participants in various ways. The range of policies is not limited to agricultural policies alone: energy policies affect energy prices and thus input costs; urban planning regimes affect decisions about developments in residential and commercial areas, which have an impact on the availability of agricultural land.

Land Use, Land-Use Change and Forestry (CRF Source Category 4)

The forest sub-category (including harvested wood products) has the highest impact on LULUCF projection results. Consequently, the uncertainties for this sub-category are expected to account for most of the uncertainty in the total LULUCF trends. A particularly high level of uncertainty is associated with the simulated changes in forest soil C stock.

Waste (CRF Source Category 5)

Several assumptions have been made regarding future waste amounts treated, with a moderate level of uncertainty as current expectations are largely based on historical activity data and population trends. Due to good quality country-specific activity data available on an annual basis (Electronic Data Management) the level of uncertainty is relatively low.

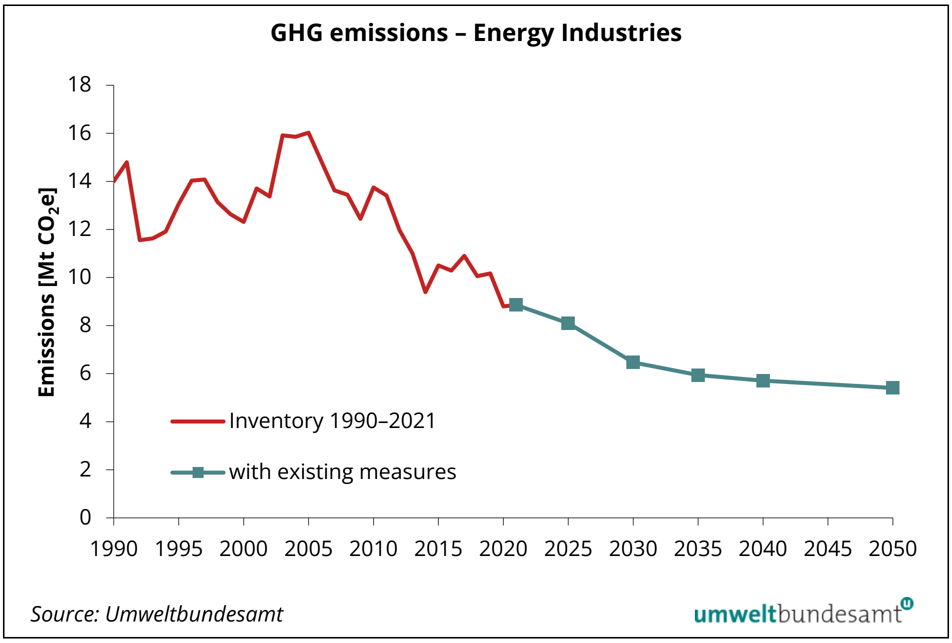
Regarding waste disposal, it is important to note that for upcoming years historical deposits are relevant as well due to application of the First Order Decay method.

2 SECTORAL SCENARIO RESULTS

2.1 Energy (CRF Category 1)

2.1.1 Energy industries (1.A.1)

Figure 6: Past trend and scenarios (2022–2050): GHG emissions from 1.A.1 – Energy Industries.



In 2021, the emissions from sub-category *1.A.1 Energy Industries* were 37% below the 1990 level. GHG emissions from thermal power plants have generally been decreasing since 2005, mainly because of the growing contribution of renewable energy sources, the substitution of solid and liquid fuels by natural gas and biomass as well as improvements in efficiency. In 2020, the last Austrian coal-fired power plant was shut down.

The share of biomass used as a fuel in this sector increased from 0.9% (1990) to 28% (2021). The contribution of hydro, wind and photovoltaic power plants to total public electricity production increased from 69% (1990) to 82% (2021). Electricity consumption increased by 50.8% since 1990 and since 2002 the increase is to a large extent covered by electricity imports (depending on year).

In the energy industries sector, GHG emissions are expected to continue to decrease due to a shift away from gas and oil to renewables. The installed capacity of hydropower and especially solar and wind plants is expected to increase significantly. The capacity of biomass CHP plants is expected to increase only up to 2030 – unless more subsidies than planned in the WEM scenario are granted.

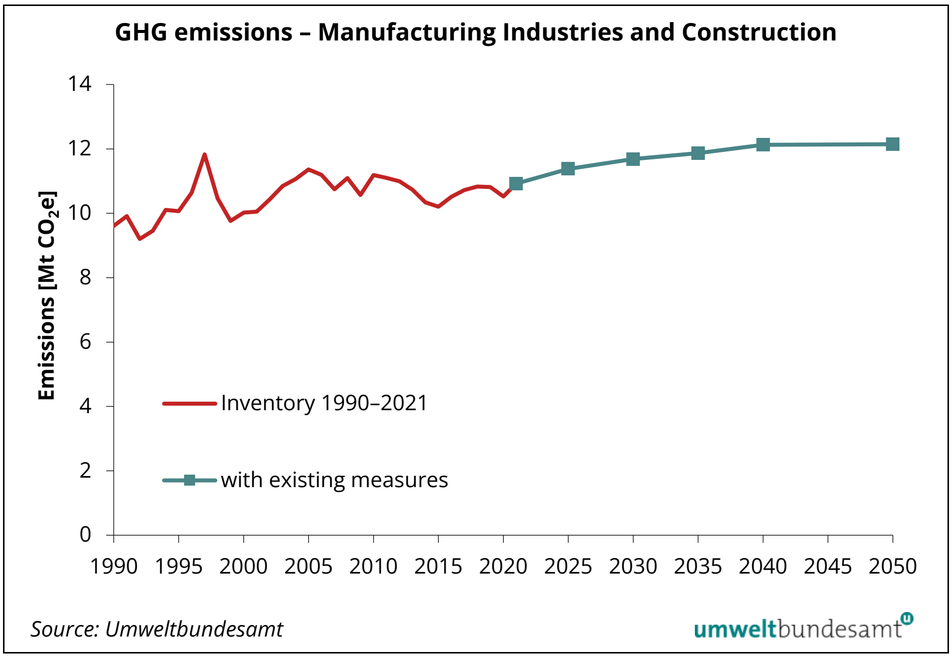
The major driving force behind the emissions in this sector is expected to be the growing electricity demand. Demand is expected to rise by more than 1% per year. The demand for district heat is expected to remain stable until 2030, and to decrease thereafter.

Emissions from petroleum refining are projected to slowly decrease by approximately 10% until 2050 due to the dwindling demand of diesel and gasoline in the transport sector.

Emissions from oil and gas exploration and storage are expected to decline considerably due to a decline of gas exploration activities expected over the next decade.

2.1.2 Manufacturing industries and construction (1.A.2)

Figure 7: Past trend and scenarios (2022–2050): GHG emissions from 1.A.2 – Manufacturing Industries and Construction.



The Industry sector is one of the main sources of greenhouse gas emissions in Austria, mainly due to its CO_2 emissions. Major sub-groups contributing to these emissions are energy related emissions from iron and steel production, the production of non-metallic minerals, the pulp and paper industry and the chemicals industry. Emissions from iron and steel production are to a major extent also included under process emissions (sector 2C).

Energy related GHG emissions from manufacturing industries and the construction sector (1.A.2 Manufacturing Industries and Construction) increased by 13.7% from 1990 to 2021, mainly from Off-road vehicles and other machinery (1.A.2.g.vii) as well as the Chemicals Industry (1.A.2.c). However, emissions from the pulp, paper and printing industry (1.A.2.d) and other manufacturing industry (1.A.2.g.viii) have been decreasing since 1990. Fuel consumption increased by 39% in that period, mainly due to increased use of natural gas and biomass. As natural gas has a lower carbon content, and CO_2 emissions from biomass combustion are not accounted for under the UNFCCC reporting framework, the increase in GHG emissions from this category is significantly smaller compared to the increase in fuel consumption.

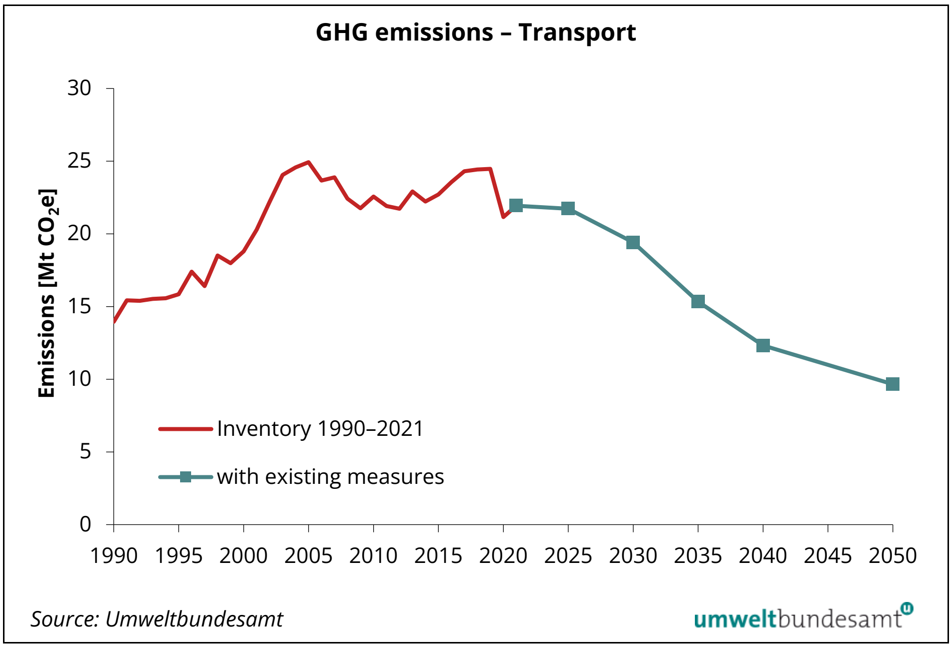
For the period 2021–2050, an increase in GHG emissions is expected as a result of higher sectoral GDP projections. Sectoral emission trends are mainly the result of different sectoral economic growth rates, which are in turn outcomes of the macroeconomic model.

Emission increases between 2021 and 2050 are expected in several industrial sectors: non-ferrous metal industry (1.A.2.b, + 1.8 %), chemical industry (1.A.2.c; +5.7 %), pulp and paper industry (1.A.2.d, + 13.41 %), food processing (1.A.2.e, + 2.3 %), non-metallic minerals industry (1.A.2.f; – 16.7 %) and other stationary manufacturing industry (1.A.2.g.8; + 5.4 %).

A decrease is expected in the iron and steel industry (1.A.2.a; – 0.3 %). The mobile sources in this sector (CRF 1.A.2.g.7) accounted for 1.4 Mt of CO_2 equivalent in 2021 and are expected to rise by 36.1% by 2050.

2.1.3 Transport (1.A.3)

Figure 8: Past trend and scenarios (2022–2050): GHG emissions from 1.A.3 – Transport.



The sector 1.A.3 Transport showed an **increase in GHG emissions since 1990** (+57%) mainly due to an increase of road performance (mileage) of diesel cars and freight transport. In addition to the increase of road performance within Austria, the amount of fuel sold in Austria but used elsewhere – an effect called fuel export mainly caused by a lower fuel tax compared to Austria's neighbouring countries – has increased considerably since 1990. GHG emissions reached a peak in 2005. **Between 2005 and 2012 total GHG emissions decreased** due to lower amounts of fuel sold together with an increased use of biofuels for blending and the gradual replacement with newer vehicles with lower specific fuel consumption. Since then GHG emissions from transport have been **gradually**

increasing with rising traffic volumes. A sharp decrease in the pandemic year 2020 was observed. **From 2020 to 2021** GHG emissions increased again by 3.7% due to increased vehicle kilometres. Sales of biofuels – pure and for blending – increased by 2.0 % in this period.

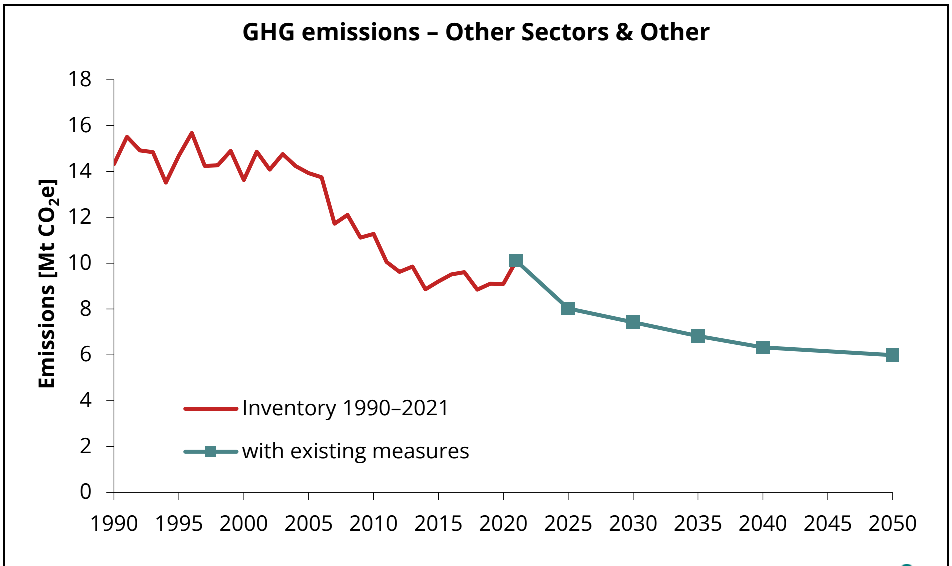
In 2021, the total share of fuel export in CRF 1.A.3.b amounted to 22 % where 31 % are coming from passenger road transport and 69 % from road freight transport. This amount is expected to remain relatively constant in the future.

The transport sector is and will remain one of the main sources of greenhouse gases in Austria. GHG emissions are assumed to decrease until 2050 (- 56.0 %) mainly as a result of the increased share of electric vehicles in road transport along with a quite stable use of biofuels with higher fuel efficiency standards.

In 2030, diesel PC will account for around 39 % of the total car fleet and gasoline PC around 44 %. BEV will account for 17 %. In 2040, BEV will account for the majority with a share of 62 % (compared to 14 % accounted for by diesel cars and 24 % by gasoline cars).

2.1.4 Other Sectors & Other (1.A.4 & 1.A.5)

Figure 9: Past trend and scenarios (2022–2050): GHG emissions from 1.A.4 – Other sectors (including Residential, Commercial/Institutional and Agriculture/ Forestry/Fishing) and 1.A.5 – Other (military).



The variation in the demand for heating and hot water generation due to climatic circumstances, the increasing building stock, energy efficiency and the change in the fuel mix are the most important drivers for emissions from category *1.A.4 Other sectors: Stationary combustion*. This subcategory amounts to about 90% of total 2021 GHG emissions of categories *1.A.4 Other Sectors* and *1.A.5 Other*, which were 29% lower in 2021 than in 1990. This reduction is mainly attributable to a declining consumption of heating oil and coal and an increase in the consumption of biomass and natural gas, as well as the growing importance of district heating and modernised heating systems. Total fuel consumption in this sector (including mobile sources) has decreased by 2.8% since 1990 to 2021.

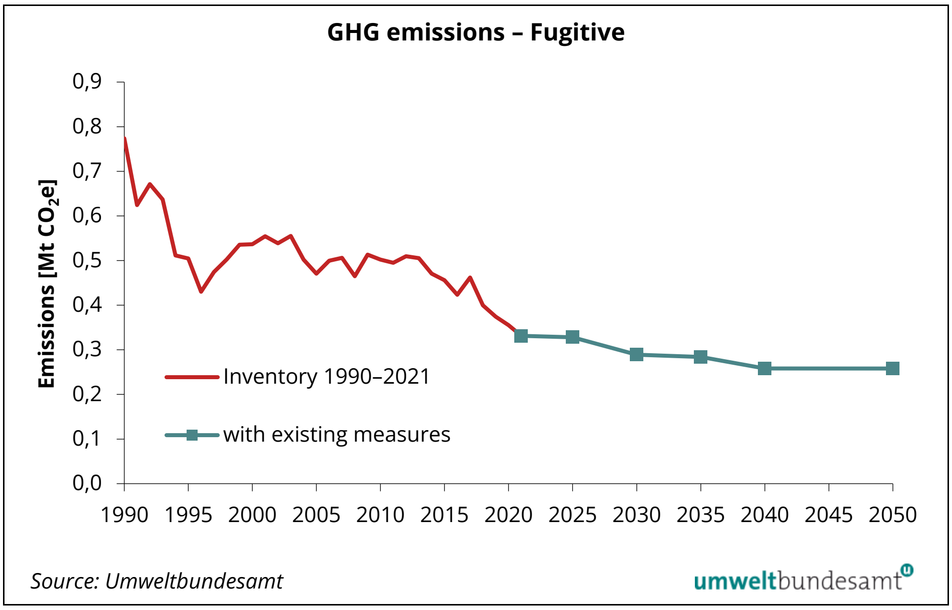
The categories *1.A.4 Other Sectors* and *1.A.5 Other* account for a considerable amount of Austria's total greenhouse gas emissions in 2021. Despite growing numbers of households, occupied living space and commercial useful floor area the total GHG emissions in this sector are expected to see substantial reductions by 2050 in the WEM scenario.

The driving force behind these reductions is the expected shift away from fossil fuels to renewables like biomass, solar heat and ambient heat, combined with a stable share of district heat and an increasing share of electricity for heat pumps, which means that more emissions will occur in category *1.A.1 Energy Industries*. Furthermore, a reduction in total energy consumption (incl. electricity) of category *1.A.4 Other sectors: Stationary combustion* of about 12% together with improved insulation for new buildings (or better insulation through renovation measures) and an improved efficiency of primary heating systems in buildings are expected to lead to a considerable reduction in GHG emissions between now and 2050.

Mobile sources in this sector (mainly from category *1.A.4.c.2 Agriculture/Forestry/Fishing: Mobile combustion*) accounted for 0.8 Mt of CO_2 equivalent in 2021 and are expected to slightly increase (+ 1.8% until 2050) in the WEM scenario.

2.1.5 Fugitive emissions (1.B)

Figure 10: Past trend and scenarios (2022–2050): GHG emissions from 1.B – Fugitive emissions.

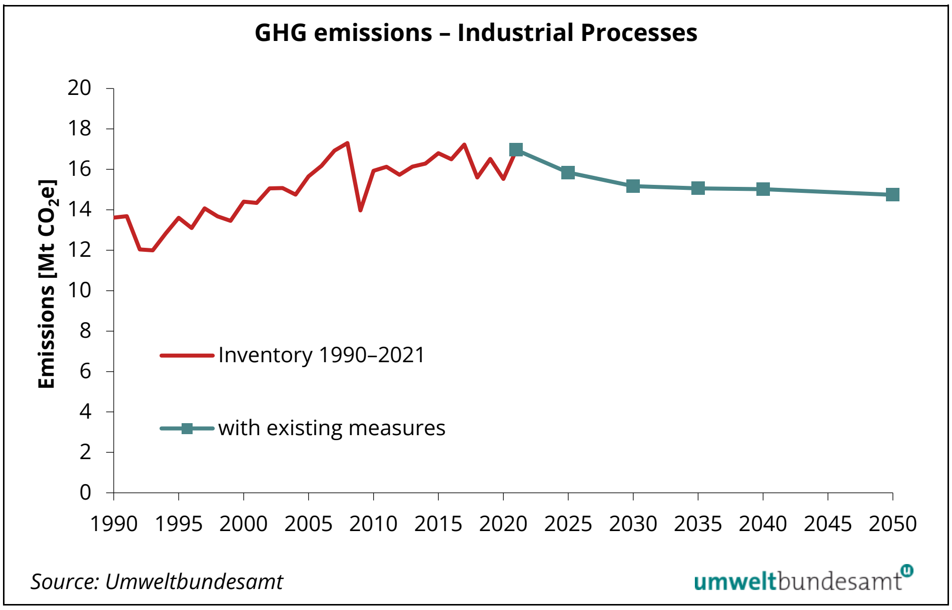


Between 1990 and 2021, fugitive emissions from coal mining, fossil fuel exploration, refining, transport, production and distribution decreased by 57%. The main driving force behind this decrease was the closure of coalmines. There have been no coal-mining activities in Austria since 2007. The increase in and after 1996 was due to an extension of the natural gas distribution network and increasing CO_2 emissions from natural gas and oil extraction.

It is expected that Austria's total fugitive emissions will decrease due to a continuous decrease in natural gas exploration. Emissions from the natural gas distribution network and gas storage will not decrease because projected final natural gas consumption will decrease by about 22.1% only.

2.2 Industrial Processes & Product Use (CRF Category 2)

Figure 11: Past trend and scenarios (2022–2050): GHG emissions from 2 – Industrial Processes & Product Use.



In 2021, greenhouse gas emissions from *Industrial Processes and Other Product Use* amounted to 16 959 kt CO_2 equivalent, which corresponds to 22% of total national emissions. The most important sub-categories of this sector are *metal industry* and *mineral industry*, generating 65% and 18% of total sectoral emissions, respectively. Other relevant sources are *Consumption of Halocarbons and* SF_6 contributing 8.7%, *chemical industry* with a contribution of 4.6 % and *Other production manufacture and use* with 2.3%. Minor emissions arise from *Electronics industry* and *Non-Energy products from fuels and solvent use*.

The most important greenhouse gas of this sector is CO_2 with a contribution of 88% to total sectoral emissions in 2021, followed by HFCs with 9% and SF_6 with 2.2%, the other GHGs contribute less than 0.5 % each.

The overall trend from 1990 to 2021 for *Industrial Processes and Other Product Use* shows an increase of 25%. Within this period, emissions were at minimum in 1993 then increased until peaking in 2008. Since then, emissions fluctuated just below this maximum. Main drivers for the trend in emissions from this sector were (i) the termination of primary aluminium production in 1993, (ii) the introduction of N_2O abatement technologies in the chemical industry in 2004 and in 2009 (which became fully operational in 2010), (iii) the economic crisis of 2009, (iv) increasing iron and steel production resulting in 61% higher GHG emissions in 2021 compared to 1990 and (iv) a strong increase of HFC emissions over the 1990-2021 period from 2 to 1 486 kt CO_2 equivalent.

Trend of projected emissions

Emissions from industrial processes are expected to continue their decreasing trend until 2050, with the main reductions taking place in the years until 2030. The main reductions are expected to be achieved in *Consumption of Halocarbons and SF6*, as well as the main sub category *Metal industries* showing a moderate decrease due to the use of imported direct reduced iron in the blast furnace. Also emissions from *Other product manufacture and use* decrease remarkably.

Trend of the main sub categories

The largest increase in GHG emissions between 1990 and 2021 can be observed in *metal industry* due to an increase in GHG emissions from iron and steel production (+61%). Emissions until 2050 are expected to decrease due to an increasing use of imported direct reduced iron in the blast furnace.

In sub-categories *mineral industry*, GHG emissions also peaked in 2008 and show an overall decrease from 1990-2021 of 2.0%. Emissions are expected to remain rather constant in the coming years.

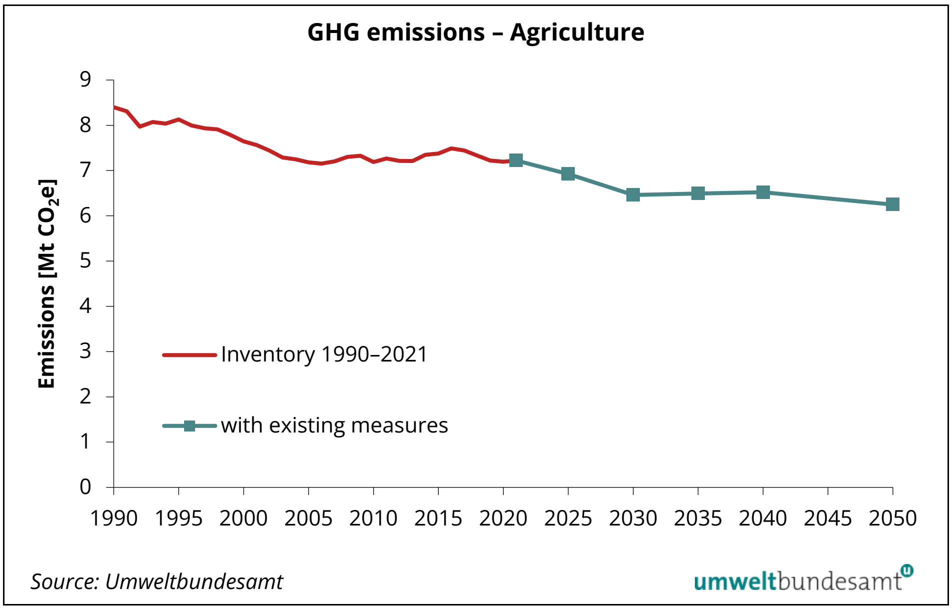
Emissions from *Consumption of Halocarbons and* SF_6 were permanently increasing with high annual growth rates from introduction to the market in the early 90ies as substitutes of Ozone Depleting Substances until peaking in 2018, where the EU F gas Regulation (Regulation (EU) No. 517/2014), targeting on limiting the consumption, started to take effect on emissions. Due to the limits and bans of the regulation, the Kigali Amendment to the Montreal Protocol as well as the increased availability of low GWP alternatives, emissions are expected to continue the downward trend until 2050, resulting in a reduction of about ¾ compared to the maximum in 2018.

In sub-categories *chemical industry*, GHG emissions declined over the same period by 46%, due to abatement measures taken in nitric acid production. Emissions are expected to increase due to slightly increasing economic growth rates

Emissions from *Other product manufacture and use* showed high fluctuations from 1990 to 2021, due to differing contributions from various sub categories starting and ending to be relevant. Currently, the disposal of noise insulating windows is the main contributor, but this effect will cease in 2028, when emissions from this sub category will stop due to the end of use of the remaining windows containing SF_6. After this, remaining emissions from this category constitute almost exclusively of SF_6 emissions from switchgears, these are expected to continue to increase due to the growing demand in energy.

2.3 Agriculture (CRF Category 3)

Figure 12: Past trend and scenarios (2022–2050): GHG emissions from 3 – Agriculture.



In 2021, greenhouse gas emissions from *Agriculture* amounted to 7 221 kt CO_2 equivalent, which corresponds to 9.3% of Austria's total emissions.

The most important sub-categories of this sector are enteric fermentation (58%) and agricultural soils (25%). Agriculture is the largest source of national N_2O and CH_4 emissions: in 2021, 72% (8.5 kt N_2O) of the total N_2O emissions and 74% (172 kt CH_4) of the total CH_4 emissions in Austria originated from this sector.

CH_4 emissions dominate with a share of 67% the total GHG emissions from the sector agriculture. The share of N_2O emissions is 31%. CO_2 emissions account for 2.1% of total greenhouse gas emissions from sector agriculture.

The overall trend in GHG emissions from Agriculture shows a decrease of 14% from 1990 to 2021. The main drivers for this trend are decreasing livestock numbers of cattle and swine as well as lower amounts of N-fertilizers applied on agricultural soils.

For the WEM scenario, the emission projections show a 13.5% decrease between 2021 and 2050. Projected figures of activity data such as livestock numbers, milk yields, mineral fertiliser quantities and crop yields strongly influence the trend. In addition, existing emission-reducing measures in the areas of feeding, animal husbandry, slurry storage and application of farm and mineral fertilisers were taken into account. The assumptions are based on existing measures as implemented in Austria, e.g. within the framework of the CAP strategic plan and existing climate policy measures.

Activity data scenarios were calculated with the agricultural sector model PASMA (WIFO & BOKU 2023). The results are briefly explained below:

Cattle numbers: WEM projections indicate that the cattle numbers will decrease by 13% between 2021 and 2030. After 2030, the number continues to decline, but at a lower rate. This is because only the output and input prices and technical coefficients change. No further increment in investment costs was assumed. In its latest outlook on agricultural markets, the European Commission also anticipates lower beef production and a declining number of dairy cows at EU level.

Pig numbers: The number of pigs decreases at a much higher rate because the output price and input cost relations are less favourable. In its most recent outlook on agricultural markets, the European Commission expects lower production of pork as well at EU level.

Poultry numbers: The number of poultry declines at a similar rate as the number of pigs until 2030. After 2030, the number of poultry decreases at a lower rate. The modelled development of the poultry population is in contrast to the observed trends. The reason lies in the international competition for poultry meat and eggs and the comparatively high production costs in Austria.

Fertilizer application: Model results indicate that mineral fertilizer application on agricultural land will increase. Reason is the nutrient deficit due to the declining animal livestock. The lower amount of organic fertilizer will be compensated by higher sales of mineral fertilizers.

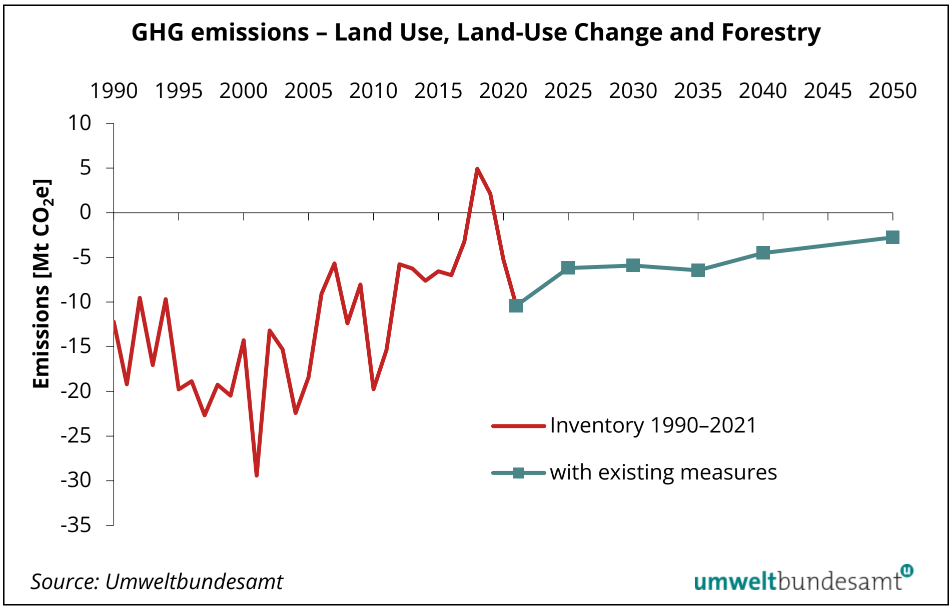
Cropland and grassland: Total cropland and grassland areas decline steadily.

Crop yields: According to the model results, the crop yields decline. Crop yields per hectare decrease slightly more compared to corresponding cropping areas.

Organic soils: Areas are assumed to stabilise at the observed level throughout the period.

2.4 LULUCF (CRF Category 4)

Figure 13: Past trend and scenarios (2022–2050): GHG emissions from 4 – Land Use, Land-Use Change and Forestry[1].



In 2021, net removals from the sector LULUCF amounted to −10 402 kt CO_2 equivalent, which corresponds to 13% of the total national GHG emissions (without LULUCF) in 2021 compared to 15% in the 1990.

With regard to the overall trend of net removals from LULUCF, the removals decrease by 77% over the observed period (1990-2050). The main driver for this trend is the biomass carbon stock change in forest land. Fluctuations are due to weather conditions which affect the growth rates on the one hand (e.g. very low increment in 2003) and windthrow and other natural disturbances on the other, as well as timber demand and prices (e.g. very high harvest rates in 2007 and 2008).

The LULUCF sector has been a net sink in most years of the past (except 2018 and 2019) and is projected to remain a net sink in the period until 2050. Between 2021 and 2050, net removals are expected to decrease by approximately 7.5 Mt of CO_2 equivalent. This will be strongly influenced by the decrease in removals from forest land caused by a decreasing trend in biomass growth. Biomass use also shows a decreasing trend but at a lower rate. Between 2030 and 2035, this trend is expected to change and the net sink is expected to increase, which can also be explained by a lower level of forest biomass use and by a slightly increasing biomass growth. However, after 2035 the net removals are projected to further decrease because biomass use slightly increases and biomass growth slightly decreases. The second largest category,

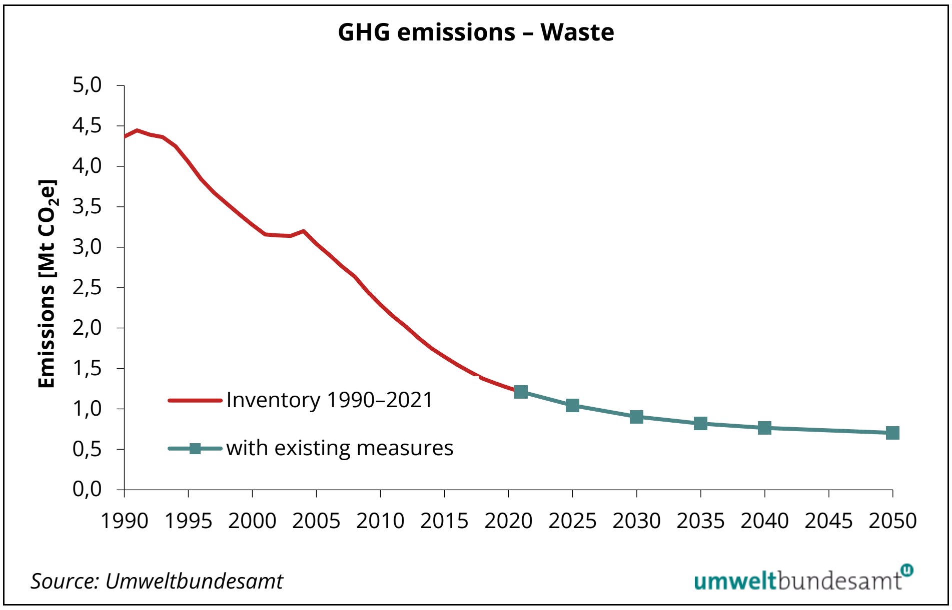
[1] The historical values of category 4.A.1 (having the main impact on the LULUCF totals) for the years 2009 and 2010 are based on averages of the NFI observation periods 2002 and 2008 and will be revised on the basis of the results of the next NFI.

harvested wood products (HWP), is projected to remain a net sink on a stable level (about −2.0 Mt CO_2 on average) during the period 2021−2050.

On the other hand, the non-forest sectors (cropland, grassland, wetlands, settlements) are sources of emissions for the projected time series, amounting to approximately 1.7 Mt of CO_2 equivalent per year.

2.5 Waste (CRF Category 5)

Figure 14: Past trend and scenarios (2022–2050): GHG emissions from 5 – Waste.



In 2021, greenhouse gas emissions from the sector *Waste* amounted to 1 211 kt CO_2 equivalent, which corresponds to 1.6% of the total national emissions.

The most important sub-category of *Waste* is *solid waste disposal*, which caused 73% of the emissions from this sector in 2021, followed by *waste water treatment and discharge* (15%) and *biological treatment of solid waste* (13%). The most important greenhouse gas is CH_4 with a share of 81% in emissions, mainly arising from solid waste disposal, followed by N_2O with 19% and CO_2 with 0.2%.

Overall, GHG emissions from waste show a decreasing trend, with a decrease of 72% from 1990 to 2021. The **main driver** for this trend is the implementation of waste management policies: Waste separation, reuse and recycling activities have increased since 1990 and the amount of waste disposed of to landfill sites has decreased correspondingly especially since 2004 when pre-treatment of waste became obligatory (although some exceptions were granted in some Austrian provinces until end of 2008). The legal basis for the reduced disposal of waste and for landfill gas recovery is the Landfill Ordinance. Since 2009, all wastes with a high organic content have to be pre-treated before being landfilled (without exception). Methane recovery from landfills was introduced in the 1990s.

The scenario shows a further downward trend in emissions from waste disposal, which is in line with the decreasing carbon content of historically landfilled waste, as well as the decrease in the amount of waste deposited. In addition, the landfill gas recovery contributes to the decreasing emissions. Emissions from biological treatment as well as waste water handling and discharge are however expected to slightly increase in line with the growing population.

3 SECTORAL METHODOLOGY

3.1 Energy (CRF Source Category 1)

Total energy demand and production was evaluated on the basis of an energy scenario developed by a consortium of the Environment Agency Austria (Umweltbundesamt), the Centre of Economic Scenario Analysis and Research (CESAR), e-think energy research and the Institute of Thermodynamics and Sustainable Propulsion Systems at the Graz University of Technology. The scenario was developed using several models:

- econometric input-output data (MIO-ES),
- domestic heating and domestic hot water supply (INVERT/EE-Lab),
- public electrical power and district heating supply (MIO ES) and
- energy demand and emissions of transport (NEMO & GEORG).

In addition, several parameters were determined endogenously, e.g. pipeline compressors and industrial autoproducers.

The econometric input-output model MIO-ES combines a private consumption module with an energy and environment module. Important input parameters are energy prices, population and household income (CESAR, 2020). This model was also used to calculate the energy sector.

For modelling energy consumption for domestic heating and domestic hot water supply, the software package INVERT/EE-Lab (e-think, 2023) has been applied. This model is based on a stochastic, non-recursive, myopic and economic algorithm with the objective function to minimise costs. The basic algorithm is based on the principle of the model INVERT. It allows for the calculation of the energy demand for heating (space heating and hot water) in residential buildings and buildings of the public or private service sector by including the effects of various funding instruments. The main inputs for the calculation are:

- availability of resources,
- market penetration of different technologies,
- maximum replacement and refurbishment periods,
- minimum and maximum lifetime of technical installations.

The results obtained with the different models were exchanged and adjusted within a few cycles. Umweltbundesamt experts combined the data obtained with the different models and included additional calculations for

- energy inputs in the iron and steel industry,
- production of electric power and district heating in industry,
- use of waste as fuel in power plants and industry,
- energy input in compressor stations,
- total energy demand,

- electricity demand in the transport sector.

3.1.1 Energy Industries (1.A.1)

3.1.1.1 Methodology of the sectoral emission scenarios

The output of the model based on MIO-ES (see Chapter 3.1) provides fuel-specific activity data for the energy industries (i.e. electricity and heat production including waste incineration). These were multiplied by established and fuel-specific emission factors used in the Austrian Inventory. Emission factors for wastes (e.g. municipal solid waste, hazardous waste) were derived from plant-specific data. The methodology used to create the emission factors is described in the Austrian Inventory Report (UMWELTBUNDESAMT, 2023).

As regards the only refinery in Austria, no major changes in production capacities or in the technologies used are expected from the current point of view. Restructuring programmes and new production units have been introduced in the past. The last one was completed in 2008. The projections are based on the output of the MIO-ES model. A slight decrease in production has been calculated due to decreasing demand in the transport sector, using a refinery-specific emission factor calculated on the basis of average emissions of the years 2020–2021.

The exploration of oil and gas is expected to decline considerably over the next decade. Emissions from oil and gas exploration and storage have been calculated by multiplying the energy input by a fuel-specific emission factor.

3.1.1.2 Assumptions

The assumptions on which the scenario is based (total inputs to power and heat plants, split into the different fuel types) can be seen in the Annex. Energy demand is shown by sector, split by fuel type (final energy consumption). The assumption on which the basic weather parameter is based (heating degree days) is explained in Chapter 1.3.4.

Energy efficiency measures (see Chapter 4) are expected to have been fully implemented, leading to a decrease in electricity demand.

EU ETS/non-ETS

In 'Public Electricity and Heat Production' (1A1a) none of the non-ETS installations uses coal. Municipal waste is burned exclusively in non-ETS installations. For natural gas and liquid fuels, it is assumed that the current ETS/non-ETS share will remain stable throughout the reporting period. 'Petroleum Refining' (1A1b) is completely covered by the ETS except for non-CO_2 greenhouse gas emissions. In the sector 'Manufacture of Solid Fuels and Other Energy Industries' (1A1c) it is assumed that the current ETS/non-ETS share will remain stable throughout the reporting period.

Scenario "with existing measures"

Price of CO2 tonne under the Emission Trading Scheme

It has been assumed that the European ETS will continue beyond 2030 and that the price will not be influenced by decisions of Austrian plant operators. Prices from recommendations of the European Commission have been used as follows:

- 80 €/t in 2030, 85 €/t in 2040, based on 2020 prices.

Renewables Expansion Act

In the scenario 'with existing measures' it is assumed that the goals of the Renewables Expansion Act (Federal Law Gazette I No. 150/2021) will be met for hydropower, photovoltaics and wind power, while the goals for electricity from biomass and renewable gases will not be met. The Act aims at a generation of additional 27 TWh of green electricity (11 TWh PV, 10 TWh, 5 TWh hydropower, and 1 TWh biomass) and 5 TWh of renewable gases by 2030. The total electricity demand in 2030 shall on a yearly basis be supplied by renewable electricity, which will be achieved in the scenario 'with existing measures'.

Green Electricity Act

In the scenario 'with existing measures' it is assumed that the goals of the Green Electricity Act 2012 (Federal Law Gazette I No. 75/2011) will be met for hydropower, exceeded for photovoltaics and wind power and that the goals for biomass will not be met. The Act aims at a construction of hydroelectric power plants with a capacity of 1 000 MW, as well as installing 2 000 MW of wind power and 1 200 MW of photovoltaic capacity, and biomass plants of 200 MW_{el} by 2020. The Green Electricity Act stipulates no specific goals beyond the year 2020.

Petroleum refining

See Chapter 3.1.1.1 for assumptions regarding this sector.

Manufacture of solid fuels and other energy industries

See Chapter 3.1.1.1 for assumptions regarding this sector.

3.1.1.3 Activities

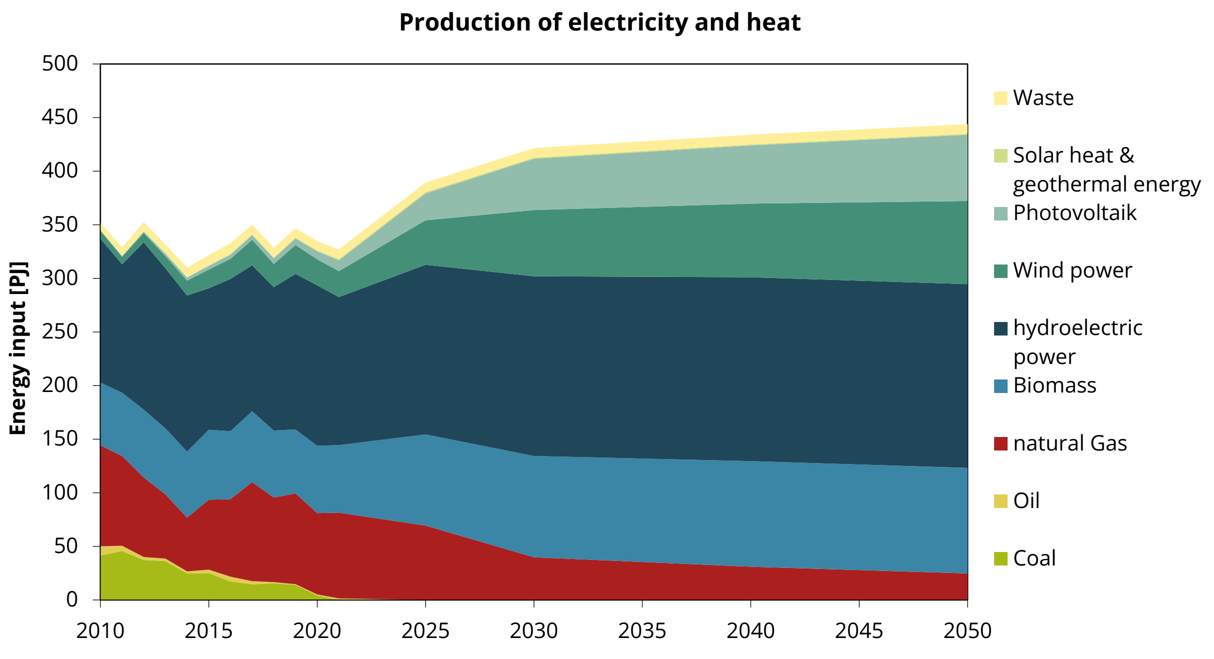
Scenario "with existing measures"

The energy input to Austrian heat and power plants is shown in Figure 16. Input to coal and oil plants is expected to decline (input to coal plants has ended in 2020) for economic reasons and because of the age of the plants, whereas input to gas plants is expected to decline only slightly. The decline in fossil fuel power plants will be driven by a significant increase in the production of hydro-electric, wind and photovoltaic energy with lower marginal costs. Input to biogas plants is expected to decline as subsidy schemes will expire, while biomass heat and power plants are assumed to remain stable.

GHG emissions (and thus energy inputs) from the only refinery in Austria are expected to decrease slightly until 2050 due to decreasing demand from transport as indicated in Chapter 3.1.1.1.

As regards oil and gas exploration and storage, natural gas is the only fuel source. Input is expected to shrink steadily due to limited reserves.

Figure 15: Energy input for electricity and heat production (1.A.1.a) – with existing measures



Source: Umweltbundesamt

3.1.2 Manufacturing Industries and Construction (1.A.2)

3.1.2.1 Methodology used for the sectoral emission scenarios

The methodology used here is the same as the methodology used in the Austrian Inventory and the emission factors and methodology are discussed in detail in the Austrian Inventory Report (UMWELTBUNDESAMT, 2023).

The models are described in the Energy Chapter 3.1.

3.1.2.2 Assumptions

Assumptions for the global oil price are given in Euro 2020. After the Covid-crisis, a sharp price increase has taken place. From 2020 to 2040 the price remains more or less constant. GDP growth is expected to average 1.3% per year until 2040 (see Chapter 1.3.4).

EU ETS/non-ETS

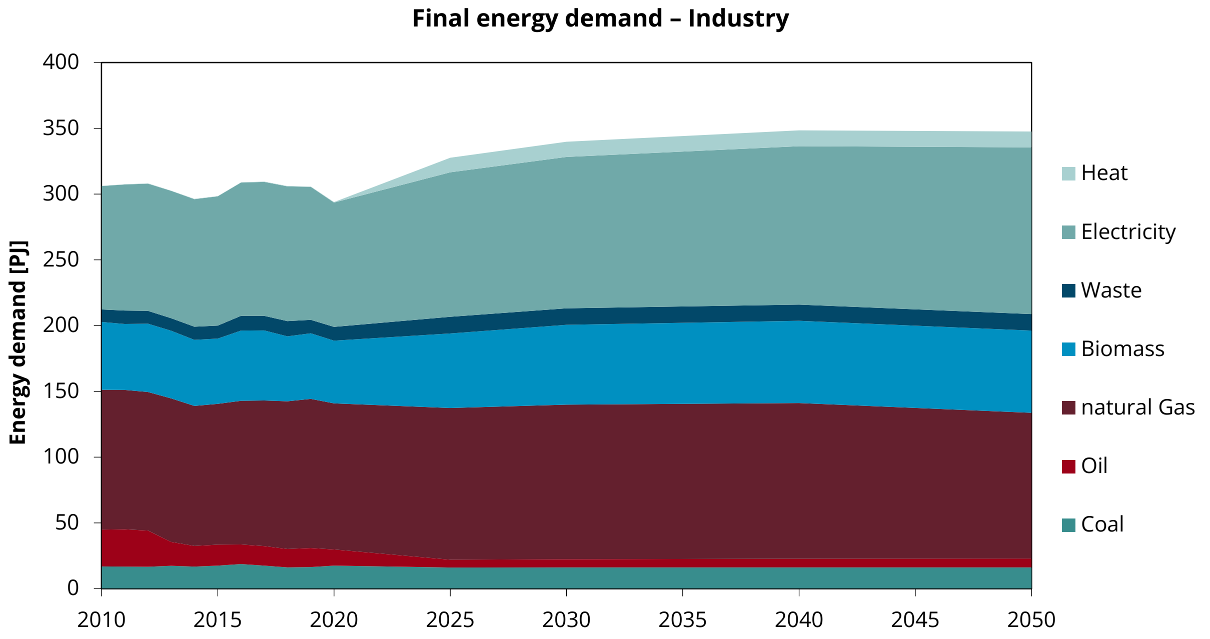
Emissions for EU ETS/non-ETS have been split on the basis of sectoral fuel input. Here the ETS share of each fuel (averaged over the most recent years) has been used for determining the fuel input for EU ETS/non-ETS until 2040.

3.1.2.3 Activities

Scenario "with existing measures"

Based on the sectoral gross value added, the energy demand in the industrial sector is expected to increase steadily from 2015 to 2040 (see Figure 18). Detailed figures are given in Annex 2.

Figure 16: Energy demand in the industrial sector (incl. off-road) – with existing measures



Source: Umweltbundesamt

3.1.3 Transport (CRF Source Category 1.A.3)

3.1.3.1 Methodology used for the sectoral emission scenarios

The scenario comprises different approaches in each CRF source category.

1 A 3 a – Aviation

According to international reporting guidelines, only GHG emissions from domestic aviation (domestic LTO and cruise traffic) need to be included in the national total. Therefore, the share of aviation in Austria's total GHG emissions from *1.A.3 Transport* is very small with 0.1%.

Projections for energy consumption in the aviation sector are based on expert judgement in line with the Austrian aviation industry. The energy demand for aviation fuels (kerosene and different types of SAF (sustainable aviation fuels)) have been estimated taking into account national long-term GDP forecasts, fleet turnover with more energy-efficient planes and higher load capacities as well as assessments of national airport and airline experts regarding the capacities on the ground and in the air.

1 A 3 b - Road Transport

The calculation of transport emissions is based on two models:

- **NEMO – Emission model for Road Transport**
  From the 2015 submission onwards, projections for the time series up to 2050 have been based on NEMO (Network Emission Model, DIPPOLD et al. 2012, HAUSBERGER et al. 2015a,b; SCHWINGSHACKL/REXEIS 2022). Energy consumption and emissions of the different vehicle categories are calculated by multiplying the yearly road performance per vehicle category (km/vehicle and year) by the specific energy use (g/km) and by the emission factors in g/km. NEMO models the road performance and emissions per vehicle size, age and motor type based on dynamic vehicle specific drop out- and road performance functions. To determine fuel consumption and emissions of domestic road transport, vehicle stock and total annual road performance (mileage driven per year) of the vehicle categories should be recorded as precisely as possible by national statistics. Vehicle registrations are being updated yearly.
  It is fully capable of depicting the upcoming variety of possible combinations of propulsion systems (internal combustion engine, hybrid, plug-in hybrid, electric propulsion, fuel cell …) and alternative fuels (CNG, biogas, FAME, ethanol, GTL, BTL, H2 …).
  In addition, NEMO has been designed so that it is suitable for all the main application fields in the simulation of energy consumption and emission output using a road-section based model approach. As there is as yet no complete road network for Austria on a high resolution spatial level, the old methodology based on a categorisation of traffic activities into 'urban', 'rural' and 'motorway' has been applied with the NEMO model.
  For more details see the chapter on methodology in 3.2.12.2. Road Transport of Austria's National Inventory Report 2023 (UMWELTBUNDESAMT, 2023).

- **KEX Tool**
  The KEX tool is used in projections to map the future development of domestic fuel demand in road transport as a function of GDP, population and fuel prices, and to calculate the quantities of fuel exported in motor vehicles abroad in the future. The KEX tool has been developed for estimating the change in domestic fuel demand and the export of fuels in motor vehicles (MOLITOR et al. 2004, MOLITOR et al. 2009). As independent variables, the KEX tool uses GDP, population, export quotas and domestic and foreign gasoline and diesel prices. Whereas the NEMO model calculates domestic fuel consumption, the KEX tool estimates the amount of fuel purchased in Austria and used abroad. The KEX tool includes a very simplified statistical tool, while NEMO includes predefined technologies for

new vehicle registrations, their market penetration and the effects on consumption and emissions.
For more details see the chapter on methodology in 3.2.12.2. Road Transport of Austria's National Inventory Report 2023 (UMWELTBUNDESAMT, 2023).

1 A 2 f, 1 A 3 c, 1 A 3 d, 1 A 4 b, 1 A 4 c, 1 A 5 – Mobile sources

The calculation of transport emissions is based on a model:

- **GEORG - Emission model for Off-Road Transport**

  Energy consumption and emissions of non-road mobile machinery (off-road) in Austria are calculated using the GEORG model (Grazer Emissionsmodel für Off Road Geräte) (HAUSBERGER 2000). GEORG has a fleet model part which simulates the actual age and size distribution of non-road mobile machinery (NRMM) stock via age- and size-dependent drop-out rates (i.e. the probability that a vehicle will have been scrapped by the following year). Using this approach, the number of vehicles in each mobile source category is calculated according to the year of the vehicles' first registration and their propulsion systems (gasoline 4-stroke, gasoline 2-stroke, diesel > 80 kW, diesel < 80 kW).

  For more details see the chapter on methodology in 3.2.13.2 Other sectors – mobile combustion of Austria's National Inventory Report 2023 (Umweltbundesamt, 2023).

1 A 3 e – Other transportation – pipeline compressors

Projections for energy demand in pipeline transport up to 2040 are based on expert judgements of European gas demand, gas and electricity prices, economic developments and on a regression analysis of observed historical trends.

3.1.3.2 Assumptions

1 A 3 a – Aviation

The forecast of the future volume of air traffic depends on different European or geopolitical developments, for example in connection with the economy, the European energy crisis or the CO_2 price development and is therefore subject to large fluctuations. The projections is based on the current 7-year forecast of the European Organization for the Safety of Air Navigation (EUROCONTROL), which shows the possible growth for pan-European air traffic which depicts air traffic movements in three scenarios (EUROCONTROL, 2023). In addition, a fourth scenario has been developed in coordination with the Austrian aviation industry and is used in the projections.

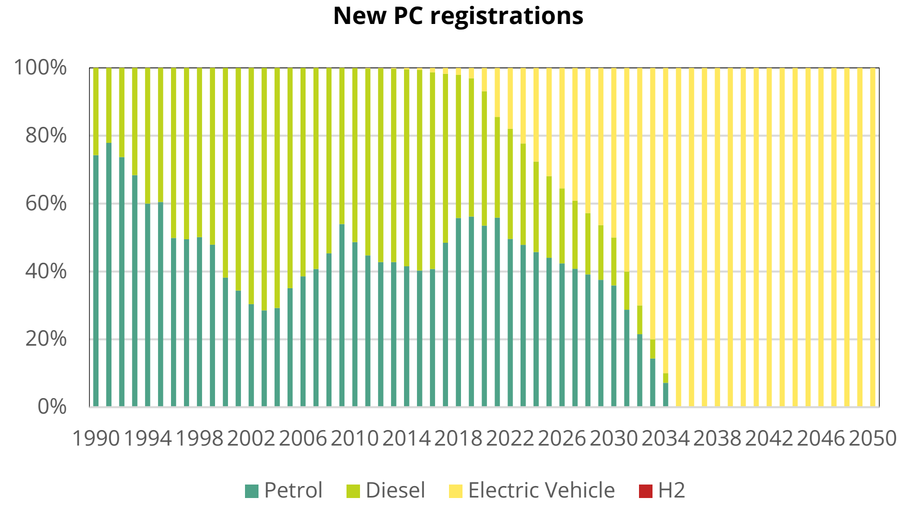
1 A 3 b – Road Transport

Development of the vehicle fleet

Diesel passenger car registrations show a decline over the past years. At the same time petrol passenger cars have been showing a higher share in new registrations than diesel since 2018. Given this trend and the problems with diesel cars and their emission behaviour, it is assumed that from 2025 onwards we will see substantial registrations of new BEVs (battery electric vehicles) over 100.000 cars per year. Petrol car registrations will continue to rise until 2024. 2035 will be the first year with 100% BEV registrations.

In a nutshell, it can be said that new passenger cars and LDV registrations follow an optimistic trend set already by the car industry following recent discussions about a ban on new vehicle registrations of cars and LDV with a conventional combustion engine. HDV registrations contain more moderate assumptions following the Clean Vehicle Directive & EU Vecto Group Trend. For details see Transport PaM N°9 "EU CO_2 reduction targets for PC, LDV and HDV" (chapter 4.5.1.1).

Figure 20: Shares per type of combustion in total new PC registrations.



Source: Umweltbundesamt

For road freight transport, electric trucks of all size categories have been available for sale for some time. However, consumer acceptance is not sufficient yet and many freight operators are experimenting with electric vehicles only in a pilot projects. Therefore, only a very small number of electric heavy duty vehicles (HDV) has been considered in the current projections. Furthermore, rail transport provides an alternative to long distance road transport. A shift away from road to rail should be aimed for in freight transport. For urban collection and delivery services, electric light duty (LDV) vehicles are already in use and included in the current projections.

Figure 21: Shares per type of combustion in total new LDV registrations.

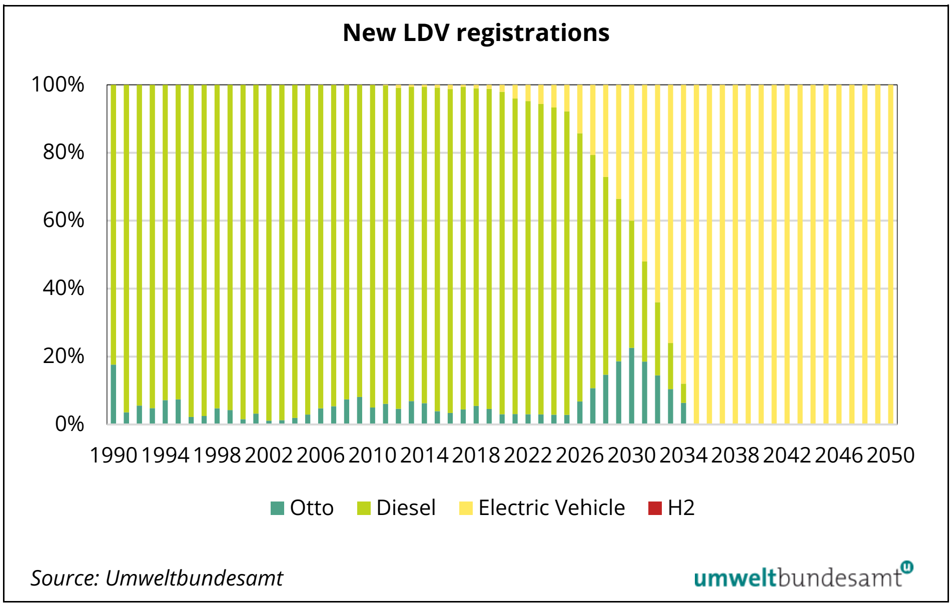
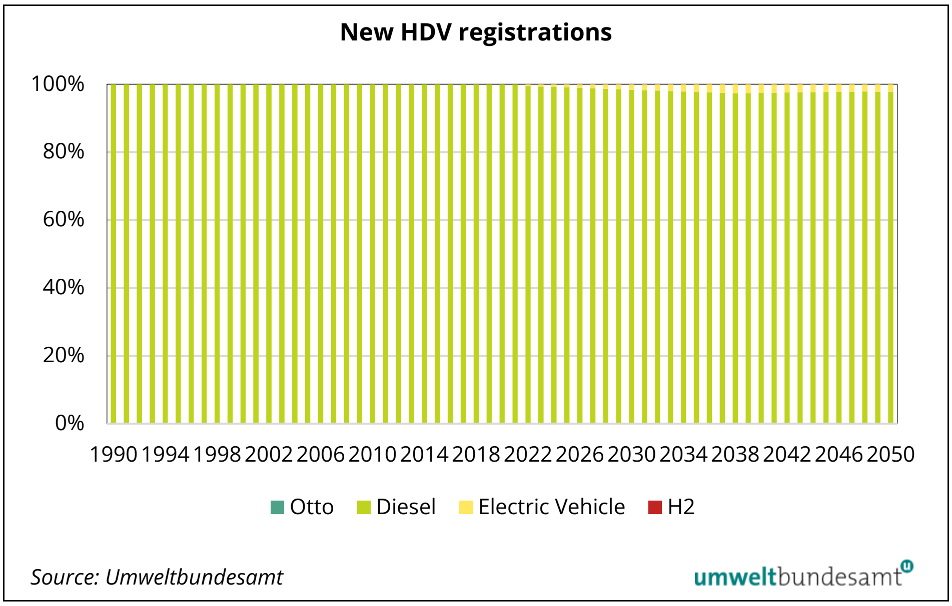


Figure 17: Shares per type of combustion in total new HDV registrations.

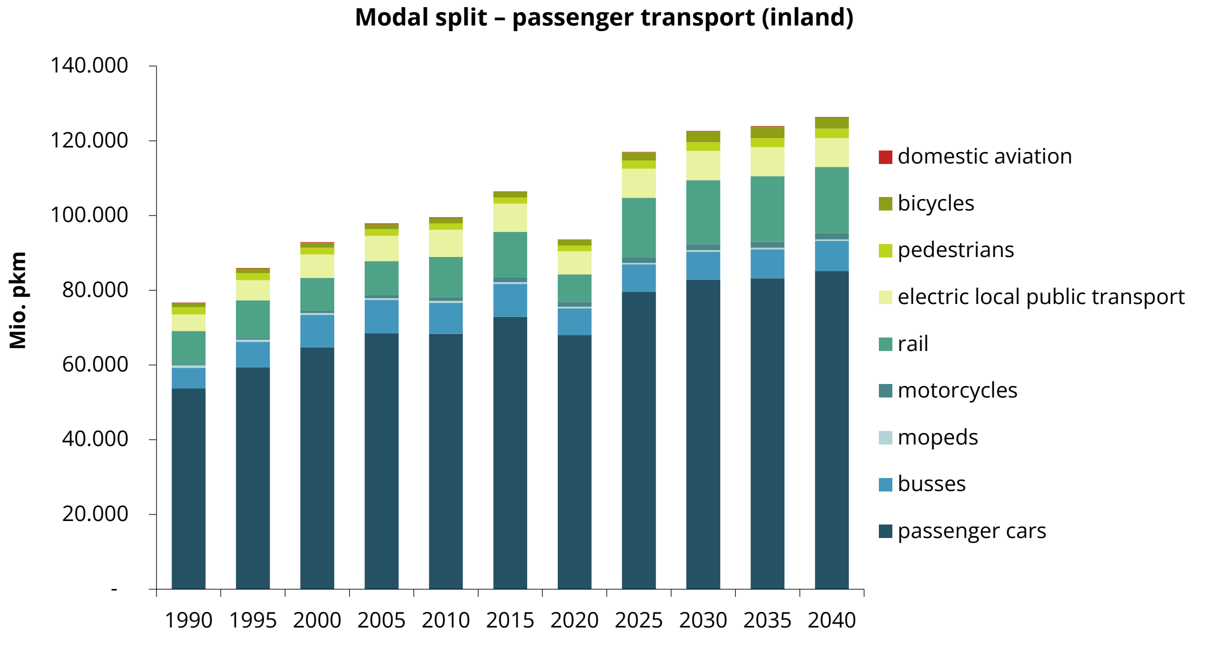


Development of passenger kilometres (pkm)

Pkm have seen a steady increase since 1990. In the WEM scenario it is assumed that pkm travelled will increase further based on assumptions for the development of parameters such as motorisation rate and population. Compared to 2021 total pkm will increase on average by 0.9% per year until 2050. The share of passenger rail transport (excl. electric local public transport) is expected to increase slightly. However, the share of rail transport will stay at around 14% (on average between 2022 and 2050). Road transport will continue to hold the major share (86% on average between 2022 and 2050).

The following graphs shows the modal split assumptions in inland passenger transport (excl. fuel export, international aviation and international navigation). The measures included in the WEM scenario will not result in a substantial change in the modal split of passenger transport.

Figure 18: Past trend and scenario (2022–2050) for pkm (excl. fuel export) – scenario with existing measures.



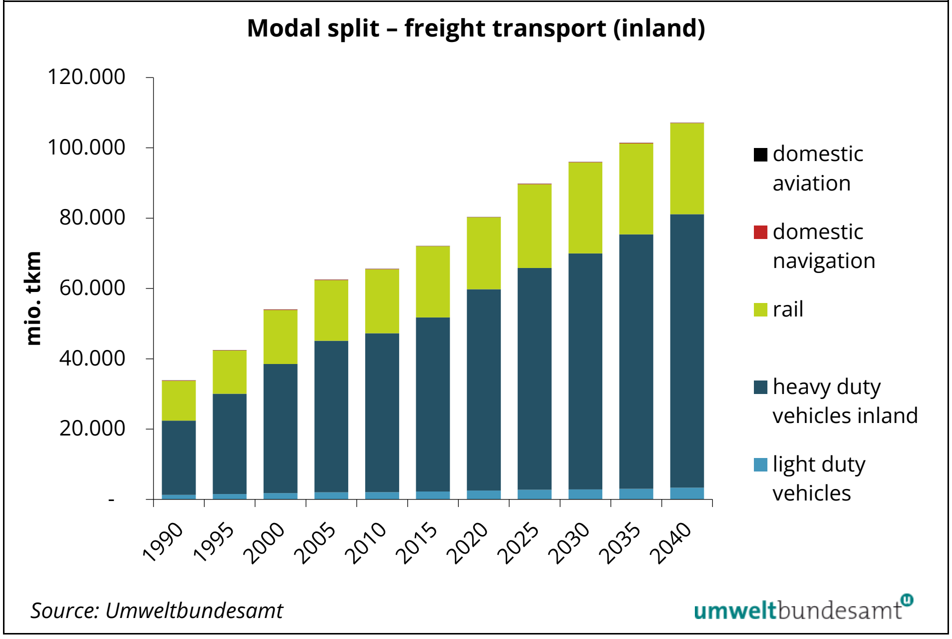
Source: Umweltbundesamt

Development of ton kilometres (tkm)

Transport volumes (given in tkm) have increased since 1990 and are expected to increase in the WEM scenario based on assumptions for the development of parameters such as GDP growth. Compared to 2021 total tkm will increase on average by 1% per year until 2050. The share of freight rail transport is expected to increase slightly. However, the share of rail transport will stay at around 25% (on average between 2022 and 2050). Road freight transport will continue to hold the major share (75% on average between 2022 and 2050). Freight volumes of domestic navigation and aviation are expected to remain constant on a very low level.

The following graphs show the modal split and its development in inland freight transport (excl. fuel export, international aviation and international navigation). The measures included in the scenario will not result in a change in the modal split of freight transport as shown in the figure below. Investments in rail infrastructure help stabilising the share of rail transport and stay competitive.

Figure 19: Past trend and scenario (2022–2050) for tkm (excl. fuel export) – scenario with existing measures.



Development of fuel export

Since the end of the 1990s, the gap between fuel sales in Austria and domestic fuel consumption has become larger. One of the reasons for this discrepancy is the 'fuel export in vehicle tanks' as a result of relatively low fuel prices in Austria, in comparison to its neighbouring countries. Especially the low tax on diesel fuel made Austria interesting for so called "fuel tourism", a phenomenon which was very strong in the 90ies. Still, a large number of vehicles tend to fuel up in Austria and use it abroad. This has been confirmed by two national studies (MOLITOR et al. 2004, MOLITOR et al. 2009).

The table below shows that most neighbouring countries have still higher diesel prices than Austria, although the recent price dynamic on the energy market has changed the stable pattern of roughly 10 Cent per litre price difference. Thus, the share of fuel export in total GHG emissions of road transport amounts "only" to 23% in 2021 (34% for PC and 66% for HDV), but has been higher through decades before with around 30%.

Table 6: Differences in gross diesel prices in €/l – average values for 2021 (EC Oil Bulletin, 9/2022)

Gross diesel prices	€/l	Difference to Austria
Austria	**1.24**	
Czech Republic	1.22	0.02
Hungary	1.49	-0.25
Slovakia	1.39	-0.15
Germany	1.25	-0.01
Slovenia	1.24	0.00
Italy	1.28	-0.04

It has been assumed that the price difference between Austria and its neighbouring countries will stay constant over time, resulting in a relatively constant share of GHG emissions from fuel exports until 2040.

The 'fuel export' phenomenon is relevant when it comes to climate policies, e.g. for Austria's UNCCC commitment (Kyoto protocol), because emissions are allocated according to national fuel sales. GHG emissions from fuel export are thus assigned to Austria and included in the national total. However, fuel export will play a minor role in passenger transport with an average share of 6% in the total GHG emissions from road transport between 2022 and 2050 in the WEM scenario. Most of the fuel export is accounted for by freight transport on the road in HDV with the assumption of an average share of 27% in total GHG emissions from road transport.

Development of alternative fuels

SAF in 1.A.3.a Aviation

The WEM scenario does not contain sustainable aviation fuels (SAF of biofuels or synthetic origin), because the future SAF admixture quotas in Europe are currently still being discussed in the trialogue between the European Commission, the Council of the European Union and the European Parliament. Irrespective of the exact level of the quotas, however, given the expected increase in air traffic by 2050, there will be enormous quantities of SAF which will be accounted for in the WAM scenario. Electric or hydrogen planes are not assessed as a valid option in the WEM scenario.

Biofuels in 1.A.3.b Road transport

Projections for alternative fuel consumption in transport are primarily based on the requirement to meet the European objective, i.e. to achieve a 14% share of renewable energy in the transport sector in 2030 (Renewable Directive RED II 2018/ 2001/EC). The 2030 goal includes a sub-target for advanced biofuels (biofuels produced from a specific raw material listed in the Renewable Energy Directive – these amounts are incorporated in the calculated volumes).

Besides the biofuels blended into the standard fuels (5% bioethanol and ETBE in gasoline and 7% biodiesel in diesel), the projections also include higher blends in diesel adding HVO[2] and the usage of pure biofuels as 100% biodiesel and HVO. HVO can be used as an additional blend for diesel on top of blending regular FAME biodiesel (given the high limits on biofuel composition of the fuel standard).

According to current blending standards, the limits of E5[3] and B7[4] have been taken as a baseline to which the "advanced biofuels" come as an addition – from 0.5% in 2020 to 3.5% in 2030 (to be continued thereafter). This means that

[2] Hydrotreated Vegetable Oil

[3] blended gasoline with 5% ethanol (volumetric)

[4] blended diesel with 7% biodiesel (volumetric)

Austria is on track for the RED II goal. Since we cannot estimate exactly which of the advanced biofuel types will be available, the following has been assumed: as long as the quantities can be fulfilled by raising E5 to E10[5], ethanol will be used. For anything beyond that, it will be HVO (as a renewable "drop-in biofuel" for diesel or in pure form). Pure vegetable oil and biogas play no role in the WEM scenario.

Other fuels

The WEM projections presented here for CNG (natural gas) are conservative, since vehicle registration data indicates no immediate breakthrough. The same is valid for LPG (liquefied petroleum gas), which fades out by 2024. Hydrogen as an alternative fuel seems to be an unlikely option without the necessary incentives and an insufficient availability of vehicle models on the market.

Electricity

The share of renewable electricity in the electric transport sector is particularly high in Austria and was a powerful lever in the achievement of the mandatory goal of a 10% share of renewable energy in transport by 2020. The amount of renewable electrical energy used is calculated using a factor of 2.5 for rail transport, and a factor of 5 for road vehicles. Electricity used by other means of transport will be calculated without factors.

For all modes, the renewable share of domestic electricity generation is used, as measured two years before the reporting year.

Current projections include all electrified road transport modes. It has been assumed that the vehicle kilometres of conventional vehicles will be substituted with electric vehicles. The increased power consumption by electric vehicles has been included in the energy-producing sectors.

1.A.3.e – Other transportation – pipeline compressors

EU ETS/non-ETS

Emissions from 'Other Transportation' (1A3e), accounted for as non-ETS emissions up to 2012, have been covered by the ETS scheme from 2013 onwards, except for emissions of greenhouse gases other than CO_2.

1.A.3.c, 1.A.3.d, 1.A.2.g.7, 1.A.4.b.2, 1.A.4.c.2 – Off-road

Projections for GHG emissions from rail (diesel and coal based) show a slight yearly decreases of 0.3% and GHG emissions from inland navigation increase by 1.8% on average between 2021 and 2050. In both sub-categories emissions follow the trend of fuel consumption.

Projections for NRMM (Non-Road-Mobile-Machinery) in industry and construction are based on the development of value added according to the NACE sectors of the DYNK model (WIFO 2018). An average yearly increase in the production index

5 blended gasoline with 10% ethanol (volumetric)

of 1.9% (construction) and 3.2% (other) up to 2050 has been assumed for the operating hours of mobile off-road machinery in industry.

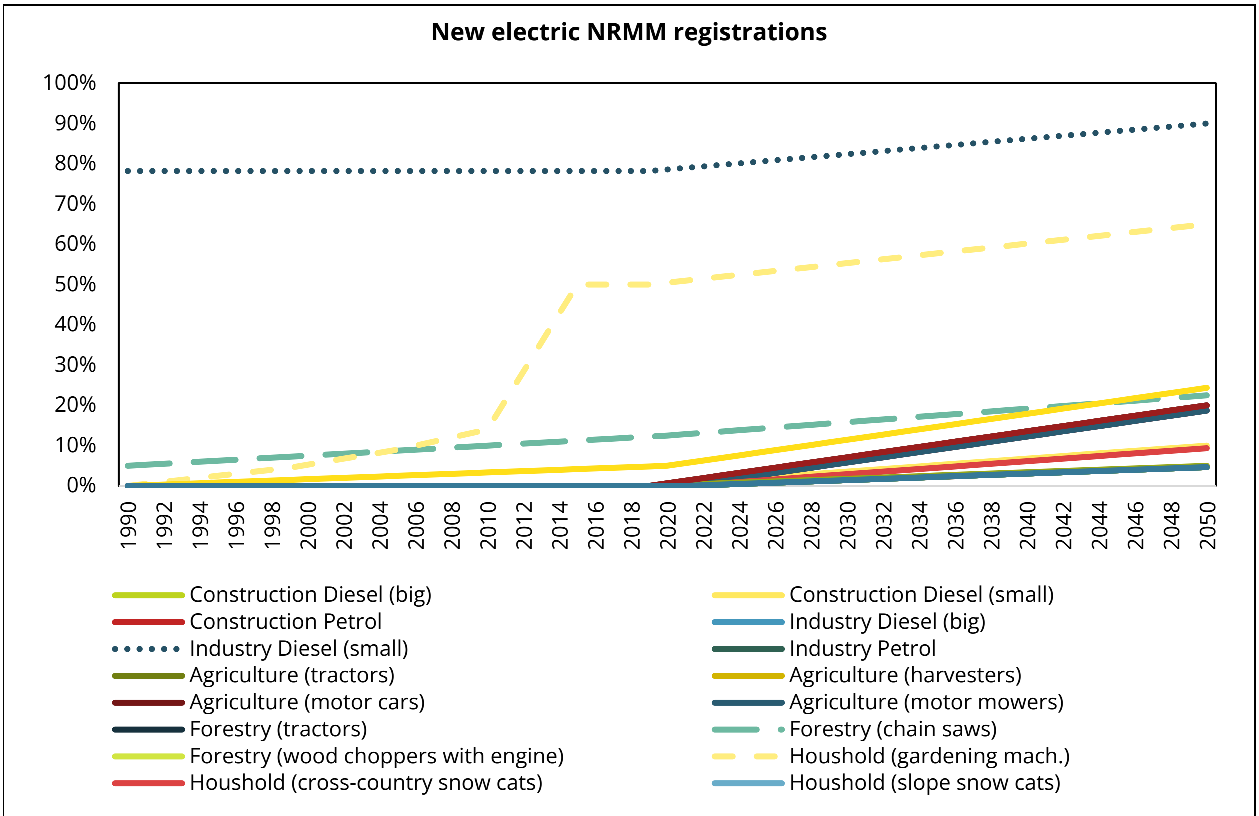
Projections for NRMM in agriculture are based on grain harvesting. The hours tractors are in use are expected to increase by around 0.2% on average per year between 2021 and 2050.

Projections for NRMM in forestry are based on woodcutting. The hours tractors and chain saws are in use in forestry are expected to increase by around 0.8% on average per year between 2021 and 2050, which reflects the historical average growth per year between 1990 and 2021.

Projections for NRMM in households are based on estimates of how many hours gardening tools are expected to be in use, showing an average yearly increase of 0.2% between 2021 and 2050. For other NRMM in households a constant trend has been assumed due to a lack of historical data.

A moderate share of electrified mobile machinery in new registrations have been assumed for all NRMM sources.

Table 7: Electric shares in total new NRMM registrations



Source: Umweltbundesamt

3.1.3.3 Activities

1.A.3.a – Aviation

In the year 2019 a record of total flight movements was recorded at all Austrian airports, before the first pandemic year 2020 brought an unprecedented decline of almost 75% and interrupted the steady increase in air traffic movements (Umweltbundesamt 2023). In the years that followed, the volume of traffic slowly recovered.

The WEM scenario depicts a slower ramp-up of flight movements compared to Eurocontrol scenarios reaching 2019 levels between 2025 and 2030 with a further increase until 2035 and a constant development until 2040. The projection of total fuel consumption is close to Eurocontrol's "base" scenario from 2030 onwards.

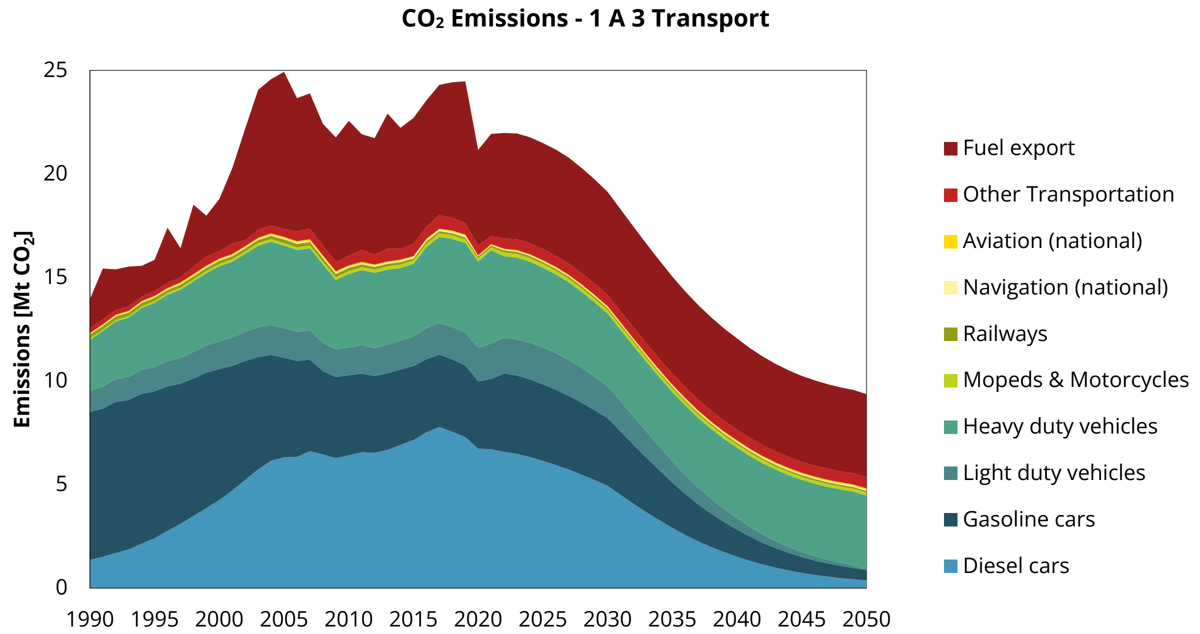
GHG emissions from domestic aviation amount to 49kt in 2050 in the WEM scenario.

1.A.3.b – Road Transport

After a steady rise of GHG emissions in the transport sector, a decrease could be observed between 2005 and 2012 due to lower amounts of fuel sold together with an increased use of biofuels for blending and the gradual replacement with newer vehicles with lower specific fuel consumption. Since then GHG emissions from transport have continued to increase with rising traffic volumes. The pandemic year 2020 stopped this trend and activities are not expected to reach the pre-pandemic level again.

For the WEM projections up to 2050 GHG emissions decline in line with the uptake of electric mobility with a decrease of 57% compared to 2021.

Figure 20: CO_2 emissions from transport – scenario with existing measures.

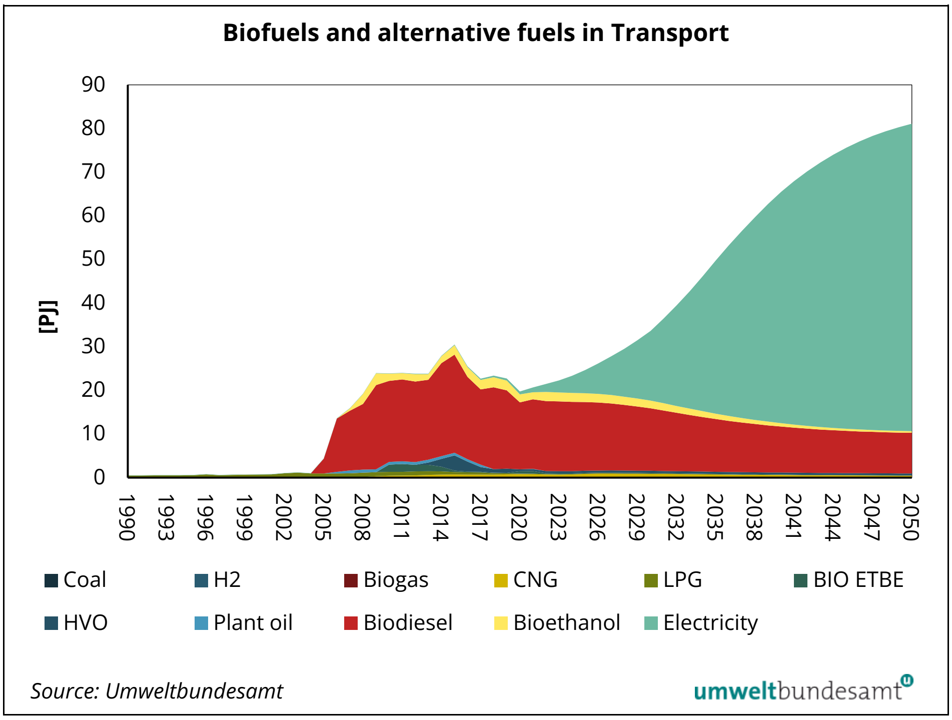


Source: Umweltbundesamt

Since 2005 biogenic fuels (biodiesel, bioethanol, and vegetable/plant oil) have been used in the Austrian road transport sector. Biodiesel and bioethanol are mainly used for blending fossil fuels, whereas vegetable/plant oil is distributed in its pure form. As blended biofuels have the main share on the biofuel market, every reduction in energy consumption of fossil fuels caused by other transport policy measures results in a similar reduction of the biofuel amounts.

The following graph shows the developments and trends in biofuels and alternative fuels like LPG, CNG and hydrogen up to 2050 in the scenario WEM. 2021 is the base year 2021 showing current data.

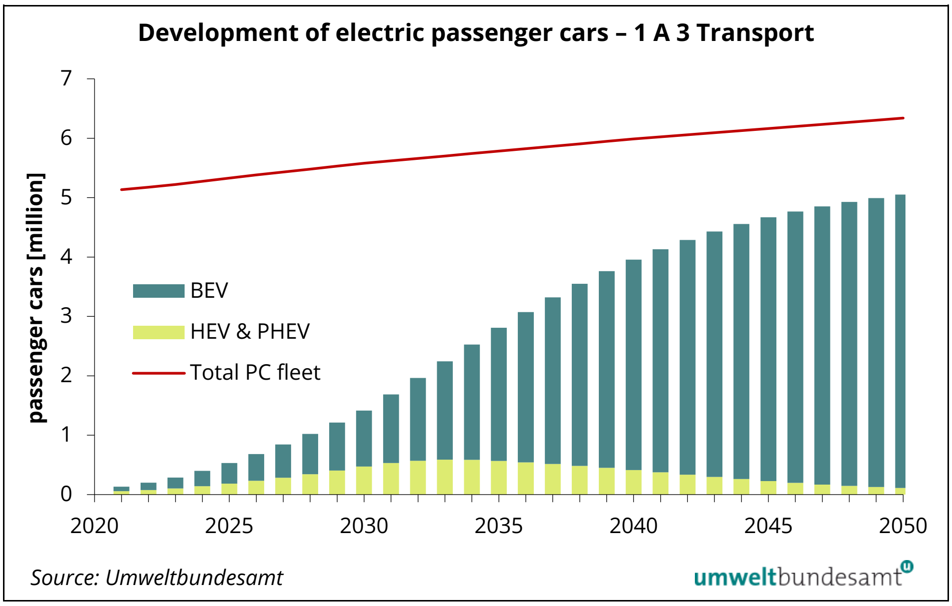
Figure 29: Biofuels and alternative fuels in Austria – scenario with existing measures.



The following graph shows the estimated passenger car fleet development for BEVs, HEVs and PHEVs in Austria up to 2050 in the WEM scenario (the base year 2021 shows current data).

The electric vehicle stock is estimated to be roughly 1.4 million passenger cars in 2030, around 4 million passenger cars in 2040 and over 5 million passenger cars in 2050, which means that 80% of the total car fleet will be electrically powered with the majority being BEVs (HEVs and PHEVs play a minor role).

Figure 21: Electric mobility in Austria – scenario with existing measures.



1 A 3 e – Other transportation – pipeline compressors

Energy demand has shown some fluctuations in recent years with a peak in 2017. In the future, energy demand is expected to decrease slightly until 2023 and then remain rather constant.

3.1.4 Other Sectors (CRF Source Category 1.A.4)

The category *1.A.4 Other Sectors* inter alia enfolds all greenhouse gas emissions from stationary fuel combustion in the small combustion sector. This summarizes categories *1.A.4.a.1 Commercial/Institutional: Stationary combustion*, *1.A.4.b.1 Residential: Stationary combustion* and *1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary combustion*). In addition, greenhouse gas emissions from mobile sources in households and gardening including snow cats and skidoos (category *1.A.4.b.2 Residential: Mobile combustion*) as well as from agriculture and forestry (category *1.A.4.c.2 Agriculture/Forestry/Fishing: Mobile combustion*) are accounted within category *1.A.4 Other Sectors*.

This section describes stationary fuel combustion emissions from category *1.A.4 Other Sectors* only. For further information on methodology, assumptions and activity of mobile sources from category *1.A.4 Other Sectors*, see chapter 3.1.3 above.

3.1.4.1 Methodology used for sectoral emission scenarios

Energy consumption from stationary combustion of categories *1.A.4.a.1 Commercial/Institutional* and *1.A.4.b.1 Residential* was calculated with a comprehensive building model (INVERT/ EE-Lab) by (e-think, 2023). All stationary combustion activities from category *1.A.4.c.1 Agriculture/Forestry/Fishing* (e.g. greenhouses, drying facilities) were derived with the econometric input-output model MIO-ES (CESAR, 2020).

Emission factors have been taken from the national emission inventory. The methodology and references are discussed in Austria's National Inventory Report (Umweltbundesamt, 2023). Furthermore, adjustments have been made for CH_4 emission factors for fuel consumption of solid fuels and wood waste to consider recent Ecodesign product policy measures for new appliances.

A short introduction to the building model can be found below.

Energy demand model for heating systems in buildings

The modelling of the energy demand of space heating and hot water preparation as well as cooling in buildings of private households and services was carried out by e-think energy research. Detailed documentation is available in (e-think, 2023).

The underlying model is referred to as INVERT/EE-Lab. It is a comprehensive dynamic bottom-up simulation tool and represents a further development of the INVERT model (see www.invert.at).

The model essentially consists of a disaggregated representation of the stock of buildings in Austria. This building stock is first mapped into building classes (age/size/renovation status), which in turn are divided into several building segments (combination with heating and hot water systems and model regions: city/country). The building segments are subjected to an annual decision-making process in the model algorithm in order to use technologies or measures (new heating/hot water systems, insulation components, window replacement). The measure that appears to be the most attractive under consideration of economic aspects is selected, whereby non-economic decision parameters are taken into account via a stochastic distribution approach.

The model evaluates the effects of different promotion schemes (investment subsidies, feed-in tariffs, tax exemptions, fuel input subsidy, CO_2 taxes, soft loans, and additional set-aside premium) on the energy carrier mix, as well as the costs of certain strategies to society when they are promoted. Furthermore, the INVERT/EE-Lab model is designed to simulate different scenarios (price scenarios, insulation scenarios, different consumer behaviour patterns etc.) and their respective impact on future trends of renewable, as well as conventional, energy sources on a national and regional level.

The core of the tool is a myopic, stochastic optimisation algorithm, which optimises the objectives of 'agents' that represent decision-makers in building related decisions. INVERT/EE-Lab models the stock of buildings in a highly disaggregated manner. Therefore, the simulation tool reflects the characteristics of an agent-based simulation.

The scenario model starts with the year 2019, based on a complete survey of all Austrian buildings for the years 2001 and 2011 (Statistik Austria 2004, 2013), supplemented with latest available building stock data of the Building and Housing Register (Statistik Austria, 2022b).

Based on the average energy demand (primary fuels) in this sector, a model calibration of non-monetary parameters has been performed using current national energy balance data of (Statistik Austria, 2022a).

The basic decision algorithm

The basic decision-making/selection process is performed on an annual basis. For each building segment it is decided if the system (building shell and heating/domestic hot water system) remains as it is or if a new heating technology or a measure to improve the building shell is required.

The overall costs (monetary costs, societal costs or greenhouse gas emissions) of each new technology/measure are compared with the respective running costs for the existing structure, and the most cost-effective technology/measure is chosen.

The objective implemented in the model is to minimise monetary costs.

Modelling energy demand

Energy demand is modelled by taking into account the demand for energy services, as well as energy efficiency. The two energy services considered are space heating and hot water supply. Behavioural aspects with respect to space heating (such as the level of indoor temperature, ventilation habits) are considered by using a service factor. This parameter describes the relationship between the actual and the theoretical (calculated) energy consumption for space heating.

The model calculates the service factor as a function of the thermal quality (specific heat load) of the building and the degree of automation of the heating system (central heating system vs. single stove heating system).

The final energy demand for hot water supply is modelled on the basis of the number of people living in a dwelling, the service demand for domestic hot water (volume of hot water at 50 °C) per person and day and on the annual efficiency of the water heating system. The model incorporates the ageing of heating systems and domestic hot water systems, which means that in the model, annual efficiency decreases from one year to another.

Overview of technology options

The technology options available are divided into 'single options' and 'combined options'. Single options include: change of heating system or domestic hot water system only, installation of new windows, insulation of outside walls only/ceiling only/floor only. Combined options include: change of heating system and domestic hot water system, insulation of outside walls and new windows, thermal improvement of the whole building shell, insulation of outside walls and ceiling, complete renovation.

Within each technology segment, a broad range of new systems can be selected for implementation, namely 20 different space heating options (with the possibility of hot water integration), 9 space heating options (without hot water integration) and 5 different stand-alone hot water systems. Solar hot water generation and solar combined systems (solar space heating and hot water system) are integrated into the model. For building shell alterations, up to 10 different insulation materials for different parts of buildings and 6 different window types are implemented in the model. The thickness of the insulation material is calculated by using an optimisation algorithm (with upper and lower boundaries).

Input data

- Price scenarios by energy carrier,
- funding programmes and amount of funding,
- building stock (part of the model),

- investment and operating costs of heating systems and renovation measures (part of the model),
- new construction rates.

Output data

- Final energy demand by energy carrier,
- renovation rates result endogenously up to any defined maximum limits for various measures and building types,
- investment sums for heating system changes or renovation measures (with or without improving energy efficiency of the building),
- Expenditure on energy carriers,
- Funding costs.

3.1.4.2 Assumptions

Building stock

Despite decreasing population growth rates in Austria, the number of permanently occupied dwellings (principal residences) is expected to increase by about 13% from 2020 to 2050 (see Table 39, Annex 2). This is due to the fact that the trend towards single households is stronger than overall population growth.

As regards the number of residential buildings, an overall increase of 26% is expected from 2020 to 2050, whereas the number of commercial (non-residential) buildings is expected to rise by about 27% during this period (see Table 39, Annex 2).

The total gross floor area of residential buildings is assumed to increase by 30% until 2050, whereas for commercial buildings the total gross floor area is expected to increase by about 27% from 2020 to 2050 (see Table 39, Annex 2).

Price assumptions

Price assumptions are especially important in this sector because they may influence decisions about the fuel that will be used for heating systems in the long term, as well as decisions regarding the quality and quantity of thermal renovation activities. Over a period of about twenty years this can have a noticeable effect on specific energy demands.

Energy prices for households and commercial are expected to rise considerably for almost all fuels from 2020 to 2050 (all values based on model results at real prices, € 2020) (see Table 37, Annex 2):

- For coal, a decrease of around 22% is expected by 2050. However, solid fuels have a negligible share of total fuel consumption for heating.
- For heating oil and other gas oil, an increase of around 32% is expected by 2050, while natural gas prices are expected to rise by 87%.

- For wood logs, wood briquettes and wood chips an increase of around 87% is expected by 2050, while wood pellets are foreseen to rise about 62% within the same timeframe.
- The electricity price (predominantly for heat pumps) is assumed to rise by about 83% until 2050.
- District heat is expected to increase by about 74% by 2050.

Detailed assumptions can be found in Annex 2.

Scenario "with existing measures"

In Austria, the policy on subsidising heating systems is aimed at the installation of efficient and low emission (CO_2) boilers (replacing fossil heating systems, old solid fuel appliances or direct electric heating). Therefore, federal and regional authorities grant financial support for biomass, heat pumps, district heat and solar heat. The subsidies vary between the different local authorities. On average, subsidies are granted for district heating (15% to 23% of the eligible environmentally relevant installation costs), log wood and wood chips (20%), heat pumps (5% to 15%) and wood pellets (23%) as well as solar heat (20% to 25%). In general, it is assumed that these percentages will remain constant over the forecast period in the WEM scenario (see Table 38, Annex 2). Additional federal subsidies for replacing of fossil heating systems temporarily rise subsidies to the upper limit. This bonus is expected to decline to zero until 2040.

The building renovation rate[6] indicates the proportion of gross floor space in a given year where improvement measures on the thermal building envelope (house front, windows, top and bottom floor ceiling) are performed. It is therefore an indicator of the renewal of buildings, which usually reduces their heating demand (see Table 41, Annex 2).

- The renovation rate for residential buildings is expected to rise starting from about 1.0% in the year 2020 up to slightly above 1.4% until 2035 and above 1.5% until 2040, however, it declines to 1.3% thereafter until 2050.
- For commercial buildings, the renovation rate starting from about 0.6% in the year 2020 peaks at slightly above 0.8% around 2025. Later it drops off and remains at 0.7% until 2040. However, it further declines to 0.5% thereafter until 2050.

Model-based results predict a rise in the boiler exchange rate[7] in residential buildings from 2.0% in 2020 to 2.7% in 2035, a slight decrease to 2.6% until 2040 and a decline to 2.2% until 2050. The boiler exchange rate in commercial

[6] Thermal renovation rate expressed as proportion of new renovated gross floor space to total gross floor space stock in the year in which the measures are performed.

[7] Boiler exchange rate expressed as proportion of gross floor space with boiler exchange to total gross floor space stock in the year in which the measures are performed.

buildings also rises from 1.4% in 2020 up to 2.3% in 2035 followed by a slight decrease to 2.2% until 2040. Thereafter it declines to 2.0% until 2050.

Moreover, the average final energy demand for heating in residential buildings is expected to decrease from 142 kWh/m² gross floor space in 2020 to 97 kWh/ m² gross floor space in 2050, while the average heating demand for commercial buildings is expected to decrease from 139 kWh/m² to 92 kWh/m².

In Chapter 4 more information on measures included in the WEM scenario can be found.

3.1.4.3 Activities

Activities described in this chapter enfold of stationary fuel combustion from category *1.A.4 Other Sectors* and its use of electricity (w/o mobile sources), solar heat, ambient heat and district heat.

Emissions were calculated on the basis of the consumption of coal (including industrial waste), oil (heating oil and other gas oil, liquefied petroleum gas), natural gas and biomass (wood log and wood briquettes, wood chips, wood pellets, charcoal), and separately for the sectors *1.A.4.a.1 Commercial/ Institutional* and *1.A.4.b.1 Residential*, which were modelled with INVERT/EE-Lab. For the sector *1.A.4.c.1 Agriculture/Forestry/Fishing* emissions were calculated on the basis of the consumption of coal, gas oil, liquefied petroleum gas, natural gas, wood log and wood briquettes and other biomass, which were modelled with an econometric input-output model (MIO-ES).

Scenario "with existing measures"

There is a discernible trend towards renewable and alternative energies, which is reflected in an increase of 107% for ambient and solar heat from 2021 to 2050. This goes along with a shift of electricity use from direct electric heating towards energy-efficient heat pumps, which are predominantly installed in new buildings. Electricity use for space heating and hot water preparation declines by 12% within the same timeframe, while other electricity use rises by about 41% until 2050 (overall increase of electricity use of 24%).

Biomass fuel consumption overall declines by 23% from 2021 to 2050. The share of fuel wood heating systems uses is expected to decline due to operating stress and because log wood is more difficult to handle in comparison to other biomass fuels. In particular, the gross floor space equipped with wood pellets heating increases by 210% within the same timeframe.

On the other hand, there are driving forces for moving away from fossil fuels. In the overall sector, a 54% reduction in the use of oil is expected for the period until 2050, as well as a 38% decline in natural gas consumption and a 97% decrease in coal use.

Total energy consumption (w/o electricity for mobile sources) is expected to fall by 7.8% in the overall sector *1.A.4 Other Sectors* (w/o mobile sources) until 2050 compared to 2021.

Figure 22: Past trend of inventory fuel energy and energy balances activity (1990–2021) and of scenarios (2025–2050): Final energy demand from category 1.A.4 Other Sectors: Stationary – scenario "with existing measures".

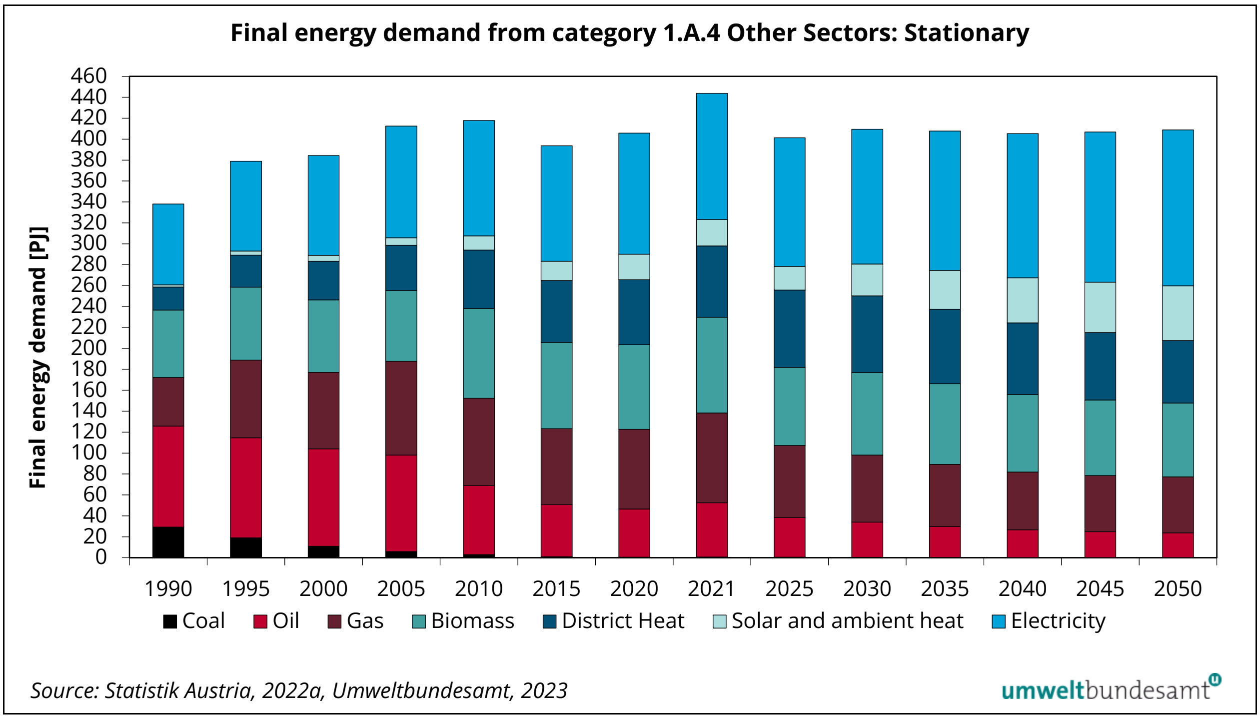
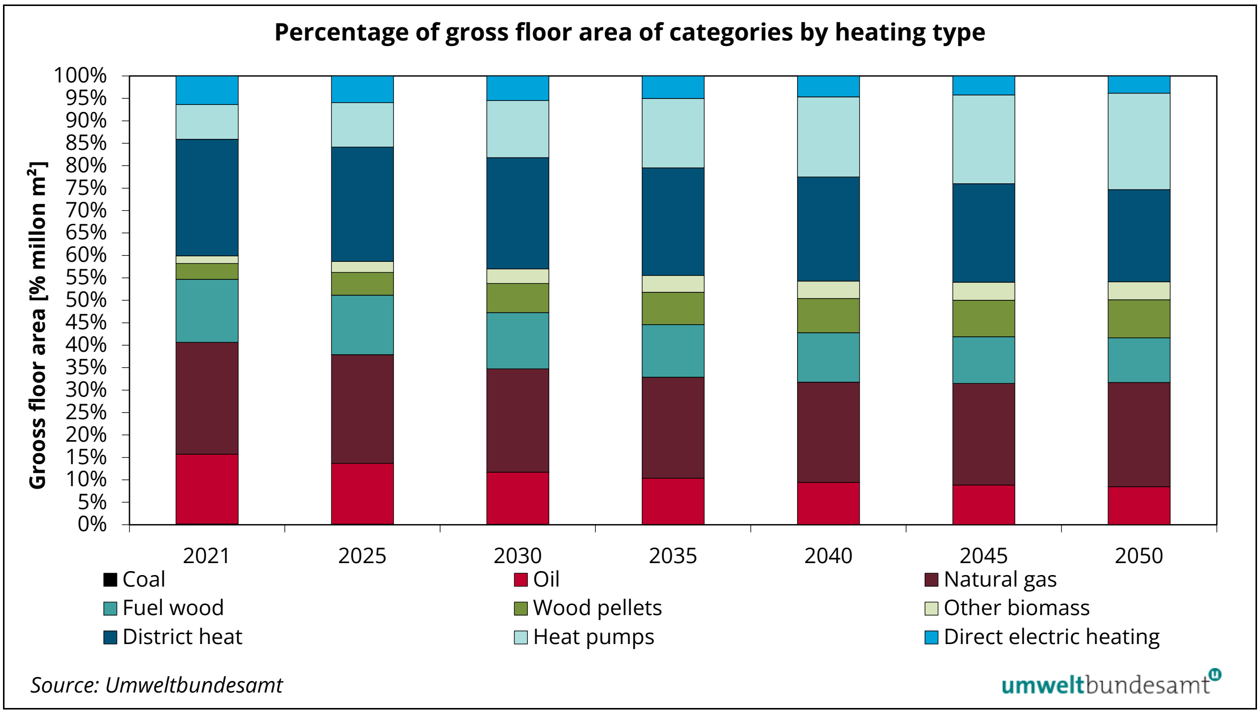


Figure 23: Percentage of gross floor area of categories 1.A.4.a.1 and 1.A.4.b.1 by heating type 2021–2050 – scenario "with existing measures".



3.1.5 Other (1.A.5)

This category contains emissions from mobile military sources. These emissions have been included in the calculations for the transport sector (3.1.3); methodological issues and emissions can be found in this chapter. In this source category all emissions from mobile military sources are summarised, including emissions from military jet fuel.

3.1.6 Fugitive Emissions from Fuels (1.B)

This sector covers fugitive CH_4 emissions from brown coal open cast mining (1.B.1), fugitive CO_2 and CH_4 emissions from combined oil and natural gas production, fugitive CH_4 emissions from oil refineries, fugitive emissions from natural gas distribution, transmission and storage (1.B.2). No specific measures are planned in the Austrian Climate Strategy to reduce emissions from this sector.

3.1.6.1 Methodology used for sectoral emission scenarios

The methodology applied for calculating projected emissions is the same as the one used in the Austrian GHG inventory (UMWELTBUNDESAMT, 2023).

CH_4 emissions from storage are calculated by multiplying the amount of stored natural gas by a national emission factor. CH_4 emissions from natural gas distribution networks are calculated by multiplying the distribution network length by an implied emission factor.

CH_4 emissions from natural gas pipelines are calculated by multiplying the pipeline length by a national emission factor.

CO_2 and CH_4 emissions from oil and natural gas production are reported by the *Association of the Austrian Petroleum* Industry for 2003 to 2021. Projected emissions are calculated by multiplying oil or natural gas production by implied emission factors which are derived from previous years.

3.1.6.2 Assumptions

No specific policies and measures are considered in the emission scenarios.

In 2006, the last brown coal open surface mine closed in Austria and it has been assumed that there will be no coal mining in the period up to 2050.

The length of the distribution network has been extrapolated until the year 2024 by means of the average yearly growth rates for 2017–2021 (75 km/year). It is assumed that the number of end consumers is not growing after 2024. CH_4 emissions are calculated by means of the averaged implied emission factors for 2017-2021.

The total main and medium range pipeline length is assumed to have the same proportion of the natural gas distribution network length as the average percentage during the period 2017–2021 (main and medium range pipeline length = 24% of the length of the distribution network). This implies that the length of the main and medium range pipeline will stop growing after the year 2024. CO_2 and CH_4 emissions are calculated by means of 2021 implied emission factors.

Natural gas storage capacity is considered to have reached a maximum in the year 2021. CH_4 emissions are calculated by the mean storage volumes and implied emission factors 2019-2021 and predicted to remain constant until the year 2050.

The CH_4 emissions from the refinery are calculated by means of the emission factor from the GHG inventory and on the basis of the projected refinery intake, which is assumed to remain at a similar level (-9% below 2021) until 2050.

CH_4 emissions from natural gas processing are calculated using the average implied emission factors for the period 2017 to 2021 and domestic natural gas production as assumed in the energy scenarios. It is assumed that natural gas production will be 50% lower than in 2021. CO_2 emissions from raw gas processing are expected to increase by 50% per Nm^3 of processed gas until the year 2040 and will stay constant afterwards.

3.1.6.3 Activities

For natural gas consumption, refinery intake and natural gas production, data from the energy projections included in this report are used.

Past trends and scenarios: pipeline and distribution lengths and natural gas storage are presented in Table 10.

Table 8: Past trend and scenarios (2020–2050) activity data: natural gas distribution, transmission and storage (Umweltbundesamt).

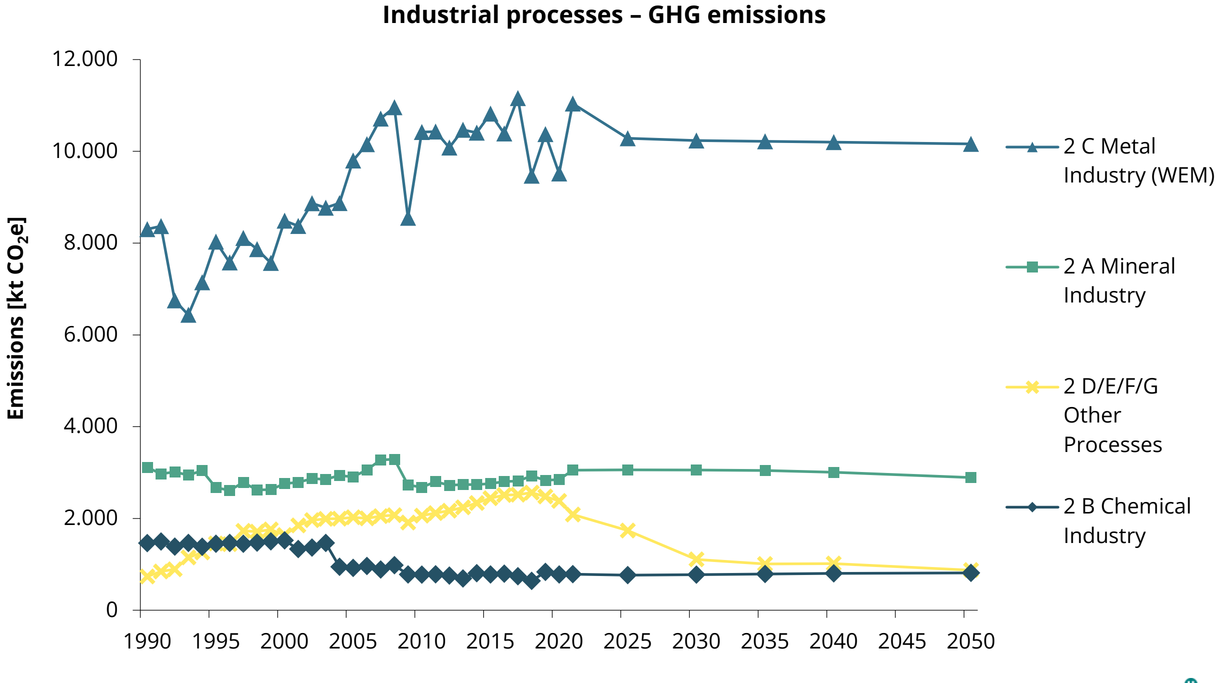
	Pipeline length [km]	Gas network length [km]	Natural gas stored [Mm^3]
1990	3 628	11 672	1 500
2000	5 966	24 099	1 665
2010	6 798	28 733	3 070
2015	7 242	30 067	5 317
2020	7 230	30 569	5 100
2025	7 301	30 817	5 479
2030	7 301	30 817	5 479
2035	7 301	30 817	5 479
2040	7 301	30 817	5 479
2050	7 301	30 817	5 479

3.2 Industrial Processes & Product Use (CRF Category 2)

The main emissions in this sector come from the metal industry (in particular iron and steel production), the chemical industry (in particular ammonia and nitric acid), the cement industry, the lime industry, lime stone use in iron and steel production and from the use of halocarbons and SF_6. Detailed assumptions have been made for these sources.

The following chart shows greenhouse gas emissions aggregated into four categories of industrial processes. Most sectors (Mineral Industry, Chemical Industry, Metal Industry) are expected to have relatively constant GHG emissions until 2050 (Figure 32).

Figure 24: GHG emissions and projections (2022–2050) from Industrial Processes and Product Use.



Source: Umweltbundesamt

3.2.1 Mineral, Chemical and Metal Industry (2.A, 2.B, 2.C)

3.2.1.1 Methodology for sectoral emission scenarios

The methodology used here is the same as the one used in the Austrian Inventory, and the emission factors including the methodology are discussed in detail in the Austrian Inventory Report (UMWELTBUNDESAMT 2023).

3.2.1.2 Assumptions

Mineral industry

Activities in the cement and lime industry and for other subsectors (i.e. lime stone use, ceramic industry and soda ash use) have been derived from the energy input of the respective subsectors, which in turn have been derived based on most recent shares of the use of each individual fuel in relation to the use at sector level. Consistent with the IPCC 2006 Guidelines for inventory compilation, the demand for lime stone in the iron and steel industry has been accounted for under 'iron and steel industry'.

Chemical industry

Ammonia production has been linked to fertiliser demand and the chemical industry (urea/melamine), whereas the production of nitric acid has been coupled to fertiliser production (see Figure 24).

Metal industry

This source category covers CO_2 emissions from iron and steel production (2.C.1) and from ferro-alloy production (2.C.2) as well as PFC emissions in aluminium production (2.C.3) and SF_6 used in aluminium and magnesium foundries (2.C.4).

SF_6 is used as an inert gas in cases of fire in light metal foundries.

Further assumptions:

a. Primary aluminium production plants in Austria closed down in 1992 and will not be reopened (only secondary Al production without SF_6).
b. The Austrian Ordinance on fluorinated gases (Federal Law Gazette II No. 447/2002) bans the use of SF_6 as a protective gas in magnesium production. The assumption for the emission projections, it thus that SF_6 is not used.
c. The production of pig iron and crude steel from oxygen steelmaking furnaces was assumed to be largely decoupled from economic growth, resulting in only marginal growth in this area. Structurally, there is no change in the WEM scenario, so the ratio between primary steel production (blast furnace route) and secondary steel production (electric arc furnace) remains unchanged. considered .

EU ETS/non-ETS

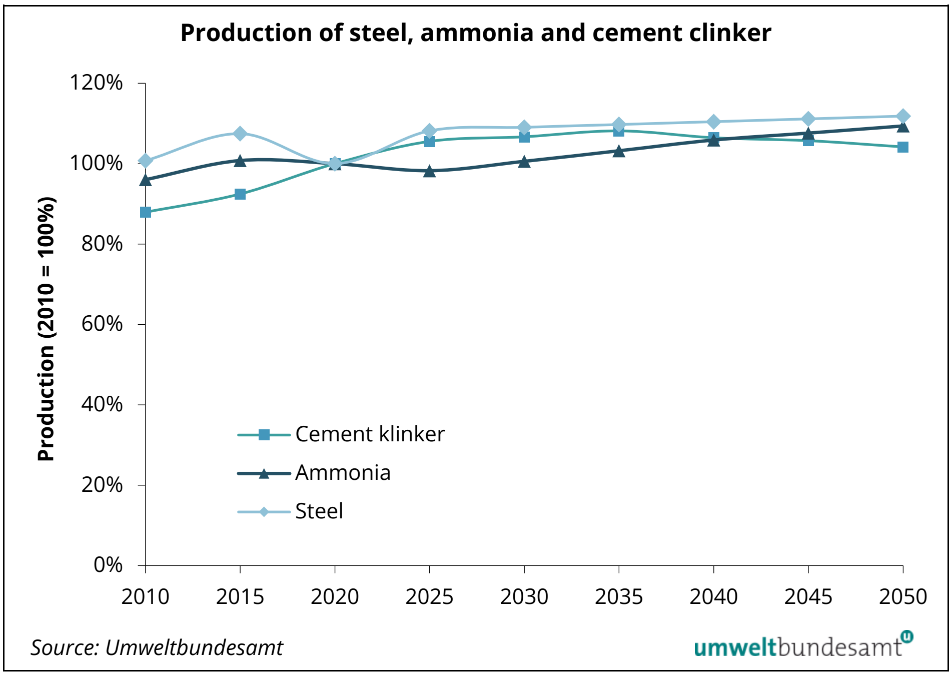
Emissions for EU ETS/non-ETS have been split on the basis of sectoral fuel input/input materials. Here the ETS share of each fuel (averaged over the most recent years) has been used for determining the fuel input//input material for EU ETS/non-ETS until 2040.

3.2.1.3 Activities

Figure 33 presents the assumptions used for the production of cement clinker, ammonia and crude steel.

Whereas production of steel shows a return to pre-pandemic production levels after 2020 and a slight growth in the following decades, the production of ammonia decreases slightly until 2025 and then increases again slightly, mainly due to a stabilising fertiliser demand and a moderate increase in other products for which ammonia is used. Cement clinker production increases slightly until 2025 and declines after 2035.

Figure 25: Assumptions for the production of steel, ammonia and cement clinker.



3.2.2 Fluorinated Gases (2.E, 2.F, 2.G)

Fluorinated gases have been in use in Austria in a wide range of applications: most importantly the use of HFCs as refrigerants in refrigeration and air conditioning systems (2.F.1); other important sources include the use of HFCs as blowing agents in the production of foams (2.F.2), HFC, PFC and SF_6 as etching or insulation gases or in semi-conductor manufacturing (2.E.1) and the use of SF_6 (2.F.9) in soundproof windows. Minor sources include the use of HFCs as fire extinguishing agents (2.F.3), HFCs as propellants in aerosols (2.F.4), HFCs as solvent (2.F.5) and SF_6 as an insulating gas in electrical equipment, research, shoes and tyres (2.G.2).

There is no production of fluorochemicals (2.B.9) in Austria and the scenario is based on the assumption that there will be no production up to 2040.

Although fluorinated gases are not used in large amounts (around 1 kt per year), they contribute approximately 2.4% of the total GHG emissions in 2021 due to their high GWPs. In Austria's Third National Communication to the UNFCCC (2001) fluorinated gases were expected to reach 3% of the total GHG emissions by 2010 and as much as 5% by 2020 in the business-as-usual scenario, mainly because of the strong increase of HFC use as substitutes for ozone layer depleting 'Montreal gases' without reduction measures. Because of this expected scenario, the Federal Environment Ministry started a consultation procedure in spring 2001 with the aim to draft an ordinance on reducing and phasing out HFCs, PFCs and SF_6 in all relevant applications on the basis of the Federal Chemicals Act. The Austrian Ordinance on fluorinated gases was adopted in 2002 (Federal Law Gazette II No. 447/2002) and amended in 2007 (Federal Law Gazette II No. 139/2007). On European level, the European Parliament and the Council of the European Union adopted the Regulation on certain fluorinated greenhouse gases (842/2006/EC) and the Directive relating to emissions from air-conditioning systems in motor vehicles (2006/40/EC). In 2014, the European Regulation was revised and changed into Regulation 517/2014, repealing the 2006 Regulation. In addition to the measures set forth in the 2006 Regulation, the 2014 Regulation aims at a phase down and selective placing on the market prohibitions for F gases within the EU. Certain F gases (those with a GWP above 2 500) were be banned as a first step, and only a certain amount of F gases is allowed to be placed on the European market each year, reducing the amount of F gases on the market from 2030 onwards to 21% of the average total from 2009–2012. This calculation is based on the total in CO_2 eq, in favour of the low GWP refrigerants. Certain uses of F gases, for instance in semiconductor manufacturing, or use as medical aerosols and (in the case of SF_6) in electronic equipment, are exempted from this ban.

In 2016, the Kigali Amendment to the Montreal Protocol was introduced, which foresees a global phase down of HFCs going further than the EU phase down and beyond 2030. This will be considered in the ongoing revision of the EU FC 2014 regulation.

3.2.2.1 Methodology used for the sectoral emission scenarios

Projected emissions are based on the results of the Austrian GHG inventory. For a comprehensive description of the emission estimation methodology please refer to the Austrian National Inventory Report 2023 (UMWELTBUNDESAMT, 2023).

Projections until 2050 are based on the assumptions from Annex V to the F gas Regulation, the Kigali Amendment and the MAC Directive. Generally, the status quo is considered to be “worst case”, measures voluntarily taken by industry for example are not considered to end, even if they are not legally binding (this is relevant for minor sub categories only). Also, no other measures, or e.g. additional voluntary efforts by industry, were considered.

Projections are calculated on the same level of detail, by making assumptions regarding the development of activity data (e.g. refrigerants filled into new installations) or emissions for every sub category.

Emission factors (which typically refer to leakage rates) are set to the values used for the latest inventory year 2021, as measures considered are fully implemented by now - except for commercial refrigeration, where a decrease of the (relatively high) EF is assumed.

Regarding disposal emissions, an increase of recovery, reuse and recycling is expected for the near future. However, as no robust data on disposal emissions is available, a default emission factor has been applied for historical years which is also used for the projections.

Methodological issues for the main subcategories are provided in more detail below.

3.2.2.2 Assumptions

The following legal framework has been considered for estimating future emissions of F-Gases in Austria:

a. The European Regulation on certain fluorinated greenhouse gases (Regulation EC 517/2014) is fully implemented. The regulation also contains a phase down of HFC use in the EU, however the stepwise reductions on amounts placed on the market are defined on EU level only, whereas on national level this development might differ. During the past few years, in Austria it showed that the amounts placed on the national market did not follow the phase-down trend of the EU regulation. The phase down in the EU generally also forces a phase down in Austria, however, this national phase down legs somewhat behind the speed at EU level.
b. The Directive relating to emissions from air-conditioning systems in motor vehicles (EU 2006/40/EC) is fully implemented.
c. The additional phase down after 2030 as foreseen in the Kigali Amendment (ratified by Austria) is also fully considered.

Stationary Refrigeration and Air Conditioning:

Supermarkets: information for the plans of HFC phase out were obtained from the majority of supermarket chains, for the rest of the market expert judgement was used. Emission factors were set constant at 2021 levels, as emissions almost exclusively will occur from installations already in place (new installations, which might show lower leakage rates, are rather using natural refrigerants).

Stationary air conditioning is a sector that showed high annual growth rates for the last decade. For the projection of stocks and FC use in stocks, studies on the development of the market as well as information from industry experts were taken into account. Generally, annual stock increase is assumed to continue until 2030, and then remaining on a more constant level (with somewhat differing development in the different sub categories). For the projections, the restrictions and bans according to the EU FC are considered, and also the phase down of HFC use as forced by the EU quota system (with a slight delay as explained above). Emission factors were held at 2021 levels, they are at a relatively low level already and are not expected to substantially decrease further.

"Industrial refrigeration" and "Commercial refrigeration (other than supermarkets)" in the Austrian model are residual categories covering all HFC amounts not considered elsewhere. The phase out of ODPs was completed some years ago, the refrigeration sector is considered as a practically saturated market, and due to the EU F-gas regulation in force, containing bans and restrictions of FC use and implementing a quota system for HFCs placement on the market, the maximum in HFC stocks has already been exceeded by now and alternatives, namely low GWP solutions and natural refrigerants, have been introduced and are feasible options for many applications already. For the projections, the restrictions and bans according to the EU FC are considered, and also the phase down of HFC use as forced by the EU quota system (with a slight delay as explained above). Emission factors for industrial refrigeration were held at 2021 levels as the values applied for the years past are at a comparable low level already. For commercial refrigeration, the EF is assumed to decrease from 15% in 2002 to 10% in 2030.

Emissions from commercial stand-alone equipment only arise from decommissioning until all equipment is disposed of (this is a minor category).

For transport refrigeration, which also is a minor category in terms of emissions, use of HFC refrigerants was assumed to halve until 2030, and then remain on the same level.

Mobile Air Conditioning: The MAC Directive (EU 2006/40/EC) requires the introduction of refrigerants with a GWP < 150 in new passenger cars placed on the market during the period 2011–2017, and in all passenger cars after 2017. For other type of vehicles (where no restrictions are in place) amounts filled into new MACs are assumed to remain on 2021 levels.

Foam Blowing: The Austrian Ordinance banned the use of fluorinated gases in this sub-category (including the use of XPS foams with a layer thickness of more than 8 cm containing HFCs with a GWP < 300, which had initially been allowed but were banned in 2008). In 2017, there was no foam production in Austria involving the use of F gases, only the use of some open cell foams. Emissions from stocks are still occurring (long lifetime of XPS/PU plates) even after 2040.

Fire Extinguishers: Constant stocks and constant emission factors based on 2021 data are assumed.

Aerosols: The F gas Regulation bans the use of fluorinated gases in this sub-category except for medical uses. It has thus been assumed that HFC emissions from metered dose inhalers will continue to increase, following the trend of the past few years, and will be constant from 2025 onwards (according to information from Ökorecherche GmbH).

Semiconductors: Projections are based on emissions of the years 2017–2021, the mean emission values of these years are applied for all years after that.

Electrical Equipment: A constant trend of emissions has been assumed for the period after 2021, as an increased demand for energy will mean an increase in equipment. Alternatives to medium voltage switchgear are currently being developed, but it is unclear when and how they will be implemented.

Other Uses of SF_6: The Austrian Ordinance bans the use of SF_6 in other applications such as footwear and car tyres as well as sound proof windows. Sound proof windows have an average life span of 25 years. Their production and installation ended in 2003. Thus, emissions are expected to occur until 2028, until the last sound proof windows filled with SF_6 has been disposed of.

3.2.3 Solvent and Other Product Use (2.D & 2.G)

In this sub sector indirect CO_2 emissions from solvent use, CO2 emissions from lubricant and paraffin was use, as well as the use of N_2O (as an anaesthetic and in aerosol cans) is considered.

3.2.3.1 Indirect CO_2 Emissions from Solvent and Other Product Use

Emission projections for 2022–2050 are calculated using the emissions of the latest inventory year and by assuming either a correlation with population growth or economic growth in some sub-sectors, or a continuation of trends in others, or a constant development in sectors where technological advances offset an increase in solvent use.

3.2.3.2 CO_2 Emissions from Lubricant and Paraffin Wax Use

For the WEM projections lubricant use was set constant at 2021 levels and paraffin wax used was projected linking emissions with population growth.

3.2.3.3 N_2O Emissions from Solvent and Other Product Use

For projections of N_2O emissions from 2 G 'Other Product Use', it has been assumed that emissions remain at 2021 levels: for cream propellants a constant value is also used for the inventory and use as anasthea has a decreasing trend in previous years, but it is unclear if this trend will continue for much longer.

3.3 Agriculture (CRF Source Category 3)

3.3.1 Sector Overview

In this sector, the focus is on sources of methane (CH_4) and nitrous oxide (N_2O) emissions. This chapter gives an overview of the European and Austrian farming policy, provides information on basic economic and technological assumptions and describes the methodologies used for the sectoral scenarios by 2050.

The EU CAP strategic plan

The Common Agricultural Policy (CAP) is a European Union policy with a long tradition, embedded in the EU's framework for action, such as the goal of a climate-neutral Europe in 2050.

By the end of 2021 Austria submitted its CAP Strategic Plan (CAP-SP) 2023-2027. The plan was approved in September 2022. It includes interventions that enable participants to receive direct payments (former 1st pillar of the CAP), and measures financed by the EAFRD (former 2nd pillar of the CAP). In addition, sector programmes (fruit and vegetables, bees, wine, hops) were implemented. Since the CAP period started with a delay of three years, we assume that the programme will continue until 2030. In the Austrian CAP-SP (BML 2022), a total of 98 interventions, based on 45 needs, are jointly programmed and implemented. According to the intervention logic, the climate-relevant interventions are assigned to objective 4 (climate) by corresponding relevant outcome indicators. Compared to the previous CAP period (2014-2020 which was extended until 2022) both climate mitigation and climate change adaptation measures have gained more weight compared to other measures. However, the volume of funds has not changed significantly.

3.3.2 Methodology used for the sectoral scenarios

The scenario with existing measures' (WEM) is based on existing measures as implemented in Austria within the framework of the CAP strategic plan. Chapter 4.9 provides information on implemented measures for the agriculture sector.

Activity data

PASMA (WIFO & BOKU 2023) provides the basic activity data for the WEM scenario.

The PASMA Model

The Positive Agricultural Sector Model Austria (PASMA), developed by the Austrian Institute of Economic Research (WIFO), maximises sectoral farm welfare and is calibrated on the basis of historical activities in arable farming, forestry, livestock breeding and agro-tourism. The method of Positive Mathematical Programming (PMP) assumes a profit-maximising equilibrium (e.g. marginal revenue equals marginal cost) in the base run and derives the coefficients of a non-linear objective function based on observed levels of production activities (WIFO & BOKU 2023).

Assumptions on prices, yields and production

PASMA price projections are based on assumptions about the development of key indicators on global agricultural commodity and food markets (OECD & FAO, 2022). Forecasts on key economic indicators are based on Kaniovski et al. (2021) and energy prices are consistent with those assumed for the energy sector.

Several sources of market data are available which can be used as a basis of price projections. All prices but energy prices were derived from OECD-FAO outlooks on agricultural markets (OECD & FAO 2022). A comparison of this

OECD-forecasts with projections of the European Commission (European Commission, 2022) shows that international bodies have very similar assumptions about the future development of key economic indicators. Due to the type of farm sector model used in this analysis, assumptions on the Austrian economic context (e.g., GDP growth, population dynamics) are not required directly. However, they are included in the exogenous price assumptions (mainly the consumer price index). Other driving forces (prices, technology, constraints) are referenced in of the following sections.

No OECD-FAO forecasts are available for the period after 2031. Therefore, the assumption was made that prices will follow the previous development from this year onwards for most activities. Price estimates of farm outputs are specific for the Austrian market situation. The observed price wedge between Austrian and EU markets was assumed to prevail in the future.

Within this project a detailed set of assumptions on technical coefficients, yields and productivity was developed in a stakeholder process, including the expertise of farm production experts from the Austrian Chamber of Agriculture, the Austrian Agency for Health and Food Security (AGES) and participants of three meetings of the project board established for this study.
Results can be summarised as follows: productivity in livestock farming, particularly in milk production, will increase in the coming years, but at a slower pace than in the past. With regard to crop yields, the consensus was that climate change is likely to lower country averages after 2030. One outcome of the discussions was that the expected yields of crops were lowered after 2030 and that the cost of stables for livestock would be significantly more expensive than in 2020. To assume higher prices is justified by the fact that compliance with environmental legislation will make investments more expensive. For more information please refer to (WIFO & BOKU 2023).

Emission calculation

Emissions are calculated based on the methodology used in the Austrian Greenhouse Gas Inventory. A comprehensive description can be found in the Austrian National Inventory Report 2023 (UMWELTBUNDESAMT 2023).A comprehensive description can be found in the Austrian National Inventory Report 2023 (UMWELTBUNDESAMT, 2023).

3.3.2.1 Enteric Fermentation (3.A)

This source category includes CH_4 emissions from the fermentation of feed within the animal's digestive system.

Scenario WEM

Feed intake parameters and methane conversion rates correspond to the national greenhouse gas inventory (UMWELTBUNDESAMT 2023). Feed intake parameters and methane conversion rates correspond to the national greenhouse gas inventory (UMWELTBUNDESAMT, 2023). Gross energy (GE) intake of dairy cows was calculated according projected milk yields.

3.3.2.2 Manure Management (3.B)

This source category includes CH_4 and N_2O emissions occurring during the housing and the storage of livestock manure.

Emission factors and parameters correspond to those of the national inventory.

Austria-specific volatile solid (VS) excretion and N excretion values for dairy cows were calculated on the basis of projected milk yields (+14% from 2020 to 2040).

In the distribution of manure management systems a continued trend towards loose housing systems has been assumed. Additionally, the trend towards liquid manure systems was taken into account.

Based on information from the CAP Strategic Plan the share of dairy and suckling cows kept on pasture was increased slightly by 10% until 2030 and kept constant thereafter.

Other assumptions on agricultural practice, such as for the storage of farm manure or the share of farm manure treated in biogas plants, correspond to those of the OLI.

For more details see Chapter 4.9.2.

3.3.2.3 Rice Cultivation (3.C)

No rice cultivation activities are projected for Austria (notation key 'NO').

3.3.2.4 Agricultural Soils (3.D)

This source category includes N_2O emissions from anthropogenic N inputs to agricultural soils.

Activity data, such as mineral fertiliser quantities, crop yields and cultivated areas were taken from the PASMA model (WIFO & BOKU 2023). The nitrogen quantities of animal manures available for the application on agricultural soils were derived from the OLI calculations following the nitrogen flow procedure.

For the calculation of N-losses the projected use of the different low-emission application techniques and solid-liquid separation until 2027 according to the CAP Strategic Plan was taken into account. For the years from 2028 onwards, the shares of the different techniques have been kept constant. For more details see Chapter 4.9.2.

3.3.2.5 Prescribed Burning of Savannas (3.E)

No prescribed burning of savannas is projected for Austria (notation key 'NO').

3.3.2.6 Field Burning of Agricultural Residues (3.F)

In Austria, a federal law restricts the burning of agricultural residues on open fields. Residue burning is only permitted occasionally and on a very small scale. For the latest inventory year 2021, no field burning occurred in Austria at all (“NO”). Our assumption is that there will be no burning also in the projected years.

3.4 Land Use, Land-Use Change and Forestry (CRF Source Category 4)

Since the last submission, LULUCF projections have been recalculated based on new historical data. Projected values are based on the same modelling exercise and have only been updated according to the changes made in the GHG inventory. There were multiple recalculations in the latest national inventory submission (2023) that also affect the results of the updated projection. For details see the National Inventory Report 2023 (UMWELTBUNDESAMT, 2023).

For the LULUCF sector, currently only a WEM scenario is available. A project is in finalisation in these days of drafting the projection report, which includes WAM projections for the cropland and grassland subcategories. Furthermore, a project started some weeks ago, which will simulate additional measures in the forest land and harvested wood product subcategories. With next submission, the reporting of a WAM scenario for the LULUCF sector will be possible.

3.4.1 Forest (4.A) and HWP (4.G)

3.4.1.1 Methodology used for the sectoral scenarios

Emission projections for sector 4.A are based on a study on the GHG balance of the Austrian Forests and their value chain (WEISS et al. 2020)), conducted by the Austrian Research Centre for Forests (BFW), the University of Natural Resources and Applied Life Sciences, Vienna (BOKU), Kompetenzzentrum Holz (Wood K Plus) and Umweltbundesamt. The study includes several scenarios, with a Reference Scenario (R), which corresponds to the existing measures scenario (WEM).

The reference scenario was established based on historical field data from the Austrian national forest inventory (NFI) 2007/09, which served as input to the CALDIS model. CALDIS is a climate-sensitive single individual-tree based forest growth model (KINDERMANN 2010; GSCHWANTNER et al. 2010; LEDERMANN, 2002) that simulates forest development on the basis of the increment of single trees. It is based on a derivative of the PROGANUS model. The model applies a set of tree species-specific, mathematical-statistical equations which describe the diameter growth and height growth of single individual trees. Temperature and precipitation data was fed into the model to simulate climatic conditions (on the basis of a regionalised RCP 4.5 climate scenario). Models for salvage cutting and incidental felling were integrated as well. An in-growth model estimated the renewal of forest stands. On this basis, above- and below-ground biomass was calculated on a single tree level (BFW 2015). For soil organic carbon the projections are based on the soil simulations for the Forest reference level (BMNT 2019c) under the assumption, that the average yearly forest soil carbon stock change will remain constant. For estimating soil organic carbon the YASSO 15 model (LISKI et al. 2009, 2005; VISKARI et al. 2020) was applied.

To ensure consistency between category 4.A Forest land and 4.G HWPs, the harvested timber volumes and the increment were estimated and calibrated iteratively based on the CALDIS model (conducted by the Austrian Research Centre for Forests) and the Forest Sector Model FOHOW2 (conducted by the University of Natural Resources and Applied Life Sciences, Vienna), which has been used for projections of HWP and fuelwood production as well as for wood demand. FOHOW2 (NORTHWAY et al. 2013) is a partial equilibrium dynamic forest sector model simulating Austria's wood product supply chain.

The modelling exercise only provides projections for total forest land (4.A) and no split into forest land sub-categories is available. In addition, it has been assumed that the forest area remains constant in the scenarios. Forest land remaining forest land and land use changes to forest land were calculated separately based on forest area trends and emission factors from the GHG inventory.

Biomass harvest and increment on afforested and deforested land is calculated by multiplying the respective projected area with annual biomass growth or drain rates. These growth/drain rates per ha afforested/deforested land are based on specific measurements of the National Forest Inventory 2016/21 at such NFI plots, and this methodology is also applied in the National GHG Inventory. Because emissions/removals are directly calculated from these biomass stock changes there is no increment and removal data in cubic meters reported under the category 4.2 Afforested land in table 3. For calculating emissions from forest land remaining forest land the harvest removals for energy use in m^3 are not estimated separately. Instead, they are included in harvest removals for non-energy use because all removals are accounted as emissions from the forest biomass C pool (Emissions from harvest removals for non-energy use are partly offset by being accounted in the HWP sector). Consequently, the notation key "IE" is used for forest harvest removals for energy use in table 3.

3.4.1.2 Assumptions

The used reference scenario assumes that there will be no policy changes and that wood demand in terms of quantity and composition will follow the same trend as observed over the past few years. Likewise, it is assumed that market participants will not change their behaviour.

GDP growth projections to 2018 were derived from the National Statistics/WIFO; for the projections after 2018, the OECD long-term forecasts were applied. Oil prices have been taken from the EIA Annual Energy Outlook 2017.

Wood imports are determined in accordance with the future developments of wood export markets. However, a maximum amount has been defined for wood imports in the model to limit wood imports, assuming that the amount of wood available for imports cannot increase indefinitely as demand is likely to rise in other countries as well. The maximum amount has been defined in line with the historical maximum amounts for the period 2000-2016. External supply of recycled paper is limited to 1 million tonnes, which corresponds to the level of recent years.

Domestic fuel wood demand will be driven by market mechanisms only and corresponds to the domestic energy scenario as reported for the WEM scenario for energy projections described in Chapter 3.1.

3.4.1.3 Activities

The land use change areas to forests were calculated based on an extrapolation of historical trends from the last NFI 2016/21. The remaining land area was calculated by subtracting the land use change areas from the total forest land area.

3.4.2 Non-forest categories (4.B-4.F)

3.4.2.1 Cropland (4.B) and Grassland (4.C)

Methodolgy

Emission projections for the cropland and grassland sector are based on projections derived from

- calculations using the PASMA model (Positive Agricultural Sector Model Austria), carried out by the Austrian Institute of Economic Research (WIFO) and the University of Natural Resources and Applied Life Sciences, Vienna (BOKU). The PASMA model was developed by the Austrian Institute of Economic research (WIFO) (WIFO & BOKU 2018) and has also been used for activity data projections in the agriculture sector (CRF Source Category 3).
- and expert judgements provided by several experts from agricultural institutions in Austria.

Estimates of the area of land use change from cropland to grassland and vice versa are based on the arithmetic means of estimations obtained from expert judgements. Land use changes from cropland/grassland to forest land as well as remaining areas of cropland and grassland are based on the results of the PASMA model with some adjustments for the remaining areas in order to ensure consistency with other land use categories such as settlements. In order to take into account the impacts of the ÖPUL programme, the areas managed through the four most important ÖPUL measures have been estimated using the PASMA model as well.

All emissions from both sectors are calculated on the basis of the methodology used for Austrian Greenhouse Gas Inventory. A comprehensive description can be found in the Austrian National Inventory Report (UMWELTBUNDESAMT 2023).

Assumptions

For a more detailed description of the methodology and assumptions related to the PASMA model see Chapter 3.3.2.

3.4.2.2 Wetlands (4.D), Settlements (4.E) and Other land (4.G)

Methodology

Wetlands: The emission projections for sector 4.D follow the same methodology as the one used in the National Greenhouse Gas Inventory (UMWELTBUNDESAMT 2023).

Settlements: Projected areas for sector 4.E Settlements are based on expert judgements as well as the 14th Austrian Spatial Planning Report (ÖROK 2015).The arithmetic means of these sources have been calculated to derive the relevant areas for the years 2013–2050. LUC areas from other land use categories which were converted to settlement areas were estimated on the basis of historical trends, overall area consistency for all sectors (year-to-year area changes are equal to net LUC areas to/from the category) and the 'availability' of cropland and grassland for settlement, based on the estimated decline in the area in these land use classes.

Other land: Estimates of areas of forest land converted to other land are based on expert judgements, assuming that the annual LUC from forest land to other land remains constant (as in the last years of the historical time series).

Assumptions

Wetlands: The results of the Real Estate Database show an average annual increase in wetland area of 1% since 1990 (UMWELTBUNDESAMT 2023). It has been assumed that this long-term increase in wetland area and LUC from forest land and grassland to wetland will continue.

Settlements: Expert judgements are based on the assumption of a continuously growing population settling mainly in urban and suburban regions, with a corresponding demand for infrastructure. Assumptions for settlement developments are described in detail in the study ÖROK (2015).

Other land: It has been assumed that the annual LUC from forest land to other land remains constant (as in the last years of the historical time series).

3.5 Waste (CRF Source Category 5)

This chapter includes information on the methods used for greenhouse gas projections, as well as assumptions on activity data projections in view of anticipated waste management and waste treatment activities. The projections described in this chapter include projections on Solid Waste Disposal, Biological Treatment of Solid Waste, Waste Incineration and Waste Water Treatment and Discharge.

Waste management and treatment activities are sources of methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions.

3.5.1 Solid Waste Disposal (5.A)

3.5.1.1 Methodology used for the sectoral emission scenarios

For the calculation of methane (CH_4) arising from solid waste disposal on land the IPCC (Intergovernmental Panel on Climate Change) Tier 2 (First Order Decay) method has been applied, taking into account historical data on deposited waste. This method assumes that the degradable organic component (DOC) of waste decays slowly over a few decades (IPCC 2006). The Tier 2 method is recommended for the calculation of landfill emissions on a national level; it consists of two equations: one for the calculation of the amount of methane generated, based on the amount of accumulated degradable organic carbon at landfills in a particular year, and one for the calculation of the methane actually emitted after subtracting the recovered and oxidised methane.

CH_4 generation is calculated separately for the different waste types, taking into account waste type-specific characteristics (DOC, DOC_F, half-life times). The Austrian Inventory distinguishes between two main categories 'residual waste' and 'non residual waste'. 'Residual waste' corresponds to mixed waste from households and similar establishments collected by municipal waste collecting systems. It is directly deposited in landfills. 'Non residual waste' is all other deposited waste containing biodegradable compounds, including waste from industrial sources; it is divided into different waste types (wood, paper, textiles, residues etc.). 'Non residual waste' covers especially residues from the sorting and pre-treatment of waste. This category has gained importance with the ban on the direct disposal of untreated waste due to the Landfill Ordinance, and accounts for 94% of the total 'non residual waste'.

Activity data is from a national source. Since 2008, the data have been taken from the Electronic Data Management, an electronic database administered by the BMK (Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology) which delivers data as input to the national Federal Waste Management Plan. The parameters used in the emissions calculation are described in UMWELTBUNDESAMT 2023.

3.5.1.2 Assumptions

In the scenarios of future waste generation and disposal amounts, predictable future trends in waste management (resulting from the implementation of legal provisions, especially the Landfill Ordinance) are considered. Residues from the pre-treatment of municipal solid waste have become the main category of deposited solid waste. Assumptions are thus in line with the assumptions made for the developments of mechanical-biologically treated waste reported as a fraction under CRF Sector 5.B.1 Composting. Some minor amounts of sludge, construction waste and paper with a low TOC content (below the threshold for TOC disposal) are expected to be landfilled as well. Assumptions on the projected amounts of these waste types are based on historical depositions, partly mean values are applied on the basis of the amounts deposited in most recent years.

A constant decrease of the methane recovery rate is assumed due to the decreasing gas generation potential of deposited waste. The assumption is based on historical values 2008–2017 as reported by the federal provinces (taken from UMWELTBUNDESAMT 2014 and UMWELTBUNDESAMT 2019b).

The parameters used for emission projections are the same as those used in the (historical) Austrian greenhouse gas inventory (see UMWELTBUNDESAMT 2023).

3.5.1.3 Activities

Disposal of waste on landfills without pre-treatment has not been allowed since 2009 (see Landfill Ordinance). The main fraction relevant for current and future waste disposal (94% share in 2021) is thus made up by residues from the pre-treatment of waste (covered by the main category 'non residual waste'), especially residues/stabilised waste from mechanical-biological treatment plants. It is expected that amounts undergoing mechanical biological treatment, and thus also the residues from this activity, will remain at a constant level for the rest of the projected period, in conformity with the assumption made for this waste category under sector 5.B (Biological Treatment of Solid Waste). Another waste fraction deposited on landfills is sludge from wastewater handling and waste from sewage treatment, with a share of 5.6% in the total amount deposited in 2021. The basis for the projections for this activity is the respective amount deposited in 2021. As the First Order Decay method is applied for emissions projections, data on historical waste disposal are also taken into account in the calculation (covering both 'residual' and 'non residual' waste). Residual waste e.g. still accounts for 46% of total methane generation in 2021.

Table 9: Past trend (1990–2020) and scenarios (2025–2050) activity data for landfilled 'Residual waste' and 'Non-residual Waste' (Umweltbundesamt).

Year	Residual Waste [kt/a]	Non-residual Waste [kt/a]	Total Waste [kt/a]
1990	1 996	649	2 644
2000	1 052	827	1 879
2005	242	390	631
2010	0.0	245	245
2015	0.0	132	132
2020	0.0	166	166
2025	0.0	190	190
2030	0.0	190	190
2035	0.0	190	190
2040	0.0	190	190
2045	0.0	190	190
2050	0.0	190	190

3.5.2 Biological Treatment of Solid Waste (5.B)

3.5.2.1 Methodology used for the sectoral emission scenarios

Sector 5.B covers category 5.B.1 – emissions from the composting of biogenic waste and mechanical-biological treatment (MBT) plants as well as category 5.B.2 – emissions from anaerobic digestion in biogas plants (unintentional leakages, storage of fermentation residues).

Composted biogenic waste comprises biogenic waste collected from households by separate collection systems and other organic waste (e.g. municipal garden and park waste) treated in composting plants (centralised composting), as well as bio-waste composted 'at source' (home composting/decentralised composting).

CH_4 and N_2O emissions from composting (5.B.1) are calculated by multiplying the quantity of waste by the corresponding emission factor (see Table 12).

Table 10: Emission factors for composting and mechanical-biological treatment (Umweltbundesamt).

[kg/t humid waste]	CH_4	N_2O
Biogenic waste composted	0.75	0.1
Mechanically-biologically treated waste	0.6	0.1

CH_4 emissions from anaerobic digestion (5.B.2) are calculated using the IPCC 2006 default EF of 5% of CH_4 of the biogas produced. The CH_4 generation potential was set to 110 m^3/t based on an assumption made for mixed organic waste (UMWELTBUNDESAMT 2011).

3.5.2.2 Assumptions

Composting plants, home composting

Home-composted waste amounts are assumed to increase in accordance with population growth (Statistik Austria, 2022c). Amounts of waste treated in composting plants are partly (50%) expected to remain at a constant 2021 level (loosely piled bulk and wood used as structural material in the composting process), and partly (50%) to increase with population growth (organic waste collected from households).

Mechanical-biological treatment plants

As regards the amount of waste undergoing a mechanical-biological treatment (MBT) in Austria, there was a decrease in activities observed from 2007 to 2012. Since then the waste amount treated in MBT has stabilised. For projections purpose it is assumed that the amounts of mechanical-biologically treated waste remain at the mean level of 2009 – 2021.

The emission factors used for the projections are in accordance with the Austrian National Inventory Report 2023 (UMWELTBUNDESAMT 2023; see also Table 13).

Anaerobic digestion

It is assumed, that waste amounts treated in anaerobic digestion plants remain constant at the level of 2021, as there is no reliable information on the future developments of anaerobic digestion and any effects on activity data available.

In 2017, an Ordinance (Abfallbehandlungspflichtenverordnung, Federal Law Gazette II No. 120/2017) was issued requiring a gas-tight cover for storage facilities. Against this background, emissions are expected to decrease. For this reason a decreasing emission factor (% of the CH_4 generated) – from 5% (2015) to a minimum of 1% (2030) – has been assumed.

3.5.2.3 Activities

On the basis of the assumptions made, projected activity data are as follows:

Table 11: Past trend (1990–2020) and scenarios (2025–2050) – activity data for biological waste treatment (Umweltbundesamt).

[kt waste treated]	1990	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Composted organic waste	418	1 467	1 689	1 834	2 019	2 227	2 335	2 365	2 393	2 417	2 434	2 452
Mechanical-biologically treated waste	345	254	623	551	439	462	458	458	458	458	458	458
Anaerobically treated waste	0	0	152	378	438	544	563	563	563	563	563	563

3.5.3 Incineration and Open Burning of Waste (5.C)

In this category, CO_2 emissions from the incineration of waste oil and clinical waste are included, as well as CO_2, CH_4 and N_2O emissions from municipal waste incineration without energy recovery. All CO_2 emissions from the Category 5 'Waste' are caused by waste incineration.

In Austria, waste oil is incinerated in specially designed so-called 'USK facilities'. Emissions from waste oil combustion for energy recovery (e.g. in the cement industry) are reported under the CRF sector 1.A – Fuel Combustion. In general, municipal, industrial and hazardous wastes are combusted for energy recovery purposes in district heating plants or on industrial sites. Emissions are therefore reported under the CRF sector 1.A – Fuel Combustion. In Austria, there was only one waste incineration plant without energy recovery in operation until 1991, with a capacity of 22 000 tonnes of municipal waste per year. This plant was rebuilt as a district heating plant which went into operation in 1996. Consequently, since the re-opening of this plant (i.e. from 1996 onwards), emissions have been reported under the CRF sector 1 A – Fuel Combustion.

3.5.3.1 Methodology used for the sectoral emission scenarios

For this calculation, the simple CORINAIR methodology has been applied: the quantity of waste oil is multiplied by an emission factor for CO_2, CH_4 and N_2O. Emission factors are consistent with the emission factors used in the Austrian Inventory (UMWELTBUNDESAMT 2022).

Table 12: Emission factors of IPCC Category 5 C – Waste Incineration (Umweltbundesamt).

Waste Type	CO_2 [kg/Mg]	CH_4 [g/Mg]	N_2O [g/Mg]
Clinical Waste	880	100	12
Waste Oil	3 224	2	24

3.5.3.2 Assumptions

It is assumed that the incineration of waste oil and clinical waste without energy recovery has been constant from 2010 onwards. All existing and planned waste incineration plants include energy recovery and emissions are therefore reported under the CRF sector 1.A – Fuel Combustion.

3.5.3.3 Activities

The 2005 Austrian Waste Incineration Ordinance sets strict air pollution limits for all types of waste incineration, without setting quantity limits. All operators with a permit for the incineration of a specific type of waste need to be registered in a national database. The numbers of waste incineration plants which are not considered in sector 1.A are as follows:

- Waste oil: 8 plants

- Clinical waste: 1 plant

Constant values (500 Mg of clinical waste and 500 Mg of waste oil) are predicted for the years until 2050 for incineration activities without energy recovery.

3.5.4 Waste Water Treatment and Discharge (5.D)

3.5.4.1 Methodology used for the sectoral emission scenarios

N_2O emissions occur as direct emissions from wastewater treatment plants and as indirect emissions from wastewater after the discharge of effluent into waterways or lakes (IPCC 2006 GL). In the Austrian inventory, N_2O emissions from wastewater handling are calculated separately for:

1. Direct N_2O emissions from advanced centralised waste water treatment plants
2. Indirect N_2O emissions from effluent originating from wastewater treatment plants
3. Indirect N_2O emissions from the effluent of the population not connected to wastewater treatment plants

N_2O emissions from wastewater treatment plants are calculated using Equation 6.9 from the IPCC 2006 GL, CS activity data and EF:

$$\mathbf{N_2O_{PLANTS} = P * T_{CND\text{-}PLANTS} * F_{IND\text{-}COM} * EF_{PLANT}}$$

N_2O_{PLANTS} = total N_2O emissions from plants for the inventory year, kg N_2O/yr

P = human population

$T_{CND\text{-}PLANTS}$ = degree of utilisation of modern, centralised wastewater treatment plants [%] (CS)

$F_{IND\text{–}COM}$ = fraction of industrial and commercial co-discharge (CS)

EF_{PLANT} = emission factor [BMLFUW 2015a] (CS)

For the calculation of indirect N_2O emissions Equation 6.7 from the IPCC 2006 GL is used, with CS activity data on nitrogen effluent:

$$\mathbf{N_2O\ Emissions = N_{EFFLUENT} * EF_{EFFLUENT} * 44/28}$$

$N_{EFFLUENT} = N_{effluent\ plants} + N_{effluent\ population\ not\ connected}$

EF_{PLANT} = [0.005 kg N_2O-N/kg N] (IPCC 2006 GL)

Data on historical $N_{effluent\ plants}$ are retrieved from EMREG ('Emissionsregister – Oberflächenwasserkörper', abbreviated 'EMREG-OW'[8]), an electronic register of material emissions to surface water bodies from point sources, especially municipal sewage treatment plants. The $N_{effluent\ population\ not\ connected}$ is based on investigations carried out by ZESSNER & LINDTNER 2005 indicating an N value per

[8] BGBl. II No.29/2009: Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über ein elektronisches Register zur Erfassung aller wesentlichen Belastungen von Oberflächenwasserkörpern durch Emissionen von Stoffen aus Punktquellen (EmRegV-OW)

inhabitant of 13 g N/EW/day (upper value of the range proposed). For the projections, N flows are expected to increase in line with Austrian population growth rates.

CH_4 emissions from domestic wastewater disposal in septic tank systems are calculated pursuant to the IPCC 2006 GL, using IPCC defaults for the average organic load (BOD), the maximal CH_4 producing capacity (B_0) and the Methane Conversion Factor (MCF).
Moreover CH_4 and N_2O emissions from the sub-category *5.D.2* Industrial wastewater handling are estimated based on a study conducted in 2019 (UMWELTBUNDESAMT 2019c), investigating the practice of wastewater handling in industrial plants in Austria.

Regarding CH_4, data on generated gas and methane concentration (measured by the plants) was collected via a survey among industrial wastewater plant operators. An EF of 1% of the methane generated was then applied for all plants with anaerobic pre-treatment. Indirect N_2O emissions were calculated using measured N loads from direct industrial discharges reported annually within the EMREG database and the emission factor for wastewater discharge, which is 0.005 kg N_2O-N/kg N. (Ipcc 2006).

A detailed description of the methodologies is included in the National Inventory Report 2023 (UMWELTBUNDESAMT, 2023).

3.5.4.2 Assumptions

The following assumptions were made with regard to N_2O and CH_4 emissions:

- An increasing connection rate to wastewater treatment plants is assumed and considered for N_2O calculation based on the historical data for 2020 (Umweltbundesamt, 2021b) and future population growth (Statistik Austria 2022c).
- The $N_{effluent}$ from wastewater treatment plants will increase with population growth. The N load for industrial co-discharger is assumed to remain constant at the level of 2021.
- The number of people not connected to a sewer system but using septic tanks or domestic treatment options will remain constant at the level of 2020, the latest year for which data on connection rate is available.

Table 13: Past Trend (1990–2020) and scenarios (2025–2050) – indicators of waste water treatment/management (STATISTIK AUSTRIA 2022c, Umweltbundesamt).

	1990	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Inhabitants [1 000]	7 678	8 012	8 225	8 361	8 630	8 917	9 193	9 363	9 521	9 654	9 756	9 857
Connection rate to wastewater treatment plants [%]	59.0	84.3	88.9	93.9	95.1	96.0	96.2	96.2	96.3	96.3	96.4	96.4
Nitrogen effluent incl. pop. not connected to wwtp [t]	41 031	23 475	17 136	11 998	10 972	11 150	11 509	11 656	11 793	11 908	11 996	12 084

4 POLICIES & MEASURES

For the submission in March only one scenario "WEM, with existing measures" was modelled, which includes all measures implemented by 1 January 2022. Later in the year also a scenario "with additional measures" will be available. This scenario will include planned policies and measures, which were reported under the National Air Pollution Control Programme and in the Integrated National Energy and Climate Plan for Austria.

The content of the chapter on policies and measures (PaMs) is in compliance with Article 18 (1) (a) a, Annex VI of the Governance of the Energy Union and Climate Action Regulation (EU 2018/1999) and Article 37, Annex XXIV of the related Implementing Regulation (EU 2020/1208).

The measures listed in this chapter provide a basis for future efforts to limit GHG emissions beyond the commitments under the Effort Sharing Regulation (ESR) (EU) 2018/842, but none of the measures on its own is expected to deliver an emission reduction beyond the existing commitments.

4.1 The framework for Austria's climate policy

In order to provide information on the legal and institutional steps to prepare for the implementation of international commitments, the following paragraphs list significant milestones in recent Austria's climate policy[9].

In November 2011, the **Austrian Climate Change Act** was implemented to ensure compliance with the GHG emissions targets and the promotion of effective measures for climate change mitigation. It stipulated maximum emission quantities for each sector for the period 2008–2012 (according to the targets of the Climate Strategy 2007, BMLFUW 2007).

In 2013, the Austrian Climate Change Act was amended. It set maximum quantities per sector for 2013–2020, based on the Annual Emissions Allocation (AEA) for Austria under the Effort Sharing Decision. According to this legislation, Austria was obliged to reach a -16% emission reduction target by 2020 (compared to 2005) in all sectors not covered by the European emissions trading scheme. Furthermore, two bodies have been established, namely the Climate Change Committee (CCC) – consisting of ministries, provinces, social partners – and the Climate Change Advisory Board (CCAB) – consisting of NGOs, political parties, scientists.

The Austrian Climate Change Act defined clear sectoral targets, responsibilities and rules and allowed for a coordinated implementation of specified measures.

[9] More detailed information can be found in the Seventh National Communication of the Austrian Federal Government: https://unfccc.int/sites/default/files/resource/69823015_Austria-NC7-1-AT_NC7.pdf

It also determined procedures under which sectoral negotiation groups developed measures which cover *inter alia* the following topics:

- Increase in energy efficiency
- Increase the share of renewable energy sources in final energy consumption
- Increase the total energy efficiency of buildings
- Inclusion of climate change mitigation measures in spatial planning
- Mobility management
- Waste prevention/avoidance
- Protection and extension of natural carbon sinks
- Economic incentives for climate change mitigation

For the implementation of individual policies and measures there are different legislative arrangements, depending on sectors and legislative and administrative competences. Based on the Climate Change Act, a first programme, covering measures ready to implement in the course of 2013 and 2014, has been prepared in the National Climate Change Committee and adopted by the Federal Government and the Länder in 2013 (BMLFUW 2013). An update of the programme has been adopted in 2016 (BMLFUW 2015c).

In June 2016 a Green Paper was published which launched a broad public consultation process (online and through working groups) that closed in December 2016 (BMWFW & BMLFUW). The results of this consultation were considered in the **Austrian Climate and Energy Strategy** (#mission 2030), which was finalised in May 2018 (BMNT & BMVIT 2018) and which served as a basis for the preparation of a draft Integrated Energy and Climate Plan according to the Energy Governance Regulation (EU/2018/1999).

The final **integrated National Energy and Climate Plan 2021-2030** (NECP, BMNT 2019a) included a number of detailed measures in the areas of greenhouse gas emissions, energy efficiency and renewable energy and the following objectives until 2030:

- Reduction of greenhouse gas emissions by 36% compared with 2005 levels in sectors that are not covered by the EU emissions trading system; But a revision of the target is under way with a target of -48 % for Austria in Commission proposal.
- Increasing the share of renewable energy in gross final energy consumption to 46– 50%;
- Coverage of 100% of domestic electricity consumption from renewable sources (national, net balance, with exceptions for controlling and balancing energy supply for grid stabilisation and internal electricity generation from fossil fuels in tangible goods production);
- Improving primary energy intensity, defined as primary energy use per GDP unit, by 25–30% compared with 2015.

In 2019, the **Austrian Long Term Strategy** has been adopted, in which Austria committed to become climate neutral by no later than 2050, without using nuclear power. However, the Austrian government programme of the current Federal Government, which has taken office in 2020, includes a legally non-binding commitment to achieve climate neutrality already by 2040 and to switch to energy from 100 percent renewable sources by 2030.

4.2 Sectoral methodologies

In general, sectoral definitions as requested by the UNFCCC reporting guidelines have been used. In each section the methodologies applied for quantifying the most important policies and measures are described, although not all measures have been quantified, either due to a lack of data or because of the complexity of the measures, linkages with other policies, or uncertainty.

General descriptions of the measures can also be found in the following: reports on the sectoral scenarios transport (HAUSBERGER &SCHWINGSHACKL 2023), other sectors – buildings (e-think, 2023) and agriculture (WIFO & BOKU 2023).

It should be noted that the quantification of the GHG emission reduction effect of a policy or measure for each year (as presented in the reporting template) is not an exercise where individual effects of measures are simply added up. Interactions between measures have to be taken into account; and measuring the total effect of measures by simply adding up figures derived from individual instruments tends to result in an overestimation of the total effect of the measures.

The allocation of the measures is undertaken on the basis of the following categories:

- Energy Industries (CRF 1.A.1) & Manufacturing Industries and Construction (1.A.2)
- Transport (CRF 1.A.3)
- Other sectors: representing energy consumption in commercial, institutional and residential buildings (CRF 1.A.4)
- Industrial Processes and Product Use (CRF sector 2)
- Agriculture (CRF sector 3)
- LULUCF (CRF sector 4
- Waste (CRF sector 5)

The same categories have been used for reporting the projections, ensuring consistency between the projection reporting and the policies and measures.

The reporting of policies and measures is consistent with the corresponding reporting requirements of the EU and the UNFCCC.

In the following chapters, each policy and measure is described, including details on underlying actions, ambitions and assumptions. Summary data can be found in the Annex.

4.3 Measures affecting more than one sector

4.3.1 PaM N°1: EU Emission Trading Scheme (ETS)

GHG affected: CO_2, N_2O

Type of policy: regulatory, economic

Implementing entity: federal government

Mitigation impact: not available

EU legislation	National Implementation	Start
Directive 2009/29/EC amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community	Federal Law Gazette I No. 118/2011 (Emissions Allowance Trading Act)	2005
Commission Regulation 601/2012/EU on the monitoring and reporting of greenhouse gas emissions		

The EU Emission Trading Scheme is the most important policy instrument for installations with a high energy demand. It is aimed at reducing CO_2 emissions from energy industries, manufacturing industries and industrial processes, as well as N_2O emissions from the chemical industry and CO_2 emissions from aircraft operators. The objective is to limit emissions by means of trading allowances (initially allocated for free or auctioned). Around 200 Austrian installations and roughly 15 aircraft operators assigned to Austria are covered by the EU ETS.

Legal basis

The basis for the EU Emissions Trading System (EU ETS) is the Emissions Trading Directive 2003/87/EC, last amended in 2015. This Directive was transposed into Austrian law through the Emissions Allowance Trading Act 2011 (‘Emissionszertifikategesetz’ EZG 2011, Federal Law Gazette I No. 118/2011).

First and second trading period

The first trading period of the EU ETS was a trial period and covered the years 2005–2007. The second period covered the years 2008–2012. In the first two trading periods, the EU ETS covered only CO_2 emissions. From 2010 onwards, N_2O emissions in Austria have been considered as well. The system covers large emitters from the industry and energy supply sectors

Third and fourth trading period

The third trading period ran from 2013–2020. Directive 2009/29/EC (the revised Directive 2003/87/EC) introduced substantial improvements to the EU ETS. The revised Directive was transposed into Austrian law through the Emissions Allowance Trading Act 2011 (Federal Law Gazette I No. 118/2011).

In the third and fourth trading period electricity generation no longer receive free allowances (apart from a few exceptions) but have to purchase allowances on the market or acquire them through auctioning.

As a result of the extension of the scope of the EU ETS in 2013, more than 20 additional installations were included in the EU ETS (compared to previous periods).

For the industry sectors and for heat generation the allocation is still free, on an interim basis. Industry sectors with a significant risk of carbon leakages receive up to 100% free allocations based on a benchmarking system. The allocation for other sectors decreased in the third period every year (from 80% in 2013 to 30% in 2020) and remained at 30 % from 2021 onwards. .

Emissions covered by the ETS have fluctuated in the thir and fourth trading period. As industrial emissions are influenced by several factors, an accurate quantification of the effect produced by the ETS is not possible without an in-depth investigation. However, ETS evaluations have shown that the ETS has a positive effect on the scale of 'cleantech' innovations (MUULS et al. 2016). This applies all the more to the period from 2021 onwards, as CO2 prices have risen significantly since then from levels of a maximum of 20 to 30 EURO in the third period to a level of almost 100 EURO in 2023.

4.3.2 PaM N°2: Domestic Environmental Support Scheme (Umweltförderungsgesetz)

GHG affected: CO_2, CH_4, N_2O

Type of policy: economic

Implementing entity: federal government

National policy: Federal Law Gazette No. 185/1993, last amendment (considered in WEM): Federal Law Gazette I No. 185/2022

The objective of the Domestic Environmental Support Scheme is environmental protection, to be achieved through the prevention and reduction of air pollution, greenhouse gases, noise and waste. The Domestic Environmental Support Scheme provides financial support to projects which improve environmental performance in the energy, manufacturing and service industry beyond mandatory standards. The Climate Protection Ministry puts the focus of its funding policy on climate change. Projects may be related to all greenhouse gases but are mainly targeted at CO_2 emissions from the use of fossil fuels.

In 2017, more than 99% of the projects funded by the Ministry were climate related. Most of the projects were targeted at mobility (57%), efficient energy use (25%) and renewable energy (17%), with funding being provided for electric cars, the distribution of heat and the switch to LED lighting and biomass heating, for example (BMK 2022b).

Estimated Impact

According to the latest evaluation (BMK 2022b), the projects funded in 2021 are expected to achieve an annual CO_2 reduction of approx. 349 ktonnes. The CO_2 savings achieved through projects funded in 2017 will amount to 6.0 million tonnes over the whole lifetime of the projects. More than 75% of the total lifetime reductions are expected to be achieved through renewable energy projects and about 20% through projects focusing on energy efficiency.

4.3.3 PaM N°3: Austrian Climate and Energy Fund (KLI.EN)

GHG affected: CO_2

Type of policy: economic, research

Implementing entity: federal government

Mitigation impact: not available

National policy: Federal Law Gazette I No. 40/2007,
last amended by Federal Law Gazette I No. 37/2017

In 2007, the Federal Government established a specific fund (Climate and Energy Fund – KLI.EN) to support the reduction of GHGs in Austria in the short, medium and long term (Federal Law Gazette I No. 40/2007). The focus is on research and development of renewable energy systems, the development and testing of new transport and mobility systems and the market penetration of sustainable energy technologies – ranging from basic and applied research to the granting of subsidies for the implementation of climate friendly technology (KLIEN 2017). Support is provided to companies, research institutions and municipalities as well as to individuals, depending on the respective programme.

The KLI.EN fund supports measures in the field of mobility, buildings, industrial production and energy supply – sectors which are the main emitters of GHGs.

Quantification/Projected GHG emissions/removals:

No recent evaluation of the effects of this policy is available. However, a high potential for GHG emission reductions can be assumed in the medium and long term as the kli:en focusses on research and demonstration projects. The emission saving potential depends very much on how far research, pilot projects or model regions can penetrate the market in the future and thus contribute to substantial emission savings.

4.4 Energy Industries (CRF 1.A.1) and Manufacturing Industries and Construction (1.A.2)

The GHG emission reduction effect of individual policies and measures has been estimated where possible. For some measures, the reduction effect could not be estimated.

To quantify the effects of the relevant policies and measures in this sector, it has been assumed that additional/less green electricity production results in less/additional electricity production in fossil fuel power plants. Emission reductions have been calculated on the basis of an emission factor of 0.4 t CO_2/MWh.

In the following, the assumptions behind the respective policies and measures are described in greater detail.

4.4.1 WEM measures for Energy/Industry

4.4.1.1 PaM N°4: Increase the share of renewable energy in power supply and district heating

An increase in the share of renewable energy in the supply of power and district heating is the main purpose of this policy designed to reduce climate impacts of the energy system. Beyond the traditional use of large-scale hydropower for electricity generation, quantitative targets have been set for increasing the share of wind power, photovoltaics, small and medium hydropower plants and biomass/biogas in electricity generation in the Green Electricity Act, and are to be achieved by market premiums and investment support. Investment support for biomass-based district heating systems has been granted (see PaM Domestic Environmental Support Scheme).

GHG affected: CO_2

Type of policy: regulatory, economic

Implementing entity: federal government

Mitigation impact: 10 900 kt CO_2 eq in 2020 (Green Electricity Act)

The instrument listed below has been taken into account in the current scenario.

Renewable Energy Expansion Act *('Erneuerbaren-Ausbau-Gesetz')*

Type: EU and National policy

EU legislation	National Implementation	Start

Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources	Federal Law Gazette I No. 150/ 2021 (Renewable Energy Expansion Act)	2021

Directive 2018/2001 on the promotion of the use of energy from renewable sources was implemented through the Renewable Energy Expansion Act. The Renewable Energy Expansion Act provides for a harmonised system for promoting electricity production from renewable energy sources by granting market premiums and investment support, respectively, for various forms of electricity generated from renewable sources, e.g. biomass, wind power, hydropower and photovoltaics.

The Renewable Energy Expansion Act was designed to increase funding for the expansion of renewables. It includes new expansion targets for renewables for 2030 (vs. 2020):

- Hydropower +5 TWh
- Wind power +10 TWh
- Photovoltaics +11 TWh
- Biomass and biogas +1 TWh.

Quantification/Projected GHG emissions/removals:

In accordance with the Renewable Energy Expansion Act, an additional 27 TWh (approximately) of electricity (compared to 2020) will be produced in green electricity plants in 2030, resulting in emission reductions of about 11 000 kt CO_2 eq. in 2030 (using an emission factor of 0.4 kt CO_2 eq./GWh), of which only a part will be realized nationally.

4.4.1.2 PaM N°5: Increase energy efficiency in energy and manufacturing industries

An increase in energy efficiency in the energy and manufacturing industries is essential if the growing demand for fuel is to be reduced, along with environmental impacts. Based on EU legislation (Energy Efficiency Directive (2012/27/EU), Austria adopted an Energy Efficiency Act in 2014.

GHG affected: CO_2

Type of policy: planning, economic, regulatory

Implementing entity: federal government, federal provinces

Mitigation impact: not available

The instruments listed below have been taken into account in the current scenario.

Energy Efficiency Act
('Energieeffizienzgesetz')

Type: EU policy

EU legislation	National Implementation	Start
Energy efficiency Directive 2012/27/EU, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC	Federal Law Gazette I No. 72/2014 (Energy Efficiency Act)	2014
Energy efficiency Directive 2012/27/EU, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (as amended by Directive 2018/2002/EU)	*Revised Energy Efficiency Act*	*2023*

The Energy Efficiency Act is aimed at a cost-efficient energy efficiency increase, to be achieved in businesses and households by 2020. It includes different provisions for energy suppliers, companies and the federal government.

The Energy Efficiency Act specifies:

- an energy efficiency target of 1 050 PJ in 2020
- Large businesses have to conduct mandatory external energy audits every four years or introduce mandatory energy or environmental management systems including regular energy audits.
- Energy suppliers are expected to deliver annual energy savings (either themselves or through measures taken by their end users) amounting to a total of 0.6% of their annual energy supply.
- Austria has to meet an annual renovation goal of 3% through refurbishments or other energy savings.
- Energy efficiency action plans providing for monitoring and the achievement of legally binding goals and the implementation of measures have to be compiled every three years.

A revision of the Energy Efficiency Act is currently under discussion in the Austrian parliament.

Quantification/Projected GHG emissions/removals:

It has not been possible to quantify the total effect on the projected GHG emissions for the energy and manufacturing industries alone, as the revised energy efficiency act has not been agreed upon yet. Furthermore, the reductions in electricity and district heat demand in other sectors have to be considered as well.

4.5 Transport (CRF Source Category 1.A.3)

This chapter lists the WEM and WAM measures relevant for the transport sector. The main objective of these measures is to reduce CO_2 emissions from fossil fuels.

4.5.1 WEM measures for transport

4.5.1.1 PaM N°6: Increase the share of renewable energy sources in road transport

One important and well established policy target for the transport sector is to increase the share of clean energy sources in road transport. The EU Directives on the promotion of renewable energy sources require Member States to replace at least 14% of the fuels used in transport by renewables (biofuels and electricity from renewable energy sources) by 2030. The Austrian Fuel Ordinance stipulates minimum targets for the share of biofuels (fatty-acid methyl ester and ethanol) in diesel and gasoline sold in Austria. Moreover, the increased share of electric mobility in road transport with a high share of renewable electricity helps to achieve the renewable target in the transport sector.

The instruments listed below have been taken into account for PaM N°9.

Implementation of Directive 2009/28/EC on the promotion of the use of energy from renewable sources
('Umsetzung der Richtlinie Erneuerbare Energieträger (2009/28/EG) gemäß *Kraftstoffverordnung 2012')* and RED II (2018/2001/EC)

GHG affected: CO_2, CH_4, N_2O

Type of policy instrument: EU Policy

Status: implemented

Start year of implementation: 2004

Implementing entity: federal government

Mitigation impact:

2030: 1 708 kt CO_2eq 2035: 1 784 kt CO_2eq

Description:

EU legislation	National Implementation	Start
RED II Directive 2018/2001/EC		
RES Directive 2009/28/EC (amendment)	KVO Federal Law Gazette II No. 168/2009, 398/2012, No. 259/2024 (last amended in No. 86/2018)	2009
Fuel Quality directive 2009/30/EC	KVO Federal Law Gazette II No. 168/2009, 398/2012, No. 259/2024 (last amended in No.86/2018)	2009

RES-E Directive 2001/77/EC	KVO Federal Law Gazette II No. 168/2009	2009
Biofuels Directive 2003/30/EC	Federal Law Gazette II No. 417/2004	2004

Biofuels have been on the Austrian market since 2005 mainly in the form of a mix of biodiesel with conventional diesel. Since October 2007, ethanol has been added to petrol (gasoline). There are standards in place for gasoline fuel (E10) and diesel fuel (B7). This means that at the moment it is possible to blend 10% of ethanol with gasoline fuels and 7% of FAME with diesel fuels. Further details can be found in Austria's annual report on biofuels in the transport sector (BMK 2023a).

Both the Directive on the promotion of renewable energy sources (2009/28/EC) and the Fuel Quality Directive (2009/30/EC) can be regarded as successors to the Biofuels Directive (2003/30/EC). They both lay down – directly and indirectly – goals for the use of biofuels and reduction of GHG emissions. Apart from an overall goal, i.e. a certain percentage of the total energy demand to be covered by renewables by 2020, the Renewable Energy Directive – RED I - also defines a goal for the use of renewables in the transport sector. By 2020, each Member State was obligated to replace at least 10% of the fuels used in transport by renewables such as biofuels, or use electricity from renewable energy sources. Regarding the renewable energy share within the transport sector, the sub-target of 10% in 2020 was reached thanks to additional activities. Besides rail and underground, the transport sector also includes electrically powered cableways or ski lifts. The amount of renewable electrical energy used is calculated using a factor of 2.5 for rail transport and a factor of 5 for road vehicles.

Objectives:

In November 2016, the European Commission published its 'Clean Energy for all Europeans' initiative. As part of this package, the Commission adopted a legislative proposal for a recast of the Renewable Energy Directive. The RED II Directive (Directive 2018/2001/EC) sets target values for the use of renewable energy sources in transport for the time horizon from 2021 to 2030 (overall EU target of 32% for renewable energy sources consumption by 2030). Moreover, Member States must require fuel suppliers to supply a minimum of 14% of the energy consumed in road and rail transport by 2030 as renewable energy.

In the current WEM scenario Austria is on track to meet the RED II goal. Electricity will be relevant in road and rail transport from 2021 onwards. Electricity consumption for other means of transport will be calculated without using factors.

Assumptions about the development of the volume of biofuels blended with fossil fuels depend largely on the amount of fossil fuel sold in the transport sector. The use of biofuels for blending will decrease over time in line with the increase in electric mobility. Thus the GHG-reduction potential will be smaller over time. The use of HVO (hydro-treated vegetable oil) and advanced biofuels will remain relatively low like in the year 2020.

EU CO_2 reduction targets for PC, LDV and HDV
('CO_2 Grenzwerte für PKW, LNF und SNF')

GHG affected: CO_2, CH_4, N_2O

Type of policy instrument: EU Policy

Status: implemented

Start year of implementation: 2019 | 2021 (urban busses)

Implementing entity: European Union (standards for car industry monitored by federal government)

Mitigation impact: (exemplary for passenger cars)

2030: 2 026 kt CO2eq   2035: 5 916 kt CO2eq

Description:

EU legislation	National Implementation	Start
Regulation (EU) 2019/631		2019
Regulation (EU) 2019/1242		2019
Directive (EU) 2019/1161	Straßenfahrzeug-Beschaffungsgesetz, Federal Law Gazette I Nr. 163/2021	2021

According to Regulation (EU) 2019/631 the targets for CO_2 emission performance standards for new passenger cars and for new light commercial vehicles compared to 2021 are as follows: -15% until 2025 and -37,5% until 2030 for passenger cars resp. -31% for light commercial vehicles. However, since the regulation was adopted, electric mobility has gained in importance – both on technological and on political side. This, combined with the increasing urgency to meet the ambitious CO2 reduction targets, has led to a shift in automotive manufacturers' strategy towards electric cars. It is therefore assumed that, from around 2035, almost all new passenger cars and light commercial vehicles sold will be battery electric vehicles (BEVs). This is in line with the proposal of the EU Commission from 14.07.2021 for a new regulation that should strengthen the CO_2-emission performance standards and amend Regulation (EU) 2019/631.[10]

Concerning the funding of electric passenger cars and light duty vehicles in Austria, as well as the related charging infrastructure, it is recognized that the funding programmes of the last years (e-mobility for private individuals, e-mobility for companies, local authorities, associations, etc.) contributed significantly to the growth of the electric vehicle fleet. As there is now a strong demand for electric passenger cars and light duty vehicles and the funding programmes and subsidies are ending, no further funding programmes and subsidies for electric passenger cars and light duty vehicles are assumed after 2023. For heavy duty vehicles of type N2 and N3, the regulation (EU) 2019/1242 has been included in the projections of the development of the fleet, for the

[10] https://eur-lex.europa.eu/resource.html?uri=cellar:870b365e-eecc-11eb-a71c-01aa75ed71a1.0001.01/DOC_1&format=PDF (28/02/2023)

fleet of urban busses the requirements of the Clean Vehicle Directive (directive (EU) 2019/1161). Further incentive mechanisms via funding programmes, both for zero emission busses (EBIN) and trucks (ENIN) plus charging infrastructure have been included in the projections. The EBIN and ENIN programmes are part of the Austrian recovery and resilience plan 2020-2026 (ERRF – NextGenerationEU) and provide funding for both, the zero-emission vehicles and the related charging infrastructure.

Current projections include all electrified transport modes on the road. For the projections it has been assumed that the vehicle kilometres of conventional diesel and gasoline cars as well as of buses will be substituted with electric vehicles. The increased power consumption by electric vehicles is included in the energy-producing sectors.

4.5.1.2 PaM N°7: Increase fuel efficiency in road transport

The increase in fuel efficiency in road transport is an essential measure for limiting energy demand in transport. One of the measures that increases the fuel efficiency is the optimization and harmonization of the driving speed. In order to raise the knowledge of the effect of the personal driving behaviour on fuel efficiency, the klimaaktiv Ecodriving programme has been implemented. Its aim is to improve the driving performance through awareness raising and training programmes. Further, speed limits, established in response to concerns about the air quality (IG-L), contribute to reduced fuel consumption and a harmonization of the driving speed on motorways.

Fiscal measures can contribute to behavioral change in the transport sector as individuals and especially companies seek to optimize their costs. Increasing the cost per liter of fossil fuel consumed is intended to create incentives for drivers or companies to reduce fuel consumption and thus their costs. A truck toll based on the EURO class, reduced even by as much 75 % resp. 100 % for zero emission trucks above 3,5 t (-75 % for the infrastructure costs, -100 % for the costs of traffic related air pollution) creates incentives for transport companies to renew their fleet in order to reduce their costs.

GHG affected: CO_2, CH_4, N_2O

Type of policy instrument: regulatory (IG-L), information related (EcoDriving), fiscal (mineral oil tax - MöSt), regulatory (truck toll)

GHG affected: CO_2*Type of policy instrument*: regulatory (IG-L), information related (EcoDriving)

Status: implemented

Start year of implementation: 1997 (IG-L), 2004 (EcoDriving), 2011 (MöSt), 2002 (truck toll)

Implementing entity: federal government

2030: 199 kt CO_2-eq 2035: 198 kt CO_2-eq

The instruments listed below have been taken into account for PaM N°10.

Air quality induced speed limits
('Bestehende Tempolimits gemäß Immissionsschutzgesetz-Luft (IG-L)')

EU legislation	National Implementation	Start
Air quality Directive 2008/50/EC	Federal Law Gazette I No 115/1997 (last amended 2018)	1997/NA

The Ambient Air Quality Act lays down ambient air quality limit values for several pollutants.

In order to reduce and avoid exceedances of the limit value for NO_2, the speed limits have been lowered on certain parts of the Austrian motorways, either permanently or in sections controlled by traffic management systems. Based on an analysis of mileage-based speed, a difference in driving speeds of 6.2 km/h was used as input for the NEMO model (DIPPOLD et al. 2012). The calculated reduction potentials for energy use and emissions were simulated in the NEMO model. Traffic volumes and speed on the respective motorway sections were used to calculate the emissions.

Eco Driving initiative
(‚klimaaktiv mobil Spritsparinitiative')

The promotion of fuel-efficient driving is a measure which aims at reducing CO_2 emissions through a behavioral change. In order to foster fuel-efficient driving, the initiative 'klimaaktiv mobil' includes the 'klimaaktiv mobil' fuel saving initiative ('klimaaktive Spritsparinitiative'). Training sessions for fuel-efficient driving are offered for car, truck, bus and train drivers to reduce fuel consumption. Compared against conventional driving, GHG emissions can be reduced by 5–15%. Nationwide competitions and pilot campaigns for companies owning large fleets have been organised and have already led to energy savings.

Fuel tax increase in 2011
('MöSt-Erhöhung 2011 Klimabeitrag')

EU legislation	National Implementation	Start
Framework for the taxation of energy products and electricity (2003/96/EC)	'Mineralölsteuergesetz 1995' Federal Law Gazette I No. 630/1994 (last amended 2021 - Mineralölsteuergesetz 2022)	2011

The mineral oil tax is a tax directly related to fuel consumption, which means that a fixed amount has to be paid per litre of fuel consumed. In 2011 the mineral oil tax was raised (i.e. a CO_2 supplement of 20 €/t CO_2 was introduced). Consequently, the petrol price increased by € 0.04 (€ 0.048 including VAT) and the diesel price by € 0.05 (€ 0.06 incl. VAT) per litre.

The purpose of increasing the fuel tax is to reduce individual motorised transport and encourage people to switch to public transport. Moreover, the aim is to reduce GHG emissions from fuel export.

Greening the truck toll
('Ökologisierung der LKW-Maut')

EU legislation	National Implementation	Start
Taxation of heavy goods vehicles 2006/38/EC	Federal Law Gazette I No. 109/2002 (last amended 2021)	2002

Under the Federal Toll Law and the Ordinance on Toll Tariffs, the mileage-based truck toll has been split into 3 categories (according to the number of axles) since 1 January 2010, differentiated by EURO class, day-time and night-time driving and zero emission vehicle. This measure is based on EU Directive 2006/38/EC on the charging of heavy goods vehicles for the use of certain infrastructures (amendment to Directive 1999/62/EC).

The reduction potential of this measure is based on observations of historical fleet renewal rates after toll rate changes, and on expert estimates by TU Graz, which have all been included in the NEMO model. The reduction potential of an early fleet renewal decreases over time and runs out in 2024. The given future fleet renewal cycle of heavy duty vehicles is determined in the fleet module of the NEMO model, which assumes that older vehicles are removed on a regular basis.

4.5.1.3 PaM N°8: Modal shift in passenger and freight transport

One of the most important policy measures is the promotion of a modal shift towards environmentally friendly transport modes. Although Austria belongs to the EU Member States with the highest share of rail transport in passenger transport, a further promotion towards active mobility is important for a reduction of GHG emissions. Besides considerable investments in railway and other public transport infrastructure over the last decade, the programme 'klimaaktiv mobil' for mobility management and awareness raising is an essential tool for the promotion of environmentally friendly and active transport modes (cycling and walking). The cornerstones of 'klimaaktiv mobil' are a funding programme for businesses, communities and associations, target group-oriented counselling programmes, awareness-raising initiatives, partnerships, and training and certification initiatives. The support for planning and implementation of walking and cycling infrastructure has been included in the programme too.

Although Austria is one of the EU member states that already has a high share of passenger transport by rail, significant investments in rail infrastructure and service continue to be made to improve the service for passengers. To further promote public transport, the nationwide "climate ticket" was introduced. This makes traveling by public transport more attractive both from an economic perspective and from the point of view of user-friendliness.

Similarly to passenger transport, also in freight transport a modal shift towards environmentally friendly transport modes is necessary in order to reduce the GHG emissions. Austria is meeting this challenge by continuously investing in the infrastructure for rail freight transport within the framework of the Austrian railways framework plan ("ÖBB Rahmenplan"). Within the framework of this plan, the "target network 2025+" will be implemented which includes improvements on major TEN-T axes (esp. Scandinavian-Mediterranean corridor and Baltic Adriatic corridor). The improvements in the railway network will improve the conditions for all rail freight companies transporting goods in and through Austria.

Further, Austria promotes the modal shift from road to rail or inland vessel by supporting companies that are transporting goods by rail and by improving the conditions for waterborne transport.

GHG affected: CO_2, CH_4, N_2O

Type of policy: financial, awareness raising, national policy, subsidies

Status: implemented + ongoing (klimaaktiv mobil)

Start year of implementation: 2006 (klimaaktiv mobil), 2022 (Federal Austrian Railway Framework Plan 2022 – 2027)

Implementing entity: federal government (klimaaktiv mobil), Federal Austrian railways (ÖBB)

Mitigation impact:

2030: 1 163 kt CO_2-eq   2035: 1 045 kt CO_2-eq

The instrument listed below has been taken into account for PaM N°11.

'klimaaktiv mobil' initiative - Mobility management and awareness
('Mobilitätsmanagement und Bewusstseinsbildung – klimaaktiv mobil Programm')

The 'klimaaktiv mobil' initiative of the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) offers extensive measures for promoting climate-friendly mobility management as well as cycling initiatives. The aim is to motivate relevant stakeholders and decision makers and to support them in the development and implementation of projects for the promotion of climate-friendly, efficient and sustainable mobility. Numerous projects have already been successfully implemented:

- Mobility management for commercial building promoters and fleet owners
- Mobility management for leisure, tourism and youth

Mobility management exists for cities, municipalities and regions.

Furthermore, several thousand climate-friendly mobility projects have been initiated – implemented by establishments, cities, municipalities and regions, tourist facilities and schools.

Recently funding for active mobility infrastructure (i.e. infrastructure for walking and cycling) incl. planning is available too. To further promote cycling, especially for longer distances and for the transport of goods, e-bikes and e-cargo bikes are also financially supported.

The CO_2 mitigation potential of klimaaktiv mobil is calculated using a factor of CO_2 reduction per euro invested, based on the results of project reports since 2007. As funding for the programme is only secured until 2030, no further investments are considered after this period. However, since the impact of a project lasts several years after it is funded (30 years for cycling infrastructure, 10 years for mobility management measures), a decreasing CO_2-mitigation potential remains after 2030.

Federal Austrian Railway Framework Plan 2022 – 2027 - passengers
('ÖBB Rahmenplan 2022 – 2027 – Personenverkehr')

EU legislation	National legislation	Start
/	Bundesbahngesetz, Federal Law Gazette Nr. 825/1992 (last amended 2021), §42	2003

The Federal Austrian railway framework plan specifies investments in the network of ÖBB-Infrastruktur AG. The legal basis for this is Section 42 of the Federal Railways Act.

The Austrian railway framework plan framework plan is a presentation of the planned projects and their investment sums, which are planned for implementation within the respective 6-year period. In further, the framework plan also includes the expenses foreseen for the maintenance of the rail network within the period. Together, this forms the substantive basis for the subsidies of the BMK to ÖBB-Infrastruktur AG, which are subsequently contractually agreed (subsidy contracts). The Federal Railways Act stipulates that the framework plan is updated annually by one year and adjusted to the new period. Within the framework of the present Austrian railway framework plan, the "target network 2025+" for passenger and freight transport (see **Fehler! Verweisquelle konnte nicht gefunden werden. Fehler! Verweisquelle konnte nicht gefunden werden.**) will be implemented.

In the area of rail passenger transport, the Austrian railway framework plan will reduce the travel time on important axes through large infrastructure projects (Brennertunnel, Semmering Basistunnel, Koralmtunnel) and investments in electrification, automation and digitalisation. Further, renovations of railway stations, improved customer services and better connections will make travelling by rail more attractive.

Nationwide and Regional public transport ticket
('Klimaticket Österreich" und "Klimaticket Regional')

EU legislation	National Legislation	Start
/	Bundesgesetz über die Einführung des Klimatickets (Klimaticketgesetz - KlimaticketG), Federal Law Gazette I Nr. 75/2021 One Mobility Gesetz (One G) Federal Law Gazette I No. 363/2021	2021

On 26 October 2021 the Klimaticket ("climate ticket"), an integrated public transport ticket, was introduced in Austria. Previously, each regional transport company had its own ticketing service, so customers travelling in more than one region had to buy several tickets from different transport companies.

The Klimaticket is available in a national and in regional version. The national version ("Klimaticket Österreich"), which is valid on all public transportation in Austria, can be purchased for 1 095 €/year (3€/day). The regional version ("Klimaticket Regional") is valid on all public transportation in a specific region. Its costs vary between 365 €/year and 860€/year.

The instrument was introduced to incentivise the use of public transport by making it easier, cheaper and thus more attractive.

Federal Austrian Railways Framework Plan 2022 – 2027 - freight
('ÖBB Rahmenplan 2022 – 2027 – Güterverkehr')

EU legislation	National legislation	Start
/	Bundesbahngesetz, Federal Law Gazette. Nr. 825/1992 (last amended 2021), §42	2003

In the area of rail freight transport, the Austrian railways framework plan has the objectives to increase the transport capacity within the railway network. The framework plan includes large infrastructure projects along important TEN-T axes (Brennertunnel on the Scandinavian-Mediterranean corridor, Semmering Basistunnel on the Baltic-Adriatic corridor), investments in intermodal terminals and cargo centres (Villach, Graz, Wels, Wien), electrification and ongoing investments in automation and digitalisation.

Action Plan Danube until 2022
(‚Aktionsprogramm Donau des BMVIT bis 2022')

Within the framework of the Action Plan Danube, Austria is continuously working on improving the navigation channel of the Danube to enable the transport of goods via inland vessel also in case of low water levels. Focus is set e.g. on a customer-oriented waterway management and improved navigation channel of the Danube, reducing greenhouse gas emissions and increasing the environmental friendliness of Danube navigation or ensuring flood protection and damage minimization in the event of a flood disaster (BMVIT 2015).

It was assumed that the constant promotion of the Danube navigation guarantees at least an upholding of the current freight volumes until 2050.

Rail Freight Subsidy and Promotion of corporate rail connections for freight transport
('Schienengüterverkehrsförderung und Anschlussbahnförderung')

The object of the rail freight subsidy is the provision of rail freight transport services in the production forms of (a) single-wagon transport, (b) unaccompanied combined transport or (b) transport of trucks and trailers by train ("Rollende Landstraße") in the form of a non-repayable grant. [11]

The promotion of corporate rail connections for transport is an instrument that aims at supporting investment in corporate feeder lines in order to maintain and expand the railway network. The improvement of rail infrastructures at company/industrial sites aims at shifting transport activities from road to rail. The intention is to increase the proportion of freight transported by rail by promoting and financing feeder lines at company locations.[12]

4.6 Other Sectors (CRF Source Category 1.A.4) – Stationary combustion (buildings)

This section describes measures aimed at energy consumption from category *1.A.4 Other Sectors* only. They are interlinked with the energy supply from sector Energy Industries (see chapter 4.4). For further information on policies and measures of mobile sources from category *1.A.4 Other Sectors*, see chapter 4.5.

Significant national policy instruments that promote the implementation of measures are the Housing Support Scheme ('Wohnbauförderung') and the Technical Building & Construction Regulations of the regional authorities ('Bundesländer'), the Austrian Climate and Energy Fund ('Klima- und Energiefonds'), the Domestic Environmental Support Scheme

[11] https://www.bmk.gv.at/themen/verkehr/eisenbahn/foerderungen/sgv.html

[12] https://www.bmk.gv.at/themen/verkehr/eisenbahn/foerderungen/anschlussbahnen.html

('Umweltförderung im Inland'), and the Austrian Climate Protection Initiative ('klimaaktiv'). The federal government funds the last three programmes.

Further details on the Domestic Environmental Support Scheme ('Umweltförderung im Inland') and the Austrian Climate and Energy Fund ('Klima- und Energiefonds') are provided in Chapter 4.3 (Measures affecting more than one sector).

4.6.1 WEM measures for other sectors – Buildings

4.6.1.1 PaM N°9: Climate Neutral New Buildings

GHG affected CO_2

Type of policy instrument: regulatory, economic, voluntary/negotiated agreements

Status: implemented

Start year of implementation: 2006

Implementing entity: federal government, federal provinces

Mitigation impact: not available

Description

Increasing the energy efficiency of buildings is one of the most effective means of reducing the carbon footprint of the Austrian population. Tighter mandatory construction standards improve the energy performance of new buildings. The installation of heating systems using renewable energy sources is the other key to climate neutral new buildings (regarding the energy use for space heating and hot water preparation).

In the WEM scenario, the full implementation of Directive 2010/31/EU sets the nearly zero-energy building standard for new buildings. High-efficiency alternative heating systems have to be considered, if available. Requirements on the renewable share support the installation of solar appliances. Federal bans on solid and liquid fossil fuel heating systems apply. In the case of subsidies from the Housing Support Scheme ('Wohnbauförderung') additional funding is granted, if stronger standards than the minimum criteria for energy efficiency of the building envelope and for the choice of heating systems are succeeded.

However, the aim of climate neutral new buildings is not fully achieved by the measures taken into account in the WEM scenario.

- Insufficient fulfilment of the energy efficiency requirements is taken into account, leading to about 5-10 kWh/(m^2.a) higher useful energy demand compared to the 'nearly zero-energy building' obligation. This is assumed because of buildings with more complex geometry (larger surface volume ratio), with additional heated building areas (e.g. hobby rooms in the basement, rooms with sloping ceilings and/or less than 2.0 m room height) and to some degree also due to lack of quality of construction (connection of components).

- The installation of natural gas heating systems in new buildings is restricted but still applicable.

Objectives *Efficiency improvements of buildings*
Efficiency improvement of appliances
Efficiency improvement in services/tertiary sector

In implementation of Directive 2010/31/EU, a nearly zero-energy building is a building that meets the requirements from 01/01/2021 of the "National Plan" (OIB-330.6-005/18), which is referenced in OIB Guideline 6, edition 2019 (OIB-330.6-026/19).

- After December 31, 2020, new buildings must be nearly zero-energy buildings as defined in Article 2, Item 2 of Directive 2010/31/EU.
- After December 31, 2018, new buildings owned by public authorities must be nearly zero-energy buildings as defined in Article 2, paragraph 2 of Directive 2010/31/EU.

Buildings for which, in specific and justified cases, a cost-benefit analysis over the economic lifetime of the building in question results in a negative result are excluded.

In the case of new construction, the technical, ecological, economic and legal feasibility of using high efficient alternative heating systems, if available, must be taken into account and documented.

In implementation of federal Oil Boiler Installation Prohibition Act ('ÖKEVG 2019') the installation of liquid or solid fossil fuel boilers in newly constructed buildings is not be permitted as of 2020.

The Housing Support Scheme ('Wohnbauförderung') provides additional subsidies for the construction of new buildings with further improved energy efficiency, the use of heating systems which use only renewable energy sources (in particular by combining biomass fuels with solar systems), as well as the use of heat recovery systems. If – in exceptional cases – condensing gas boilers are promoted, compensatory measures such as solar thermal or photovoltaics installations are mandatory (Constitutional Art. 15a Agreement).

Subsidies of the Domestic Environmental Support Scheme ('Umweltförderung im Inland') and the Austrian Climate and Energy Fund ('Klima- und Energiefonds') for the construction of new buildings are also bound to fulfillment of environmental requirements.

OIB Guideline 6 – Energy Savings and Thermal Insulation
('OIB Richtlinie 6 – Energieeinsparung und Wärmeschutz')

Type: EU policy, national policy, regional legislation

EU legislation	National Implementation	Start
Recast of the Energy performance of buildings (Directive 2010/31/EU) and amended by the Directive 2018/844	OIB Guideline 6, edition 2019 (OIB-330.6-026/19)	2020 (depending on legislation in the federal provinces)
	National plan according to Art. 9(3) of 2010/31/EU, edition 2018 (OIB-330.6-005/18)	2018

The 2019 edition of the OIB Guideline 6 of the Austrian Institute for Constructional Engineering (released in April 2019) transposes (like its predecessors) the EU Directive on the energy performance of buildings (Directive 2010/31/EC) into national law for both residential and non-residential buildings.

The federal provinces are responsible for translating this guideline into their respective regional laws (amending the predecessors of OIB Guideline 6, released in October 2011 and March 2015). The periodical adjustments of the OIB Guideline 6 include the successive stages of the National Plan.

The National Plan required an improvement of the building standards for new buildings every two years to achieve a 'nearly zero energy' building standard to comply with the target of the EU Directive in 2020. The focus is no longer just on the thermal heat demand of buildings but also on hot water, ventilation, cooling, the demand for electricity, and photovoltaics – all of which impact on total energy efficiency. Moreover, the new energy certificate for buildings specifies parameters such as the total energy efficiency factor, CO_2 emissions and the demand for primary energy on the cover sheet. Minimum requirements are specified for thermal useful heat demand and final energy consumption.

There is no information about policy costs. However, the level of ambition of the National Plan is set to meet the cost-optimal level of the EPBD (Directive 2010/31/EU) through a corresponding OIB document released in March 2014 ('OIB-Dokument zum Nachweis der Kostenoptimalität der Anforderungen der OIB-RL6 bzw. des Nationalen Plans gemäß 2010/31/EU', revised by OIB-330.6-005/18).

Oil Boiler Installation Prohibition Act
('Ölkesseleinbauverbotsgesetz – ÖKEVG 2019')

Type: National legislation: Federal Law Gazette I No. 6/2020.

The installation of liquid or solid fossil fuel boilers in newly constructed buildings will not be permitted as of 2020.

Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal – State)

(Vereinbarung gemäß Art. 15a B-VG über 'Maßnahmen im Gebäudesektor zum Zweck der Reduktion des Ausstoßes an Treibhausgasen (Bund – Länder)')

*Type: V*oluntary/negotiated agreements (amended in national and regional legislation): Federal Law Gazette I No. 19/2006.

Instruments to support energy efficient new residential buildings within the Housing Support Scheme ('Wohnbauförderung') are regulated by the Austrian 'Article 15a BV-G Agreement of the Federal Constitutional Law' between the federal government and the federal provinces. This constitutional agreement came into effect in 2006 (Federal Law Gazette II No. 19/2006, succeeded by Federal Law Gazette II No. 251/2009, last amendment: Federal Law Gazette II No. 213/2017).

Funding Programmes for New Buildings

('Förderprogramme für Neubau')

Type: national policy

In the WEM scenario it has been assumed that the following funding and national programmes will be continued in order to support renewable heating systems and to improve the improve the thermal energy efficiency of the building envelope of new buildings:

- Domestic Environmental Support Scheme ('Umweltförderung im Inland')
- Housing Support Scheme ('Wohnbauförderung')
- Austrian Climate and Energy Fund ('Klima- und Energiefonds')

In the WEM scenario it is assumed that annually climate-effective funds provided for new buildings (building related funding only)[13] at real € 2020 prices will drop by 13% until 2025, by 21% until 2030, by 39% until 2035, by 62% until 2040, by 79% until 2045 and by 85% until 2050 (compared to 2021). From 2021

[13] 'Climate-effective building related-funding only' means that the allocated funding is effective within the category *1.A.4.a Commercial/Institutional* or *1.A.4.b Residential* solely for purpose of supporting renewable heating systems and energy efficiency of energy consumption for space heating and hot water generation. Moreover, only subsidies for cost categories as modelled in the INVERT/EE-Lab model by (e-think, 2023) are chosen (windows/external doors, insulating materials for facade, roof, top and bottom floor ceiling, and for heating systems but excluding heat distribution or heat release appliances or cost of disposal). Thus, the amount of funding paid out by the funding body is potentially significant higher than the values taken into account for modelling.

until 2030, nominal funding budgets are set constant at the level of 2021. After 2030, funding is set to be further decline in the WEM scenario (see Table 14).

Table 14: Budget of funding programmes for energy efficiency and heating systems of new buildings.

Budget, real [Mio. € 2020]	2021	2025	2030	2035	2040	2045	2050
Commercial/Institutional buildings	2.2	1.9	1.7	1.3	0.8	0.5	0.3
Residential buildings	241	211	191	147	94	52	38
Heating systems	17	15	13	11	5.7	1.6	1.0
Total	**260**	**227**	**206**	**160**	**100**	**54**	**39**

4.6.1.2 PaM N°10: Thermal Improvement of Building Stock

GHG affected: CO_2

Type of policy instrument: regulatory, economic, information, voluntary/negotiated agreements

Status: implemented

Start year of implementation: 2006

Implementing entity: federal government, federal provinces

Mitigation impact: not available

Description

Increasing the energy efficiency of buildings is one of the most effective means of reducing the carbon footprint of the Austrian population. Tighter mandatory construction standards improve the energy performance of buildings undergoing major renovation.

In the WEM scenario, the full implementation of Directive 2010/31/EU maintains a mandatory energy performance building standard for major renovation. In the case of subsidies from the Housing Support Scheme (‘Wohnbauförderung’) additional funding is granted, if stronger standards than the minimum criteria for energy efficiency of the building envelope are succeeded.

However, there is no obligation for renovation of buildings with poor thermal hull quality taken into account in the WEM scenario.

Objectives

Efficiency improvements of buildings
Efficiency improvement in services/tertiary sector

In implementation of Directive 2010/31/EU, a building undergoing major renovation has to meet the requirements from 01/01/2021 of the "National Plan" (OIB-330.6-005/18), which is referenced in OIB Guideline 6, edition 2019 (OIB-330.6-026/19). Buildings for which, in specific and justified cases, a cost-benefit analysis over the economic lifetime of the building in question results in a negative result are excluded.

The Housing Support Scheme (‘Wohnbauförderung’) provides additional subsidies for major renovation with further improved energy efficiency.

Subsidies of the Domestic Environmental Support Scheme ('Umweltförderung im Inland') and the Austrian Climate and Energy Fund ('Klima- und Energiefonds') are also bound to fulfillment of environmental requirements.

Support for the thermal renovation of buildings is provided under several programmes, e.g. the federal Building Renovation Initiative for Commercial/Institutional buildings ('Sanierungsoffensive für Betriebe') and the Building Renovation Initiative for Residential Buildings ('Sanierungsoffensive für Private').

The measures for building renovation are supported by various information and networking activities, such as the Austrian Climate Protection initiative ('klimaaktiv') and consultancy service, information and education campaigns by federal provinces.

The Austrian Act on the Presentation of an Energy Performance Certificate ('Energieausweis-Vorlage-Gesetz 2012 – EAVG 2012') requires mandatory information on the energy performance of buildings, which may influence decisions towards energy efficiency of buildings. The obligation for having energy performance certificates applies, when renting, leasing or selling buildings.

There are interdependencies with PaM N°11: Replacement of Fossil Fuels in Building Stock since energy efficiency measures entail for example an exchange of heating systems to switch to renewables and low carbon technologies.

OIB Guideline 6 – Energy Savings and Thermal Insulation
('OIB Richtlinie 6 – Energieeinsparung und Wärmeschutz')

Type: EU policy, national policy, regional legislation

EU legislation	National Implementation	Start
Recast of the Energy performance of buildings (Directive 2010/31/EU) and amended by the Directive 2018/844	OIB Guideline 6, edition 2019 (OIB-330.6-026/19)	2020 (depending on legislation in the federal provinces)
	National plan according to Art. 9(3) of 2010/31/EU, edition 2018 (OIB-330.6-005/18)	2018

The 2019 edition of the OIB Guideline 6 of the Austrian Institute for Constructional Engineering (released in April 2019) transposes (like its predecessors) the EU Directive on the energy performance of buildings (Directive 2010/31/ EC) into national law for both residential and non-residential buildings.

The federal provinces are responsible for translating this guideline into their respective regional laws (amending the predecessors of OIB Guideline 6, released in October 2011 and March 2015). The periodical adjustments of the OIB Guideline 6 include the successive stages of the National Plan.

The National Plan set evolving targets for existing buildings undergoing major renovation. The focus is no longer just on the thermal heat demand of buildings but also on hot water, ventilation, cooling, the demand for electricity, and photovoltaics – all of which impact on total energy efficiency. Moreover, the new energy certificate for buildings specifies parameters such as the total energy efficiency factor, CO_2 emissions and the demand for primary energy on the cover sheet. Minimum requirements are specified for thermal heat demand and final energy consumption.

There is no information about policy costs. However, the level of ambition of the National Plan is set to meet the cost-optimal level of the EPBD (Directive 2010/31/EU) through a corresponding OIB document released in March 2014 ('OIB-Dokument zum Nachweis der Kostenoptimalität der Anforderungen der OIB-RL6 bzw. des Nationalen Plans gemäß 2010/31/EU', revised by OIB-330.6-005/18).

Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal – State)
(Vereinbarung gemäß Art. 15a B-VG über 'Maßnahmen im Gebäudesektor zum Zweck der Reduktion des Ausstoßes an Treibhausgasen (Bund – Länder)')

*Type: V*oluntary/negotiated agreements (amended in national and regional legislation): Federal Law Gazette I No. 19/2006.

Instruments to support energy efficient residential buildings undergoing major renovation within the Housing Support Scheme ('Wohnbauförderung') are regulated by the Austrian 'Article 15a BV-G Agreement of the Federal Constitutional Law' between the federal government and the federal provinces. This constitutional agreement came into effect in 2006 (Federal Law Gazette II No. 19/2006, succeeded by Federal Law Gazette II No. 251/2009, last amendment: Federal Law Gazette II No. 213/2017).

Funding Programmes for Existing Buildings
('Förderprogramme für bestehende Geböude')

Type: national policy

EU legislation	National Implementation	Start
Recast of the Energy performance of buildings (Directive 2010/31/EU) and amended by the Directive 2018/844	Federal Law Gazette I No. 202/2021 (last amendment considered in WEM scenario)	2021
	Federal Law Gazette I No. 185/1993	1993

In the WEM scenario it has been assumed that the following funding and national programmes will be continued in order to improve the thermal energy efficiency of the building envelope of existing buildings:

- Domestic Environmental Support Scheme ('Umweltförderung im Inland')
- Housing Support Scheme ('Wohnbauförderung')
- Austrian Climate and Energy Fund ('Klima- und Energiefonds')
- Building Renovation Initiative for Commercial/Institutional buildings ('Sanierungsoffensive für Betriebe')
- Building Renovation Initiative for Residential Buildings ('Sanierungsoffensive für Private')
- Austrian Climate Protection Initiative ('klimaaktiv'):
  - e5-communities: consultancy for communities to promote climate policies
  - energy saving: education, information and advice for consumers and commercial enterprises to reduce energy consumption
  - renewable energy: provide know-how and support networking for committed companies and associations
- Renovation of federal buildings (federal real-estate property)
- Consultancy service and information campaigns

Funding for thermal renovation is provided under all relevant funding programmes of the federal government and the federal provinces.

The Building Renovation Initiative for Commercial/Institutional buildings ('Sanierungsoffensive für Betriebe') is an incentive of the federal government to promote the renovation of commercial and institutional buildings. It is assumed that this instrument will remain in place after 2021.

- Funding is available for the thermal renovation of buildings that are more than 20 years old. The initiative is aimed at companies and commercial organisations, including registered associations and professional organisations.

The Building Renovation Initiative for Residential Buildings ('Sanierungsoffensive für Private') is an incentive of the federal government that was launched in 2011 to promote the renovation of private buildings. It is planned to remain in place for private households in 2022 and beyond.

- Funding is available for the thermal renovation of buildings that are older than 20 years. The initiative is aimed at owners and tenants of rented apartments in multi-storey buildings and detached/semi-detached family houses.

In the WEM scenario it is assumed that annually climate-effective funds provided for renovation of buildings w/o heating systems (building related funding only)[14] at real € 2020 prices will drop by 13% until 2025, by 21% until 2030, by 81% until 2035, by 94% until 2040, by 95% until 2045 and by 97% until 2050 (compared to 2021). From 2021 until 2030, nominal funding budgets are set constant at the level of 2021. After 2030, funding is set to be further decline in the WEM scenario (see Table 15).

Table 15: Budget of funding programmes for thermal renovation of existing buildings (w/o heating system).

Budget, real [Mio. € 2020]	2021	2025	2030	2035	2040	2045	2050
Commercial/Institutional buildings	12	11	9.6	2.4	0.8	0.6	0.4
Residential buildings	246	215	194	48	16	12	7.8
Total	**258**	**225**	**204**	**50**	**17**	**12**	**8.2**

All subsidies for heating systems in existing buildings (alongside or without thermal renovation of the building envelope) are considered in chapter 4.6.1.3 (PaM N°11: Replacement of Fossil Fuels in Building Stock) below.

Act on the Presentation of an Energy Performance Certificate
('Energieausweis-Vorlage-Gesetz 2012 – EAVG 2012')

Type: EU policy, national policy, regional legislation

EU legislation	National Implementation	Start
Recast of the Energy performance of buildings (Directive 2010/31/EU) and amended by the Directive 2018/844	Federal Law Gazette I No. 27/2012	2012

The aim of the recast of the Directive on the energy performance of buildings (2010/31/EU) is to improve the efficiency of previous building regulations and to counteract deficiencies in national implementation. The mechanisms have remained the same:

- Definition of calculation methods for total energy efficiency and minimum requirements
- Specifications for the creation, submission and notification of the energy performance certificate
- Inspections of heating and cooling systems.

[14] 'Climate-effective building related-funding only' means that the allocated funding is effective within the category *1.A.4.a Commercial/Institutional* or *1.A.4.b Residential* solely for purpose of energy efficiency of energy consumption for space heating and hot water generation. Moreover, only subsidies for cost categories as modelled in the INVERT/EE-Lab model by (e-think, 2023) are chosen (windows/external doors, insulating materials for facade, roof, top and bottom floor ceiling, and for heating systems but excluding heat distribution or heat release appliances or cost of disposal). Thus, the amount of funding paid out by the funding body is potentially significant higher than the values taken into account for modelling.

The new elements include requirements for building technology systems, requirements for low-energy buildings and the compulsory creation of financial incentives by the Member States.

Austria has implemented the Buildings Directive and introduced several measures such as the Act on the Presentation of an Energy Performance Certificate ('Energieausweis-Vorlage-Gesetz 2012' – EAVG 2012), and the Austrian Institute of Construction (OIB) Engineering Guidelines have been adopted to maximise energy efficiency in new and existing residential buildings in Austria.

The energy certificate has to specify the thermal heating demand and the total energy efficiency factor for a particular building. When selling a building or an apartment the owner is obliged to present an energy certificate for the building. The energy certificate must not be older than 10 years and must be provided at least 14 days after the sale. It is assumed that the energy certificate influences potential buyers' decisions. It will therefore be an incentive for sellers to take measures in order to achieve a positive energy performance. A quantification of the emission reductions achieved through this measure has not been possible.

4.6.1.3 PaM N°11: Replacement of Fossil Fuels in Building Stock

GHG affected: CO_2

Type of policy instrument: regulatory, economic, information, voluntary/negotiated agreements

Status: implemented

Start year of implementation: 2006

Implementing entity: federal government, federal provinces

Mitigation impact: not available

Description

Increasing the share of renewable energy share of heating systems is the other important measure used to achieve a reduction of CO_2 emissions.

In the WEM scenario, the full implementation of Directive 2010/31/EU maintains that for buildings undergoing replacement of heating systems (alongside or without thermal renovation of the building envelope) high-efficiency alternative systems have to be considered, if available. Requirements on the renewable share support the installation of solar appliances. In the case of subsidies from the Housing Support Scheme ('Wohnbauförderung') additional funding is granted, if stronger standards than the minimum criteria for the choice of heating systems are succeeded.

In the WEM scenario, it is assumed, that the focus programme Stepping out of Oil and Gas ('Raus aus Öl und Gas') maintains higher subsidy rates until 2025 for the exchange of fossil fuel heating systems. This bonus phases out until 2040.

Awareness raising measures at national level by the Austrian Climate Protection Initiative ('klimaaktiv) and at regional level by federal provinces about the advantages of modern heating systems are expected to increase the boiler exchange rate, especially for replacement of fossil fuels.

However, the aim of replacing of all fossil fuels in building stock is not fully achieved by the measures taken into account in the WEM scenario.

- There is no obligation for replacement of existing fossil fuel heating systems with renewable heating systems taken into account.
- The installation of natural gas and gas oil heating systems in existing buildings is restricted but still applicable (continued use of fossil fuels).

Objectives *Efficiency improvements of buildings*
Efficiency improvement in services/tertiary sector
Efficiency improvement of appliances
Increase in renewable energy supply

Following the implementation of Directive 2010/31/EU in OIB Guideline 6, edition 2019 (OIB-330.6-026/19), in the case of major renovation, the technical, ecological, economic and legal feasibility of using high efficient alternative systems, if available, must be taken into account and documented.

The Housing Support Scheme ('Wohnbauförderung') provides additional subsidies for the use of heating systems which use only renewable energy sources (in particular by combining biomass fuels with solar systems), as well as the use of heat recovery systems. If – in exceptional cases – condensing gas boilers are promoted, compensatory measures such as solar thermal or photovoltaics installations are mandatory (Constitutional Art. 15a Agreement).

Subsidies of the Domestic Environmental Support Scheme ('Umweltförderung im Inland') and the Austrian Climate and Energy Fund ('Klima- und Energiefonds') for the switch of fossil fuel heating systems towards renewables are also bound to fulfillment of environmental requirements.

Support for the replacement of fossil fuel heating systems is provided under the Building Renovation Initiative for Residential Buildings ('Sanierungsoffensive für Private') within its focus programme Stepping out of Oil and Gas ('Raus aus Öl und Gas').

The District Heating and Cooling Act aims at the construction of district cooling systems in order to reduce electricity demand, as well as at the expansion of district heating networks. Subsidies are provided for that purpose.

The measures for installation of renewable heating systems are supported by various information and networking activities, such as the Austrian Climate Protection initiative ('klimaaktiv') and consultancy service, information and education campaigns by federal provinces.

OIB Guideline 6 – Energy Savings and Thermal Insulation
('OIB Richtlinie 6 – Energieeinsparung und Wärmeschutz')

Type: EU policy, national policy, regional legislation

EU legislation	National Implementation	Start
Recast of the Energy performance of buildings (Directive 2010/31/EU) and amended by the Directive 2018/844	OIB Guideline 6, edition 2019 (OIB-330.6-026/19)	2020 (depending on legislation in the federal provinces)
	National plan according to Art. 9(3) of 2010/31/EU, edition 2018 (OIB-330.6-005/18)	2018

The 2019 edition of the OIB Guideline 6 of the Austrian Institute for Constructional Engineering (released in April 2019) transposes (like its predecessors) the EU Directive on the energy performance of buildings (Directive 2010/31/ EC) into national law for both residential and non-residential buildings.

The federal provinces are responsible for translating this guideline into their respective regional laws (amending the predecessors of OIB Guideline 6, released in October 2011 and March 2015). As for heating systems, in the case of major renovation, the technical, ecological, economic and legal feasibility of using high efficient alternative systems, if available, must be taken into account and documented.

Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal – State)
(Vereinbarung gemäß Art. 15a B-VG über 'Maßnahmen im Gebäudesektor zum Zweck der Reduktion des Ausstoßes an Treibhausgasen (Bund – Länder)')

*Type: V*oluntary/negotiated agreements (amended in national and regional legislation): Federal Law Gazette I No. 19/2006.

Instruments to support renewables in existing residential buildings within the Housing Support Scheme ('Wohnbauförderung') are regulated by the Austrian 'Article 15a BV-G Agreement of the Federal Constitutional Law' between the federal government and the federal provinces. This constitutional agreement came into effect in 2006 (Federal Law Gazette II No. 19/2006, succeeded by Federal Law Gazette II No. 251/2009, last amendment: Federal Law Gazette II No. 213/2017).

District Heating and Cooling Act
('Wärme- und Kälteleitungssausbaugesetz')

Type: National legislation: Federal Law Gazette I No. 150/2021 (last amendment), Federal Law Gazette I No. 113/2008.

The District Heating and District Cooling Act (DHDC) as amended was implemented in 2009. It aims at achieving cost effective CO_2 emission reductions and enhancing energy efficiency by subsidies. The construction of district cooling systems is expected to lower the electricity demand for air conditioning and to use existing heat and waste heat potentials, especially from industries. Renewable energy sources shall be included and district heating expanded in rural areas. Further expansions in agglomerations will be triggered.

Funding Programmes for Replacement of Fossil Heating Systems
('Förderprogramme für den Austausch fossiler Heizsysteme')

Type: national policy

EU legislation	National Implementation	Start
Recast of the Energy performance of buildings (Directive 2010/31/EU) and amended by the Directive 2018/844	Federal Law Gazette I No. 202/2021 (last amendment considered in WEM scenario)	2021
	Federal Law Gazette I No. 185/1993	1993

In the WEM scenario it has been assumed that the following funding and national programmes will be continued in order to support renewable heating systems in existing buildings:

- Domestic Environmental Support Scheme ('Umweltförderung im Inland')
- Housing Support Scheme ('Wohnbauförderung')
- Austrian Climate and Energy Fund ('Klima- und Energiefonds')
- Stepping out of Oil and Gas ('Raus aus Öl und Gas') as focus programme of the Building Renovation Initiative for Residential Buildings ('Sanierungsoffensive für Private')
- Austrian Climate Protection Initiative ('klimaaktiv'):
  - e5-communities: consultancy for communities to promote climate policies
  - energy saving: education, information and advice for consumers and commercial enterprises to reduce energy consumption
  - renewable energy: provide know-how and support networking for committed companies and associations
- Renovation of federal buildings (federal real-estate property)
- Consultancy service and information campaigns

Funding for the replacement of fossil heating systems is provided under all relevant funding programmes of the federal government and the federal provinces.

The Building Renovation Initiative for Residential Buildings ('Sanierungsoffensive für Private') is an incentive of the federal government that was launched in 2011 to promote the renovation of private buildings with special emphasis on the replacement of fossil heating systems. It is planned to remain in place for private households in 2022 and beyond.

- Financial support under the focus programme Stepping out of Oil and Gas ('Raus aus Öl und Gas') is available for the replacement of a fossil heating system (oil, gas, coal/coke all-purpose burner and electricity-powered night or direct storage heaters) with climate-friendly technology in private residential buildings.
- Climate friendly technologies are the connection to local district heating, biomass boilers (wood log and wood briquettes, wood chips, wood pellets) and heat pumps. All installed new systems have to be high efficient and environmentally friendly (according to list of eligible appliances).
- Additional subsidies are granted for centralising of heating systems in multi-storey residential buildings and for installation of solar thermal.
- The initiative is aimed at owners and tenants of rented apartments in multi-storey buildings and detached/semi-detached family houses.

In the WEM scenario it is assumed that annually climate-effective funds provided for replacement of heating systems w/o new buildings (building related funding only)[15] at real € 2020 prices will drop by 13% until 2025, by 21% until 2030, by 34% until 2035, by 66% until 2040, by 90% until 2045 and by 94% until 2050 (compared to 2021). From 2021 until 2030, nominal funding budgets are set constant at the level of 2021. After 2030, funding is set to be further decline in the WEM scenario (see Table 16).

Table 16: Budget of funding programmes for replacement of heating systems (w/o new buildings).

Budget, real [Mio. € 2020]	**2021**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Commercial/Institutional buildings	10	9.0	8.2	6.8	3.5	1.0	0.6
Residential buildings	154	134	121	102	53	15	9.1
Total	**164**	**143**	**130**	**109**	**56**	**16**	**9.7**

[15] 'Climate-effective building related-funding only' means that the allocated funding is effective within the category *1.A.4.a Commercial/Institutional* or *1.A.4.b Residential* solely for purpose of supporting renewable heating systems and energy efficiency of energy consumption for space heating and hot water generation. Moreover, only subsidies for cost categories as modelled in the INVERT/EE-Lab model by (e-think, 2023) are chosen (windows/external doors, insulating materials for facade, roof, top and bottom floor ceiling, and for heating systems but excluding heat distribution or heat release appliances or cost of disposal). Thus, the amount of funding paid out by the funding body is potentially significant higher than the values taken into account for modelling.

All subsidies for heating systems of new buildings are considered in chapter 4.6.1.1 (PaM N°9: Climate Neutral New Buildings) above.

All subsidies for renovation of the building envelope in existing buildings (alongside or without exchange of the heating system) are considered in chapter 4.6.1.2 (PaM N°10: Thermal Improvement of Building Stock) above.

4.6.1.4 PaM N°12: Energy Efficiency Measures in Buildings

GHG affected CO_2, CH_4

Type of policy instrument: regulatory, information

Status: implemented

Start year of implementation: 2007

Implementing entity: federal government, federal provinces

Mitigation impact: not available

Description

An increase in energy efficiency in electricity demand in buildings is a further policy target which is to be achieved by far-reaching instruments at EU level. Especially the eco-design requirements (Directive 2005/32/EC) for energy-using products and mandatory labelling of household appliances according to their energy consumption (see instrument Energy Labelling of Space and Water Heating Products below), supported by awareness raising measures at national level to inform people of energy efficient products, and advice provided by regional energy agencies are included here.

Objectives

Efficiency improvements of buildings
Efficiency improvement of appliances
Efficiency improvement in services/tertiary sector

In implementation of Directive 2005/32/EC, the national Eco-design Ordinance *('Ökodesign-Verordnung 2007 – ODV 2007)* set the legal basis for minimum standards for energy-related products. These ecodesign requirements are defined by several Commission Regulations (EU), such as for space heaters and combination heaters, water heaters and hot water storage tanks, solid fuel local space heaters, local space heaters and for solid fuel boilers. The use of white goods of high-efficiency in exchange for old household appliances is promoted.

Energy efficiency measures in buildings provided by the federal provinces include hydraulic balancing of the heat distribution, the optimization of technical building appliances, energy consulting and elaboration of renovation concepts.

In the WEM scenario this is reflected by assuming higher overall efficiency of new heating systems and to some extent lower CH_4-emissions of new combustion technologies (if applicable ecodesign requirements are more stringent than national policy).

Eco-design Ordinance
('Ökodesign-Verordnung 2007 – ODV 2007)

Type: EU policy

EU legislation	National Implementation	Start
Eco-design Directive 2012/27/EU (amending 2009/125/EC)	Federal Law Gazette II No. 187/2011 (Amendment)	2011
	Federal Law Gazette II No. 126/2007	2007

The Eco-design Ordinance transposes the EU Eco-design Directive 2009/125/EC into national law. It consists of minimum eco-design requirements for specific energy-using products. These products are marked with the CE label and have to meet the minimum requirements defined in the EU Directive.

In product design, environmental impacts (resource use and energy consumption, emissions and recyclability) and safety-related requirements must be considered, as well as the whole product life cycle, from the choice of raw materials until final waste disposal.

During the first phase of the implementation of the Eco-design Directive primarily consumer products (household appliances) were affected. The amended Directive extends the scope to services and industries, such as heating systems, ventilation and air conditioning, machines, pumps and transformers.

Energy Labelling of Space and Water Heating Products
('Elektrotechnikgesetz 1992')

Type: EU policy

EU legislation	National Implementation	Start
Regulation (EU) 2017/1369 setting a framework for energy labelling and repealing Directive 2010/30/EU (repealing Directive 2010/30/EU)	Federal Law Gazette I No. 204/2022 (repealing Federal Law Gazette II No. 232/2011)	2022
Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products	Federal Law Gazette II No. 232/2011	2011

The former Directive 2010/30/EU included the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products. It was implemented in Austria in 2011 (Federal Law Gazette II No. 232/2011). It specified different energy classes, starting from A+++ (the best class) to D (the poorest performance class). As with the new Eco-design Regulation (EU) 2017/1369, the scope has been expanded to include a larger group of energy-consuming products.

Regulation (EU) 2017/1369 (repealing Directive 2010/30/EU) sets a framework for energy labelling with a new scope for the energy classes (A to G). National market surveillance and control of products has been included in the Electrical Engineering Act (*'Elektrotechnikgesetz 1992'*) repealing former legislation.

Energy labelling of space and water heating products and of other energy-using products helps consumers to compare products in terms of their energy consumption. Specific electricity use requirements have been established for the following products: dishwashers, refrigerators, freezers, washing machines, televisions, room air conditioning appliances, laundry dryers, vacuum cleaners, space and combination heaters, water heaters and electric lamps.

Funding Programmes for Energy Efficiency Measures in Buildings
('Förderprogramme für Energieeffizienzmaßnahmen in Geböuden')

Type: national policy, information

EU legislation	National Implementation	Start
Recast of the Energy performance of buildings (Directive 2010/31/EU) and amended by the Directive 2018/844	Federal Law Gazette I No. 202/2021 (last amendment considered in WEM scenario)	2021
	Federal Law Gazette I No. 185/1993	1993

In the WEM scenario it has been assumed that the following funding and national programmes will be continued in order to improve the energy efficiency of existing buildings:

- Domestic Environmental Support Scheme ('Umweltförderung im Inland')
- Austrian Climate Protection Initiative ('klimaaktiv'):
  - e5-communities: consultancy for communities to promote climate policies
  - energy saving: education, information and advice for consumers and commercial enterprises to reduce energy consumption
  - renewable energy: provide know-how and support networking for committed companies and associations
- Consultancy service and information campaigns

All subsidies for renovation of the building envelope in existing buildings (alongside or without exchange of the heating system) are considered in chapter 4.6.1.2 (4.6.1.2 PaM N°10: Thermal Improvement of Building Stock) above.

Funding for energy efficiency measures in buildings is provided under all relevant funding programmes of the federal government and the federal provinces.

4.7 Fugitive Emissions from Fuels (CRF Source Category 1.B)

It is assumed that no specific measures will be implemented in this sector.

4.8 Industrial Processes and Product Use (CRF Source Category 2)

The measures listed here are only aimed at F gas emissions and emissions from product use, as other measures relevant for the industry sector are covered in the energy sector. These measures focus on energy efficiency and the use of renewable energy sources, which also affect GHG emissions from industrial processes.

4.8.1 WEM measures for industrial processes and product Use

4.8.1.1 PaM N°13: Decrease emissions from F gases and other product use

A considerable decrease in emissions from F gases and other product use is the target to be achieved in this sector. National bans[16] on certain uses have been in force since 2002: the use of SF_6 is prohibited for most applications, the use of HFCs and PFCs is banned e.g. in the production of foam materials. National regulations were complemented by EU law at a later stage: provisions for the maintenance of refrigeration and air conditioning systems aim at a minimisation of emissions; the use of refrigerants with GWPs higher than 150 in the air conditioning systems of new passenger car models has been prohibited since 2013, and since 2017 refrigerants with a GWP higher than 150 are banned in all new cars. In 2014, a revised EU F gas Regulation came into effect, aiming at reducing the amount of F gases from 2030 onwards to 21% of the average amount of refrigerants used in the European Union between 2009–2012 (in CO_2 eq). The quota applies to refrigerants only, and does not affect semiconductor manufacturing, electrical equipment, or medical aerosols. In 2016 the Kigali Amendment to the Montreal Protocol was adopted, and signed by Austria and the EU in 2018. This amendment foresees a global phase-down of HFCs, which will mean that developed countries will have to phase-down HFCs placed on the market by -83% compared to the total used in 2019/2020 after 2035. The EU F

[16] Due to the 2014 EU F-Gas regulation, the Austrian ordinance became obsolete and was repealed in 2022.

gas Regulation is currently under review, and it can be expected that these provisions will be added. However, until then, we are referring to the Kigali Amendment as it has been available up to now.

GHG affected: HFCs, PFCs and SF_6

Type of policy: regulatory

Implementing entity: federal government

Mitigation impact: not available

The instruments listed below have been taken into account in the current scenario.

Quota system for the production and import of F gases
('Umsetzung der EU-F-Gas-Verordnung 2014')

Type: EU policy (EU Regulation No 517/2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006)

The EU Regulation aims at reducing F gases by prohibiting certain F gases with high GWPs, and controlling the production and imports of other F gases in the European Union. Aspects of Regulation No 842/2006 regarding the reduction of leakage rates and the training of staff have been implemented. The Regulation includes a number of provisions to reduce emissions such as the regular servicing and maintenance of refrigeration and air conditioning equipment, recovery of equipment containing F gases, training and certification of personnel involved in the installation, servicing and maintenance of equipment and systems; reporting on imports, exports and the production of F gases, as well as the labelling of products containing F gases and a ban on the use of SF_6 in magnesium die casting effective from 1 January 2008, except where the quantity used is below 850 kg per year, and a ban on the use of SF_6 for the filling of tyres (effective from July 2007).

The amendment also deals with the placing on the market of F gases and the control of their use: from 1 January 2020 onwards the use of fluorinated gases with a global warming potential of 2 500 or more to service or maintain refrigeration equipment with a charge size of 40 tonnes of CO_2 equivalent or more will be prohibited (for certain categories, this rule will not apply before 2030, recycled uses will be permitted). For the placing on the market, as well as for imports and production, a quota system will be applied. The maximum quantity of F gases imported or produced in the EU will be controlled by applying the following percentages (annual average of the total quantity placed on the market in the European Union) from 2009–2012 (expressed in t of CO_2 equivalent): 2015: 100%; 2016–17: 63%; 2018–20: 63%; 2021–23: 45%; 2024–26: 31%; 2027–29: 24%; 2030: 21%. Only certain uses, e.g. for military equipment, etching for semiconductor material, and medical aerosols, will qualify for an exemption.

Quantification/Projected GHG emissions/removals:

A quantification of the reduction potential is not available.

Reducing HFC emissions from air conditioning in motor vehicles
('Verringerung von HFC Emissionen durch Klimaanlagen von Kraftfahrzeugen')

Type: EU policy

EU legislation	National Implementation	Start
HFCs in mobile air conditioning systems – Directive 2006/40/EC	Federal Law Gazette I No. 275/2007 (amendment)	2007
	Federal Law Gazette No. 267/1967	

According to the EU Directive on HFCs in mobile air conditioning units, car manufacturers are no longer allowed to use refrigerants with a GWP (global warming potential) higher than 150 in new passenger car models placed on the market. This affects the period from 2013 onwards. From 2017 onwards, the use of refrigerants with a GWP higher than 150 is prohibited.

The objective is to phase out refrigerants with a high GWP in passenger cars and light duty vehicles.

Quantification/Projected GHG emissions/removals:

A quantification of the reduction potential is not available.

Limitation of VOC emissions from the use of organic solvents in industrial installations
('Begrenzung der Emissionen bei der Verwendung organischer Lösungsmittel in gewerblichen Betriebsanlagen')

Type: EU and national policy

EU legislation	National Implementation	Start
Industrial Emissions Directive 1999/13/EC	Federal Law Gazette II No. 301/2002	2002
	Federal Law Gazette II No. 42/2005 (amendment)	2005
	Federal Law Gazette II No. 77/2010 (amendment)	2010

Emissions of volatile organic compounds from the use of organic solvents in certain industrial installations and commercial enterprises fall within the scope of the Industrial Emissions Directive. The operators are obliged to comply with regulations concerning emission limits. For this reason, regular measurement and reporting is necessary. An annual solvent report has to be submitted to the district authorities.

The Austrian Ordinance on VOC emissions further includes guidelines for the reduction of emissions.

4.9 Agriculture (CRF Source Category 3)

4.9.1 WEM measures for agriculture

4.9.1.1 PaM N°14: Implementation of EU agricultural policies

Agricultural policy according to CAP-SP as implemented in 2023. This includes the agri-environmental programme and the subsidies for climate relevant investments.

GHG affected: CO_2, CH_4, N_2O

Type: EU policy

Status: implemented

Start year of implementation: 2023

Implementing entity: federal government

Mitigation impact: not available

EU legislation	National Implementation	Start
REGULATION (EU) 2021/2115 CAP Strategic Plans	implemented	2023

Austria's CAP Strategic Plan (CAP-SP) 2023-2027 was approved in September 2022. Under the Austrian GAP-SP (BML, 2022), a total of 98 interventions are jointly programmed and implemented. For more information please refer to Chapter 3.3.1).

The implementation of this policy includes e.g. improvements in feeding, the covering of manure storages, low-loss application of manure and biogas slurry, promotion of organic farming, promotion of grazing, reduced usage of mineral fertilisers.

4.10 Land use, Land-Use Change and Forestry (CRF Source Category 4)

For the LULUCF WEM scenario no other measures since the last projection submission were taken into account.

4.10.1 WEM measures for LULUCF

Several of the measures attributed to other sectors influence emissions/removals in the LULUCF sector as well. In the following, measures from the agriculture and energy sector are listed which also affect carbon stocks in the LULUCF sector.

Agriculture

The main sector which overlaps with LULUCF is the agriculture sector. Measures taken in this sector directly and indirectly contribute to carbon stock changes. In this context, the most relevant measure is Austria's CAP Strategic Plan(see PAM N°22) for the period 2023-2027, including several measures that promote the enhancement of carbon stocks in the agricultural environment (e.g. reduced tillage, organic farming), especially in soils.

Energy

There are several other cross-cutting and mainly energy-related measures listed in the Austrian LULUCF Action Plan which are relevant for the LULUCF sector, such as:

- EU Emission Trading Scheme (ETS) (see 4.3.1 PAM N°1)
- Domestic Environmental Support Scheme (see 4.3.2 PAM N°2)
- Austrian Climate and Energy Fund (KLI.EN) (see **Fehler! Verweisquelle konnte nicht gefunden werden.** PAM N°3)
- Replacement of Fossil Fuels in Building Stock (see 4.6.1.3 PAM N°11)
- Increase the share of clean energy sources in road transport (see 4.5.1.1 PAM N°6)

These measures aim at increasing the share of renewable energy sources such as biomass and switching to fuels with a lower (fossil) carbon content, which primarily affects the emissions in the energy industries sector, as well as in the housing and transport sector, but also has indirect impacts on LULUCF.

4.10.1.1 PaM N°15: Sustainable Forest Management

Type of policy: regulatory

Implementing entity: federal government, federal provinces

Mitigation impact: not available

The overall principles of forest management in Austria are stipulated in the Forest Act (Federal Law Gazette I No. 1975/440, as amended), section 1: preservation of forest area, preservation of the productivity of forest sites and their functions, and the preservation of yields for future generations; i.e. sustainable management. The Forest Act furthermore assigns four functions to forests: productive (i.e. sustainable timber production), protective (i.e. protection against erosion and natural hazards, welfare (i.e. the protection of environmental goods such as drinking water), and recreation (use for recreation).

With the Forest Act providing the regulatory basis for forest management in Austria, a wide range of forest-related measures are regulated or triggered by it, all of which are clustered together in this PAM and listed in the following:

- Guiding Principles of Forest Management
- General ban on forest clearance/deforestation
- General ban on forest destruction
- Immediate re/afforestation after felling
- Ban on forest litter removal
- Forest protection (from fires and pests)
- Provisions for harvest haulage & forest roads
- Sustainable use of forests
- Austrian Forest Dialogue
- Forest cooperatives
- Task Force Renewable Energy
- Protection of wetlands

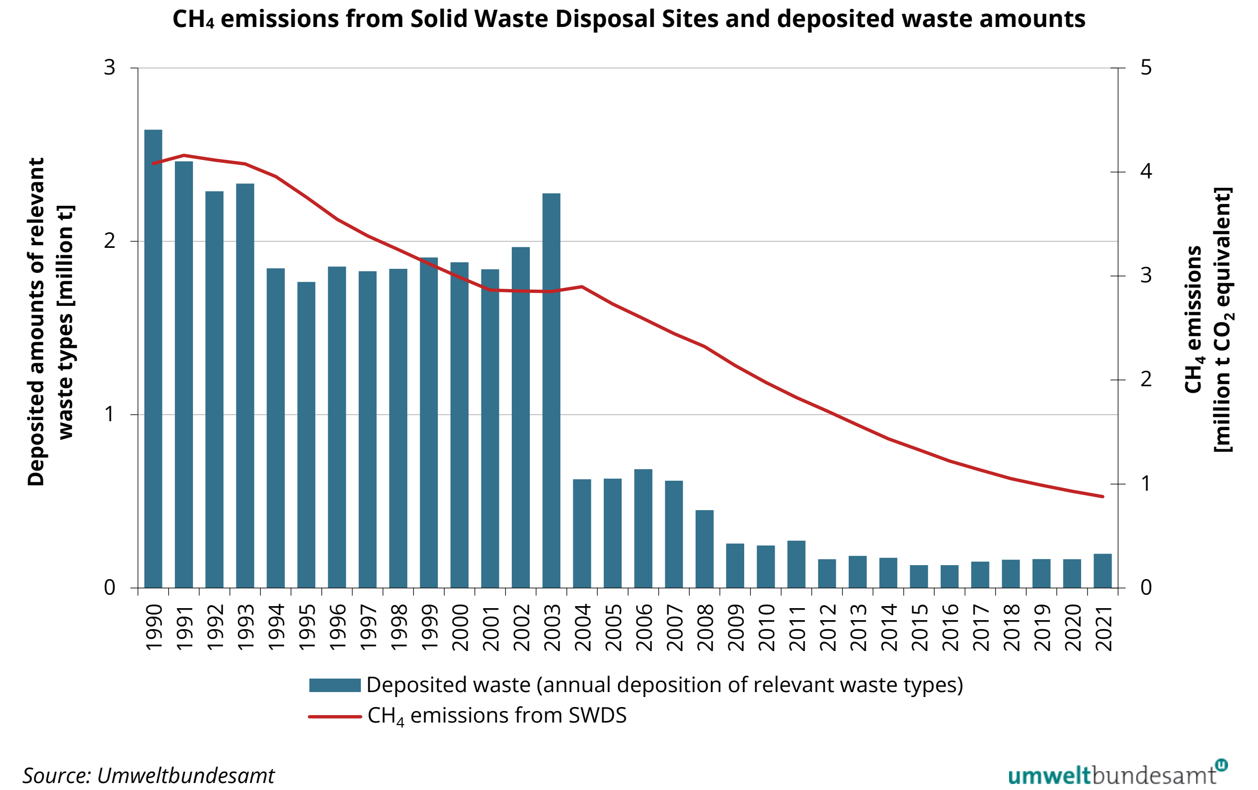
These measures are explained in more detail in the Austrian LULUCF Action Plan (see BMLFUW 2015b).

A LULUCF-specific quantification cannot be given for the PAMs listed above due to a lack of data and because of overlapping activities.

4.11 Waste (CRF Source Category 5)

In the WEM scenario for waste, the decreasing trend in the amounts of deposited waste (and the respective carbon content) is expected to continue, mainly as a result of the requirements of the Landfill Ordinance, but also because waste incineration and other forms of treatment are becoming more important. The indicator ‘annually deposited waste/CH_4 emissions’ also shows this trend (see the Figure 34 below).

Figure 26: Methane emissions from landfills and annually deposited waste with relevant organic carbon content.



4.11.1 WEM measures for waste

This chapter lists the WEM measures relevant for the waste sector. The main objective of these measures is to reduce CH_4 emissions from waste treatment. Separate quantifications of the reduction potentials are not possible, but the overall effect is included in the “with existing measures” scenario. Largest reductions are expected in category solid waste disposal, where emissions further decrease from 878 kt CO_2e in 2021 to 490 kt CO_2e in 2035 and 366 kt CO_2e in 2050.

4.11.1.1 PaM N°16: Reduce emissions from landfill sites

GHG affected: CH_4

Type of policy instrument: regulatory

Status: implemented

Start year of implementation: 1995

Implementing entity: federal government, federal provinces

Mitigation impact: not available

Description:

Type: EU policy, national policy

EU legislation	National Implementation	Start
EU Waste Framework Directive (2008/98/EC) – Source separation of biowaste	Federal Law Gazette No. 68/1992, as amended 456/1994 (Ordinance on the separate collection of biogenic waste)	1995
EU Landfill Directive (1999/31/EC)	Federal Law Gazette No. 164/1996, Federal Law Gazette II No. 39/2008 (Ordinance on landfills)	1997 / 2008

The Austrian Landfill Ordinance is the most effective instrument for reducing emissions in the waste sector. Based on this Ordinance, no untreated biodegradable waste has been allowed on landfills since 2004, with no exemptions since 2008. To reduce the carbon content of waste prior to landfilling, beside source separation of biowaste, incineration and mechanical-biological treatment (pre-treatment options) of mixed municipal waste have increasingly been applied in Austria. Since 1992 source separation of biowaste for subsequent recycling is obligatory in Austria according to the Federal Law Gazette No 68/1992 (as amended 1994).

Furthermore, emissions from mass landfills are limited by the collection and use of landfill gas as required by the Landfill Ordinance. Provisions as stipulated in the Landfill Ordinance 2008 focus on (1) managing the water balance and the aerobic in-situ stabilisation of closed landfills and (2) increasing efforts to collect landfill gas (e.g. through detection of leakages, examination of gas collection systems).

Quantification/Projected GHG emissions/removals:

For a quantification of this instrument several assumptions would need to be made, leading to a high level of uncertainty. Surveys of gas collection systems conducted in 2014 (UMWELTBUNDESAMT 2014) and 2019 (UMWELTBUNDESAMT 2019b) showed that the measures described can lead to higher amounts of landfill gas collected at least at some landfills. However, no future trend for gas collection rates can be derived from these studies. The upcoming study on the gas collection systems will cover the period 2017 to 2021 and will be published end of 2023.

4.11.1.2 PaM N°17: Strengthen waste prevention & increase recycling

GHG affected: CH_4

Type of policy instrument: regulatory

Status: implemented

Start year of implementation: see Type: EU policy, national policy

Implementing entity: federal government, federal provinces

Mitigation impact: not available

Description:

Waste prevention is one crucial instrument to reduce future emissions. To achieve this, projects, awareness raising campaigns and networks (e.g. '*Lebensmittel sind kostbar*' i.e. 'Food is prescious' and "United against waste') have been established to minimise food waste and to promote the re-use of waste (see also Austrian Waste Prevention Programme 2023 in (BMK 2023)).

Moreover, the EU Single-Use Plastics (SUP) Directive as well as the EU Packaging and Packaging Waste Directive aim to reduce the amounts of plastic packaging waste and sets measures to increase recycling. In addition, the EU Waste Framework Directive sets targets to recycle total municipal waste. In Austria a ban on the marketing of plastic carrier bags to reduce waste volumes has already been imposed.

Type: EU policy, national policy

EU legislation	National Implementation	Start
EU Waste Framework Directive (2008/98/EC) – Recycling of total municipal waste	Federal Law Gazette No. 102/2002, as amended by Federal Law Gazette No 200/2021[17] ("Waste Management Act"/"AWG")	2008
EU Single-Use Plastics (SUP) Directive (2019/904/EC)	Federal Law Gazette No. 102/2002, as amended by Federal Law Gazette No 200/2021[17] ("Waste Management Act/"AWG")	2022
EU Packaging and Packaging Waste Directive (94/62/EC)	Federal Law Gazette II No. 184/2014, as amended by Federal Law Gazette II No. 597/2021 ("Packaging Ordinance")	2015

Quantification/Projected GHG emissions/removals:

A quantification on the effects of these waste prevention measures cannot be made. On the one hand because of the uncertain effect on the total waste volume, on the other hand because of the parallel effects in various disposal and recovery treatment routes (incineration, MBT, composting, biogas plants), which are also partly interconnected (e.g. landfilling of residues from MBTs).

However, a certain reduction effect is assumed in the projections by decoupling population growth and waste generation: While current population forecasts assume a growth of 3.2% by 2030 (compared to 2021), in the projections a constant amount of treated and landfilled waste is considered (refer to chapter 3.5).

[17] „AWG"-amendment Circular Economy Package

4.11.1.3 PaM N°18: Reduce emissions from biological treatment by implementing BAT in the waste treatment process

GHG affected: CH_4, N_2O

Type of policy instrument: regulatory

Status: implemented

Start year of implementation: see Type: EU policy, national policy

Implementing entity: federal government, federal provinces

Mitigation impact: not available

Description:

Emissions from the aerobic treatment of biogenic waste can be limited by a comprehensive implementation of the requirements stipulated in the "State of the Art of Composting". Besides, the EU report on the best available techniques (BREF Waste Treatment – JRC 2018) provides guidance to prevent emissions from aerobic and anaerobic treatment processes for IED installations. Related legally binding requirements to be transposed into the permits of the installations are published by EU Implementing Decision 2018/1147.

Type: EU policy, national policy

EU legislation	National Implementation	Start
EU Implementing Decision establishing BAT conclusions for waste treatment (2018/1147)	No national transposition required	2018
-	Guideline on the State of the Art of Composting	2009

Quantification/Projected GHG emissions/removals:

A separate quantification cannot be made. The emission factors used in the Austrian greenhouse gas inventory (Umweltbundesamt 2023) for aerobic waste treatment already correspond to the state of the art (Amlinger 2005). A reference scenario is not available.

Regarding anaerobic treatment in biogas plants, declining emissions are assumed by applying the best available techniques, taken into account an increased utilisation of gas-tight covers for storage facilities.

5 SCENARIO DEFINITION

For the submission in March only one scenario "with existing measures" was modelled, which includes all measures implemented by 1 January 2022. Later in the year also a scenario "with additional measures" will be available. This scenario will includes planned policies and measures which were reported under the National Air Pollution Control Programme and in the Integrated National Energy and Climate Plan for Austria.

The following tables summarise the policies and measures and their instruments for both scenarios. Details can be found in Chapter 4 and are provided in the reporting table according to Implementing Regulation (EU) No 1208/2020, which has been submitted together with this report.

5.1 Scenario "with existing measures"

Table 17: PAMs included in the scenario "with existing measures"

CRF	Policies & Measures
Measures affecting more than one sector	No. 1. EU Emission Trading Scheme (ETS) No. 2. Domestic Environmental Support Scheme No. 3 Austrian Climate and Energy Fund
1.A.1 Energy industries and 1.A.2 Manufacturing Industries and Construction	No°4: Increase the share of renewable energy • in power supply and district heating • Renewable Energy Expansion Act ('Erneuerbaren-Ausbau-Gesetz') No°5: Increase energy efficiency in energy and manufacturing industries • Energy Efficiency Act
1.A.3 Transport	No°6: Increase the share of renewable energy sources in road transport • Implementation of Directive 2009/28/EC on the promotion of the use of energy from renewable sources • EU CO2 reduction targets for PC, LDV and HDV No°7: Increase fuel efficiency in road transport • Air quality induced speed limits • Eco Driving initiative • Fuel tax increase in 2011 • Greening the truck toll No°8: Modal shift in passenger and freight transport

CRF	Policies & Measures
	• klimaaktiv mobil' initiative - Mobility management and awareness • Federal Austrian Railway Framework Plan 2022 – 2027 - passengers • Nationwide and Regional public transport ticket • Federal Austrian Railways Framework Plan 2022 – 2027 – freight • Action Plan Danube until 2022
1.A.4 & 1.A.5 Other Sectors (Residential, Commercial, Agriculture and Other)	No°9: Climate Neutral New Buildings • •OIB Guideline 6 – Energy Savings and Thermal Insulation • •Oil Boiler Installation Prohibition Act • •Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal – State) • •Funding Programmes for New Buildings No°10: Thermal Improvement of Building Stock • •OIB Guideline 6 – Energy Savings and Thermal Insulation • •Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal – State) • •Funding Programmes for Existing Buildings • •Act on the Presentation of an Energy Performance Certificate No°11: Replacement of Fossil Fuels in Building Stock • •OIB Guideline 6 – Energy Savings and Thermal Insulation • •Constitutional Art. 15a Agreement on Measures in the Building Sector to reduce Greenhouse Gas Emissions (Federal – State) • •District Heating and Cooling Act • •Funding Programmes for Replacement of Fossil Heating Systems No°12: Energy Efficiency Measures in Buildings • Eco-design Ordinance • Energy Labelling of Space and Water Heating Products • Funding Programmes for Energy Efficiency Measures in Buildings

CRF	Policies & Measures
1.B Fugitive Emissions from fuels	No policies and measures.
2 Industrial Processes and solvent use	No°13: Decrease emissions from F gases and other product use • Quota system for the production and import of F gases • Reducing HFC emissions from air conditioning in motor vehicles • Limitation of VOC emissions from the use of organic solvents in industrial installations
3 Agriculture	No. 14: Implementation of EU agricultural policies • Common Agricultural Policy (CAP)
4 LULUCF	No. 15 Sustainable Forest Management
5 Waste	N°16: Reduce emissions from landfill sites N°17: Strengthen waste prevention & increase recycling N°18: Reduce emissions from biological treatment by implementing BAT in the waste treatment process

6 CHANGES WITH RESPECT TO SUBMISSION 2021

According to Article 18 (3) of Regulation 2018/1999/EU, Member States shall communicate any substantial changes to the information reported pursuant to this Article during the first year of the reporting period, by 15 March of the year following the previous report.

Changes with respect to the previous GHG emission projections of 2021 (UMWELTBUNDESAMT 2021a) are influenced by four main factors:

1. Changes in the underlying data (e.g. GHG inventory, energy balance)
2. Update of new emission factors
3. Changes in assumptions for activity scenarios have changed.
4. These changes can be triggered by revised economic or technical scenarios, additional policies and measures and revisions of policies or measures due to amendments to legal texts.
5. Changes in the models used for activity or emission scenario
6. Update of global warming potentials (GWP) from AR4[18] to AR5[19].

The following tables show a comparison of past trends and scenarios for national emission totals and by sector.

Table 18: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – national totals (in kt CO_2e), (Umweltbundesamt).

Total – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	78 171	92 916	85 237	86 096	87 333	89 098	90 847		
Projections 2013	78 162	92 880	84 594	82 444	81 640	82 764	84 039		
Projections 2015	78 683	92 496	84 788	79 737	79 067	76 779	75 957	75 677	
Projections 2017	78 805	92 642	85 059	78 851	75 393	72 724	69 767	67 274	
Projections 2019	78 670	92 567	84 753	78 897	79 669	76 637	73 961	72 298	
Projections 2021	78 420	92 147	84 337	78 462	76 885	75 232	72 540	70 719	69 329
Projections 2023	79 047	92 589	84 693	78 884	73 911	73 358	67 809	62 620	59 044
Difference 2023/21	+627	+441	+357	+422	-2 975	-1 873	-4 730	-8 099	-10 284

[18] https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter2-1.pdf (Table 2.14)

[19] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf (Table 8.A.1)

6.1 Energy Industries (1.A.1)

Table 19: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – Energy Industries (in kt CO_2e), (Umweltbundesamt).

1.A.1 – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	13 842	16 184	12 605	10 671	10 910	12 005	12 842		
Projections 2013	13 842	16 359	14 293	12 301	11 416	12 155	12 815		
Projections 2015	13 842	16 364	14 150	10 362	9 896	8 635	8 348	9 362	
Projections 2017	13 838	16 240	13 988	10 928	8 943	8 335	8 081	7 597	
Projections 2019	14 100	16 397	14 028	10 792	9 873	8 169	7 311	6 824	
Projections 2021	14 011	16 032	13 756	10 511	9 873	8 169	7 311	6 824	6 470
Projections 2023	14 008	16 026	13 747	10 502	8 800	8 097	6 467	5 940	5 706
Difference 2023/21	-4	-6	-9	-9	-1 073	-72	-844	-884	-764

Revisions up to the year 2021 are mainly due to updates of the national energy balance. For the 2021 projections the energy balance with data up to 2019 was used, whereas for the 2023 projections the energy balance with data up to 2021 was used. A significant decrease in energy consumption was caused by the COVID-crisis from 2020 to 2022. In the energy industries the decommissioning of coal based plants took place sooner than expected, therefore emissions have decreased.

6.2 Manufacturing Industries and Construction (1.A.2) & Industrial Processes & Product Use (2)

Table 20: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – Manufacturing Industries and Construction & Industrial Processes & Product Use (in kt CO_2e), (Umweltbundesamt).

1.A.2 & 2 – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	23 395	27 156	27 436	29 910	32 040	34 189	36 536		
Projections 2013	23 394	27 536	26 626	26 214	27 284	28 747	30 426		
Projections 2015	23 475	27 458	27 386	26 966	27 786	28 284	28 949	28 750	
Projections 2017	23 553	27 408	27 470	27 144	26 189	25 791	25 242	25 337	
Projections 2019	23 562	27 308	27 322	27 058	27 588	27 029	26 796	27 058	
Projections 2021	23 416	27 008	27 044	26 780	25 177	25 962	25 693	25 792	26 044
Projections 2023	23 225	27 013	27 123	27 004	26 046	27 222	26 856	26 927	27 149
Difference 2023/21	-191	+5	+79	+224	+869	+1 260	+1 163	+1 135	+1 105

1A2 & 2 Processes

Changes to the report of 2021 are mainly due to the fact the previous projects overestimated the decrease of industrial emissions. Even in the prime year of the Covid-crisis, 2020, the emissions have proven to be higher than in the projections. Additional changes are due to the use of the new energy balance (1990–2021).

2 F gases

Table 21: Comparison of projections 2011, 2013, 2015, 2017, 2019 and 2021 – CRF 2 F-gases (in kt CO2e), (Umweltbundesamt).

2 F gases – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	1 600	1 628	1 713	1 734	1 738	1 785	1 804		
Projections 2013	1 600	1 628	1 575	1 501	1 494	1 514	1 533		
Projections 2015	1 656	1 825	1 900	2 135	2 302	1 938	1 606	1 568	
Projections 2017	1 656	1 831	1 901	2 034	1 975	1 468	881	751	
Projections 2019	1 656	1 833	1 904	1 988	1 871	1 327	856	735	
Projections 2021	1 656	1 764	1 761	2 053	2 227	1 441	908	864	847
Projections 2023	1 550	1 789	1 846	2 273	2 198	1 532	896	798	806
Difference 2023/21	-106	+25	+85	+220	-30	+91	-12	-66	-40

The calculation model for F gases is improved regularly, whenever new information becomes available. The changes made between the 2015 projections and later projections are mostly due to the fact that the calculation model for stationary air conditioning has undergone major improvements, and is continuously improved. Furthermore, projection scenarios before 2015 were not based on the EU F gas Regulation or on information on new technologies, which became available at a later date. The difference between the 2021 and 2023 projections is due to several improvements of the FC inventory, particularly a more accurate allocation of refrigerant consumption to the different sub sectors, especially in stationary refrigeration and air conditioning.

6.3 Transport (CRF Source Category 1.A.3)

Table 22: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – Transport (in kt CO_2 eq) (Umweltbundesamt).

1.A.3 – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	14 010	24 981	23 308	24 850	24 872	24 684	24 513		
Projections 2013	14 030	25 040	22 452	23 695	23 800	23 931	23 965		
Projections 2015	13 974	24 939	22 379	23 169	23 267	23 261	23 042	22 594	
Projections 2017	13 976	24 934	22 529	22 587	22 708	22 461	21 466	20 228	
Projections 2019	13.975	24.944	22.568	22.676	24.478	24.529	23.669	22.859	
Projections 2021	13 957	24 944	22 585	22 726	24 555	24 605	23 743	22 933	22 095
Projections 2023	13 952	24 928	22 567	22 702	21 156	21 724	19 413	15 337	12 318
Difference 2023/21	-5	-15	-18	-24	-3 400	-2 881	-4 330	-7 596	-9 777

For the year 2020 the difference between the 2021 and 2023 projections is due to the slump in activities caused by the pandemia. The 2021 submission for the transport sector included a modelling result which was already estimated before 2020. The differences in the years 2025 to 2040 are due to a revision of the share of BEVs in new car registrations and following the reduced amount of fossil fuels needed, which was much more conservative in the old projection.

6.4 Other Sectors (CRF Source Category 1.A.4 & 1.A.5)

Table 23: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – Other Energy Sectors (in kt CO_2 eq), (Umweltbundesamt).

1.A.4 & 1.A.5 – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	14 468	14 435	12 089	11 173	10 244	9 161	8 067		
Projections 2013	14 441	13 748	11 448	10 648	9 710	8 678	7 705		
Projections 2015	14 507	13 742	11 506	10 292	9 305	7 966	7 095	6 401	
Projections 2017	14 622	13 684	11 298	8 892	8 436	7 344	6 384	5 518	
Projections 2019	14 269	13 651	11 106	9 061	8 579	7 978	7 364	6 800	
Projections 2021	14 289	13 915	11 263	9 196	8 579	7 978	7 364	6 800	6 340
Projections 2023	14 322	13 928	11 276	9 199	9 098	8 019	7 419	6 820	6 329
Difference 2023/21	+33	+13	+13	+3	+518	+41	+55	+20	-12

The changes to the submission in 2021 are predominantly due to an update of projections using the INVERT/EE-Lab model (e-think, 2023) for the stationary fuel combustion in sectors *1.A.4.a Commercial/ Institutional* and *1.A.4.b Residential* in the years 2025-2050. The same reasoning applies to GHG emissions from

1.A.4.c.1 Agriculture/Forestry/Fishing, which were recalculated based on the output of the econometric input-output model (MIO-ES).

Minor adjustments in the energy balance (1990–2021) apply for former years 1990, 2005, 2010 and 2015), in particular fossil fuel use for heating.

The difference in the year 2020 is due to emerging trends in activity data (energy consumption) for the recent inventory data years.

- In particular, natural gas use of households is 7.8% higher in the inventory year 2020 than projected in the submission 2021. This leads to about +480 kt CO_2 emissions in 2020.
- In addition, higher fossil fuel use in stationary sources from category *1.A.4.c Agriculture/Forestry/Fishing* contributes to +54 kt CO_2 emissions in 2020.
- Increased fossil fuel use in mobile sources from category *1.A.4.c Agriculture/Forestry/Fishing* causes +31 kt CO_2 emissions in 2020.
- On the other hand, overall reduced fossil fuel use in mobile combustion of category *1.A.4.b Residential* reduces emissions 2020 by 18 kt CO_2 against the submission 2021. For the same reason, the contribution of category *1.A.5 Other* declines by 16 kt CO_2 in the year 2020.
- Because of lower fossil fuel use in stationary combustion of category *1.A.4.a Commercial/ Institutional*, the emissions 2020 fall by 14 kt CO_2.

The INVERT/EE-Lab model was updated with recent statistical data on building stock and thermal building quality. The model was recalibrated against the new energy balance. New measures were introduced into the WEM scenario, inducing a steeper path GHG emission reduction in the years around 2020 to 2025 compared to the submission 2021:

- According to the Oil Boiler Installation Prohibition Act (‘Ölkesseleinbauverbotsgesetz – ÖKEVG 2019’) the installation of liquid or solid fossil fuel boilers in newly constructed buildings are not be permitted as of 2020.
- The concerted funding of replacement of fossil fuel heating systems, namely with the focus programme Stepping out of Oil and Gas (‘Raus aus Öl und Gas’), maintains higher subsidy rates until 2025 for the exchange of fossil fuel heating systems.

Changes in price assumptions influence decisions as to which fuels will be preferred for heating systems in the long term as well as decisions regarding the quality and quantity of thermal renovation activities:

- To reflect the recent European energy crises, the energy prices (at real prices, € 2020) are assumed to peak around the year 2023 and fall back until 2030, but stabilizing at higher level than 2020. Thus, the prices for heating oil and other gas oil (+38%) and natural gas (+46%) are significantly higher in the year 2025 than in the submission 2021.

- In addition, price assumptions for renovation and exchange of heating systems have been raised against the submission 2021 by about 20% (at real prices, € 2020).

In overall effect, the differences for projected years 2025, 2030, 2035 and 2040 stay below ±1.0% of the GHG emissions submitted 2021.

6.5 Fugitive Emissions from Fuels (1.B)

Table 24: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – Fugitive emissions (in kt CO_2e).

1.B – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	312	440	448	444	431	409	388		
Projections 2013	311	441	516	539	570	582	594		
Projections 2015	702	482	521	560	574	589	604	607	
Projections 2017	702	482	521	477	464	364	306	223	
Projections 2019	702	437	468	424	389	318	275	210	
Projections 2021	702	437	468	424	384	321	282	212	179
Projections 2023	774	471	502	456	355	328	289	284	258
Difference 2023/21	+72	+33	+34	+32	-29	+7	+7	+72	+79

The difference between the 2023 and 2021 projections is mainly due to the assumption that length of the gas distribution network is not increasing and that natural gas production is higher (e.g. factor of 4 higher in 2040) than in the 2021 projections.

6.6 Agriculture (3)

Table 25: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – Agriculture (in kt CO_2 eq) (Umweltbundesamt).

3 – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	8 558	7 399	7 534	7 625	7 693	7 687	7 663		
Projections 2013	8 558	7 412	7 453	7 654	7 733	7 711	7 687		
Projections 2015	7 959	6 878	6 852	6 874	7 044	7 052	7 063	7 192	
Projections 2017	8 189	7 104	7 094	7 168	7 342	7 347	7 357	7 538	
Projections 2019	8 137	7 038	7 103	7 249	7 467	7 545	7 626	7 721	
Projections 2021	8 120	7 017	7 095	7 274	7 110	7 192	7 272	7 364	7 458
Projections 2023	8 400	7 181	7 188	7 376	7 197	6 923	6 462	6 493	6 520
Difference 2023/21	280	165	93	102	87	-268	-810	-871	-938

Emission calculations are based on projected activity data obtained from the PASMA model (WIFO & BOKU 2023). Since the last study (WIFO & BOKU 2018) the PASMA model was updated on the basis of a new inventory time series (1990-2020), new legal and economic conditions affecting prices, costs, and technical coefficients in the sectoral agriculture projections.

Within the 2022 inventory submission, Austria revised its agriculture inventory substantially. New updated and representative values for nitrogen and energy intake, excretion of nitrogen (Nex) and volatile solids (VSex) based on a new country specific study (HÖRTENHUBER et al. 2022, HÖRTENHUBER et al. 2023) have been included into the inventory. Improvements of the enteric CH_4 emission calculations based on the IPCC Refinement 2019 (IPCC 2019), taking into account new information, parameters and detailed data in animal feeding, resulted in lower GHG emissions, especially in the last years of the time series. Detailed information on the inventory revision of the 2022 submission can be found in Austria’s Informative Inventory Report 2022 (UMWELTBUNDESAMT 2022a) and in Austrira’s National Inventory Report 2022 (UMWELTBUNDESAMT 2022b).

Within the 2023 inventory submission, Austria changed the GWP values for CH_4 from 25 to 28 and for N_2O from 298 to 265 in accordance with the requirements of the EU Governance Regulation. Overall, this change resulted in higher GHG emissions from the agriculture sector for the entire time series (+235 kt CO_2eq in 2020).

The new WEM scenario considers the CAP strategic plan for the first time putting more emphasis on reducing air pollutants and greenhouse gas emissions. Furthermore, energy prices are estimated to be significantly higher as well as the cost of investments are increasing at a higher rate, mainly because of improved animal welfare standards and the price surge observed.

6.7 LULUCF (CRF Source Category 4)

Table 26: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – LULUCF (in kt CO_2 eq) (Umweltbundesamt).

4 – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	– 13 139	– 17 332	– 4 773	– 3 493	– 1 823	– 1 823	– 1 823		
Projections 2013	– 10 023	– 7 395	– 3 611	3 533	5 031	5 031	5 031		
Projections 2015	– 9 878	– 7 626	– 3 894	3 508	5 005	5 005	5 005	5 005	
Projections 2016	– 12 827	– 11 367	– 6 564	– 8 836	– 8 332	– 8 668	– 5 142	– 5 416	
Projections 2017	– 12 153	– 10 756	– 5 911	– 4 848	– 7 747	– 8 101	– 4 608	– 4 905	
Projections 2019	– 11 988	– 10 659	– 5 864	– 4 551	– 4 202	– 3 464	– 2 671	– 3 131	
Projections 2021	-12 196	-10 833	-5 724	-4 163	-4 594	-3 633	-3 129	-3 605	-1 608
Projections 2023	-12 207	-18 418	-19 759	-6 563	-5 222	-6 199	-5 913	-6 451	-4 522
Difference 2023/21	-11	-7 585	-14 035	-2 400	-628	-2 566	-2 784	-2 846	-2 914

The revisions with respect to the projections 2021 are due to:

- Updates of historical time series for all categories based on changes in the GHG inventory, which were mainly due to data from the latest National Forest Inventory, that was published in 2022 and led to substantial recalculations.
- Update of the projected soil C stock change, based on the new forest soil simulation for the historical time series and the soil simulations for the forest reference level.
- Update of the projected biomass increment and harvest on afforested and deforested areas, based on new input datafrom the last NFI 2016/21.
- Update of projections activity data for cropland, grassland and settlements to provide a consistent land use matrix.

6.8 Waste (CRF Source Category 5)

Table 27: Comparison of projections 2011, 2013, 2015, 2017, 2019, 2021 and 2023 – Waste (in kt CO_2 eq) (Umweltbundesamt).

5 – WEM	1990	2005	2010	2015	2020	2025	2030	2035	2040
Projections 2011	3 586	2 322	1 815	1 423	1 144	964	838		
Projections 2013	3 587	2 345	1 806	1 392	1 128	961	847		
Projections 2015	4 226	2 632	1 993	1 515	1 195	992	856	771	
Projections 2017	3 925	2 791	2 158	1 656	1 312	1 083	930	833	
Projections 2019	3 925	2 791	2 158	1 638	1 294	1 069	921	827	
Projections 2021	3 926	2 794	2 125	1 551	1 206	1 005	874	794	742
Projections 2023	4 367	3 041	2 289	1 645	1 259	1 045	903	819	765
Difference 2023/12	+441	+247	+165	+94	+53	+40	+29	+25	+22

The revision is largely due to the change of the GWP from AR4 to AR5 for submission 2023, raising the GWP of CH_4 from 25 to 28. The increasing effect of this GWP switch is higher in the early years as CH_4 emissions from 5.A Solid Waste Disposal are decreasing over time (-114 kt CH_4, - 78% from 1990-2021)

Compared to the 2021 projections, major methodological revisions were carried out for category 5.B Biological Waste Treatment. Amounts of home composted waste (part of 5.B.1) were re-estimated for inventory submission 2023 applying a new methodology developed for the Federal Waste Management Plan 2023 (Umweltbundesamt 2023b)[20] delivering a more plausible result than previously estimated. This was done in view of a future reporting obligation regarding home-composted quantities to the European Commission (In the future home composting is to be included in the AT recycling rate for municipal waste).

Only minor revisions were reported for the categories 5.A and 5.D as new data became available for the annual inventory (deposited amounts, N flows, connection rate 2020) slightly changing the basis for extrapolation.

[20] https://www.bmk.gv.at/themen/klima_umwelt/abfall/aws/bundes_awp/bawp2023.html

7 ABBREVIATIONS

AEA .... Austrian Energy Agency

B7 .... Blended diesel with 7% biodiesel (volumetric)

BEV .... Battery Electric Vehicle

BFW .... Bundesamt und Forschungszentrum für Wald
Austrian Federal Office and Research Centre for Forest

BMLFUW .... Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft
Federal Ministry of Agriculture, Forestry, Environment and Water Management

BMUJF .... Bundesministerium für Umwelt, Jugend und Familie
Federal Ministry for Environment, Youth and Family (before 2000, Environment now included with: BMLFUW)

BMLFUW .... Bundesministerium für Nachhaltigkeit und Tourismus
Federal Ministry of Sustainability and Tourism

BMWA .... Bundesministerium für Wirtschaft und Arbeit
Federal Ministry for Economic Affairs and Labour (renamed as BMWFJ)

BMWFJ .... Bundesministerium für Wirtschaft, Familie und Jugend
Federal Ministry of Economy, Family and Youth (formerly called BMWA)

BMWFW .... Bundesministerium für Wissenschaft, Forschung und Wirtschaft (formerly called BMWFJ)

CHP .... Combined Heat and Power

CRF .... Common Reporting Format (UNFCCC)

E5 .... Blended gasoline with 5% ethanol (volumetric)

E10 .... Blended gasoline with 10% ethanol (volumetric)

EEG .... Energy Economics Group

EU .... European Union

GDP .... Gross Domestic Product

Gg .... Gigagramme

GHG .... Greenhouse Gas

GWh .... gigawatt hours

GWP.. Global Warming Potential

HEV.. Hybrid Electric Vehicle

HVO .... Hydrotreated Vegetable Oil

IPCC.. Intergovernmental Panel on Climate Change

LEAP .... Long-range Energy Alternatives Planning System

LTO .... Landing/Take-Off cycle

LULUCF .... Land Use, Land-Use Change and Forestry – IPCC-CRF Category 5

Mt .... Megatonne

NFI .... National Forest Inventory

NIR.. National Inventory Report

NRMM .... Non-Road-Mobile-Machinery

OLI .... Österreichische Luftschadstoff Inventur (Austrian Air Emission Inventory)

PAM .... Policies and Measures

PHEV.. Plug-in Hybrid Vehicle

QA/QC .... Quality Assurance/Quality Control

QMS.. Quality Management System

SNAP .... Selected Nomenclature on Air Pollutants

SVO.. Straight Vegetable Oil

Tg.. Teragramme

UFI .... Umweltförderung im Inland (Domestic Environmental Support Scheme)

UNFCCC .... United Nations Framework Convention on Climate Change

WAM.. scenario 'with additional measures'

WEM .... scenario 'with existing measures'

UNFCCC .... United Nations Framework Convention on Climate Change

NDC .... National Determined Contribution

WIFO.................................. Österreichisches Wirtschaftsforschungsinstitut (Austrian Institute of Economic Research)

Greenhouse gases

CH_4..................................... methane

CO_2 .... carbon dioxide

N_2O .... nitrous oxide

HFC .... hydrofluorocarbons

PFC .... perfluorocarbons

SF_6...................................... sulphur hexafluoride

NF_3..................................... nitrogen trifluoride

Notation Keys

According to UNFCCC guidelines on reporting and review (FCCC/CP/2002/8)

'NO' (not occurring)	for activities or processes in a particular source or sink category that do not occur within a country;
'NE' (not estimated)	for existing greenhouse gas emissions by sources and removals by sinks which have not been estimated. Where 'NE' is used in an inventory for emissions or removals of CO_2, CH_4, N_2O, HFCs, PFCs, or SF_6, the Party should indicate why emissions or removals have not been estimated (see Annex III)
'NA' (not applicable)	for activities in a given source/sink category that do not result in emissions or removals of a specific gas. If categories in the CRF for which 'NA' is applicable are shaded, they do not need to be filled in
'IE' (included elsewhere)	for emissions by source and removals by sinks of greenhouse gases estimated but included elsewhere in the inventory instead of the expected source/sink category. Where 'IE' is used in an inventory, the Annex I Party should indicate, using the CRF completeness table, where in the inventory the emissions or removals from the displaced source/sink category have been included and the Annex I Party should explain such a deviation from the expected category
'C' (confidential)	for emissions by sources and removals by sinks of greenhouse gases which could lead to the disclosure of confidential information, given the provisions of paragraph 27 as mentioned above

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ANNEX 1: EMISSIONS

Table 28: CO_2 emissions in 2020–2021 and projections 2025–2050 (Umweltbundesamt).

CO_2 [kt]	2020	2021	2025	2030	2035	2040	2050
Total excluding LULUCF	62 121	66 019	62 729	58 441	53 473	49 988	46 623
Total including LULUCF	56 757	55 478	56 398	52 412	46 925	45 380	43 769
1.Energy	48 784	50 933	48 400	44 155	39 199	35 758	32 538
A. Fuel Combustion	48 674	50 849	48 309	44 081	39 124	35 696	32 477
1. Energy Industries	8 686	8 739	7 961	6 320	5 789	5 556	5 256
a. Public Electricity and Heat production	5 665	5 635	4 919	3 314	2 943	2 824	2 480
b. Petroleum Refining	2 732	2 750	2 839	2 832	2 672	2 568	2 612
c. Manufacture of Solid Fuels and Other Energy Industries	289	354	203	175	175	164	164
2. Manufacturing Industries and Construction	10 395	10 792	11 237	11 540	11 718	11 970	11 985
3. Transport	20 918	21 684	21 465	19 168	15 139	12 160	9 538
a. Domestic Aviation	23	24	41	47	48	48	48
b. Road Transportation	20 313	21 162	20 753	18 450	14 429	11 456	8 817
c. Railways	81	81	92	88	84	80	73
d. Domestic Navigation	23	35	40	44	48	52	61
e. Other Transportation	479	382	540	540	530	523	539
4. Other Sectors	8 642	9 604	7 617	7 023	6 449	5 981	5 669
a. Commercial/Institutional	1 290	1 554	1 357	1 204	1 106	1 017	985
b. Residential	6 469	7 185	5 426	4 977	4 495	4 107	3 818
c. Agriculture/Forestry/Fisheries	883	865	834	841	849	857	865
5. Other	33	30	30	29	29	29	28
B. Fugitive Emissions from Fuels	109	84	91	74	75	62	62
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	109	84	91	74	75	62	62
2. Industrial Processes & Product Use	13 187	14 935	14 177	14 136	14 123	14 078	13 938
A. Mineral Products	2 846	3 050	3 059	3 054	3 045	3 006	2 890
B. Chemical Industry	677	688	661	671	683	695	706
C. Metal Production	9 509	11 031	10 285	10 234	10 217	10 199	10 163
D. Non-energy products from fuels and solvent use	154	165	172	177	178	178	179
E. Electronics industry	NO	NO	NO	NO	NO	NO	NO
F. Product uses as substitutes for ODS	NO	NO	NO	NO	NO	NO	NO
G. Other product manufacture and use	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	149	149	149	148	149	150	145
4. Land Use, Land-Use Change and Forestry	-5 364	-10 541	-6 331	-6 029	-6 547	-4 608	-2 855
5. Waste	2	2	2	2	2	2	2
C. Incineration and open burning of waste	2	2	2	2	2	2	2

Table 29: CH_4 emissions in 2020–2021 and projections 2025–2050 (Umweltbundesamt).

CH_4 [kt]	**2020**	**2021**	**2025**	**2030**	**2035**	**2040**	**2050**
Total excluding LULUCF	232.25	232.12	214.94	195.79	192.60	190.36	181.51
Total including LULUCF	233.21	233.09	215.89	196.74	193.55	191.31	182.46
1. Energy	21.65	22.96	20.29	19.22	18.13	16.92	16.00
A. Fuel Combustion Activities	12.86	14.14	11.84	11.55	10.67	9.91	8.99
1. Energy Industries	1.00	1.03	1.17	1.22	1.25	1.24	1.24
2. Manufacturing Industries and Construction	0.76	0.78	0.85	0.88	0.89	0.92	0.92
3. Transport	0.74	0.76	0.80	0.70	0.48	0.30	0.14
4. Other Sectors	10.37	11.57	9.02	8.74	8.04	7.45	6.68
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Fugitive Emissions from Fuels	8.79	8.83	8.45	7.67	7.46	7.01	7.02
2. Industrial Processes & Product Use	2.12	2.09	1.84	1.85	1.86	1.87	1.88
B. Chemical Industry	1.97	1.94	1.84	1.85	1.86	1.87	1.88
3. Agriculture	171.52	171.95	163.78	150.88	151.89	152.89	147.28
A. Enteric Fermentation	149.36	149.71	142.37	131.18	131.99	132.80	127.83
1. Cattle	140.40	140.66	134.10	124.63	125.81	127.00	123.19
2. Sheep	3.15	3.22	2.90	2.15	2.07	1.99	1.64
3. Swine	2.43	2.42	2.22	2.02	1.83	1.64	1.21
4. Other	3.38	3.42	3.15	2.39	2.29	2.18	1.78
B. Manure Management	22.16	22.24	21.41	19.70	19.89	20.08	19.45
1. CH_4 Emissions	22.16	22.24	21.41	19.70	19.89	20.08	19.45
1. Cattle	18.05	18.15	17.64	16.36	16.84	17.33	17.37
2. Sheep	0.12	0.12	0.11	0.08	0.08	0.08	0.06
3. Swine	3.14	3.12	2.86	2.60	2.35	2.09	1.53
4. Other	0.85	0.85	0.80	0.66	0.62	0.59	0.49
5. Waste	36.95	35.11	29.02	23.85	20.73	18.68	16.35
A. Solid Waste Disposal	33.24	31.37	25.52	20.65	17.50	15.44	13.08
B. Biological Treatment of Solid Waste	2.80	2.84	2.59	2.29	2.31	2.33	2.36
C. Incineration and Open Burning of Waste	0.02	0.02	0.02	0.02	0.02	0.02	0.02
D. Waste Water Treatment and Discharge	0.89	0.89	0.89	0.89	0.89	0.89	0.89

Table 30: N_2O emissions in 2020–2021 and projections 2025–2050 (Umweltbundesamt).

N_2O [kt]	2020	2021	2025	2030	2035	2040	2050
Total excluding LULUCF	11.66	11.78	11.62	11.28	11.16	11.02	10.49
Total including LULUCF	12.09	12.21	12.02	11.62	11.42	11.25	10.74
1. Energy	2.04	2.14	2.18	2.19	2.04	1.90	1.77
A. Fuel Combustion Activities	2.04	2.14	2.18	2.19	2.04	1.90	1.77
1. Energy Industries	0.32	0.33	0.39	0.42	0.44	0.43	0.43
2. Manufacturing Industries and Construction	0.40	0.41	0.44	0.46	0.47	0.49	0.51
3. Transport	0.82	0.86	0.89	0.85	0.70	0.56	0.44
4. Other Sectors	0.50	0.54	0.45	0.46	0.44	0.41	0.39
5. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes & Product Use	0.30	0.28	0.32	0.32	0.33	0.33	0.33
B. Chemical Industry	0.18	0.16	0.19	0.20	0.20	0.21	0.21
G. Other Product Manufacture and Use	0.13	0.12	0.12	0.12	0.12	0.12	0.12
3. Agriculture	8.48	8.52	8.26	7.89	7.89	7.88	7.47
B. Manure Management	1.77	1.78	1.68	1.54	1.52	1.49	1.38
2. N_2O Emissions	1.77	1.78	1.68	1.54	1.52	1.49	1.38
1. Cattle	1.05	1.06	1.00	0.92	0.93	0.94	0.90
2. Sheep	0.03	0.03	0.02	0.02	0.02	0.02	0.01
3. Swine	0.21	0.21	0.20	0.18	0.16	0.14	0.10
4. Other	0.06	0.06	0.06	0.05	0.04	0.04	0.03
5. Indirect N_2O Emissions	0.41	0.42	0.40	0.37	0.36	0.36	0.32
D. Agricultural Soils	6.71	6.74	6.57	6.35	6.38	6.39	6.09
1. Direct N_2O Emissions from Managed Soils	5.63	5.66	5.54	5.37	5.39	5.40	5.14
2. Indirect N_2O emissions from Managed Soils	1.08	1.08	1.03	0.98	0.99	0.99	0.95
5. Waste	0.84	0.85	0.87	0.88	0.89	0.90	0.92
B. Biological Treatment of Solid Waste	0.27	0.28	0.28	0.28	0.29	0.29	0.29
C. Incineration and Open Burning of Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste Water Treatment and Discharge	0.57	0.57	0.59	0.60	0.61	0.62	0.63

Table 31: HFC, PFC SF_6 and NF_3 emissions in 2020–2021 and projections 2025–2050 (Umweltbundesamt).

HFC [kt CO_2e]	**2020**	**2021**	**2025**	**2030**	**2035**	**2040**	**2050**
Total	1 705	1 486	1 249	769	664	666	509
2. Industrial Processes & Product Use	1 705	1 486	1 249	769	664	666	509
E. Electronics Industry	3	3	3	3	3	3	3
F. Consumption of Halocarbons and SF_6	1 702	1 483	1 246	765	661	662	505
PFC [kt CO_2e]							
Total	27	23	31	31	31	31	31
2. Industrial Processes & Product Use	27	23	31	31	31	31	31
E. Electronics Industry	27	23	31	31	31	31	31
SF_6 [kt CO_2e]							
Total	455	371	240	84	91	97	110
2. Industrial Processes & Product Use	455	371	240	84	91	97	110
E. Electronics Industry	13	15	25	25	25	25	25
G. Other Product Manufacture and Use	436	351	215	59	66	73	86
NF_3 [kt CO_2e]							
Total	11	12	13	13	13	13	13
2. Industrial Processes & Product Use	11	12	13	13	13	13	13
E. Electronics Industry	11	12	13	13	13	13	13

ANNEX 2: KEY PARAMETERS FOR SECTORAL SCENARIOS

Energy Industries

Table 32: Projected fuel input into main activity power and heat plants – scenario "with existing measures". (Umweltbundesamt).

Energy [TJ]	2020	2021	2025	2030	2035	2040	2050
Bituminous/Anthracite Coal	4 313	0	0	0	0	0	0
Residual Fuel Oil	836	1 389	0	0	0	0	0
Natural gas	75 772	80 070	69 386	39 723	33 053	30 913	24 723
Waste	8 717	9 003	9 003	9 003	9 003	9 003	9 003
Biomass	62 880	63 002	85 096	94 599	98 740	98 585	98 428
Hydropower	149 552	138 040	158 202	167 578	171 742	171 603	171 531
Wind power	24 450	24 264	41 455	61 831	64 081	68 572	77 491
Photovoltaics	7 355	10 017	25 183	47 877	50 560	54 335	61 832
Geothermal	935	1 244	1 082	1 076	1 046	1 003	881

Manufacturing Industries and Construction

Table 33: Projected fuel input into autoproducer power and heat plants – scenario "with existing measures" (Umweltbundesamt).

Energy [TJ]	2020	2021	2025	2030	2035	2040	2050
Bituminous/Anthracite Coal	18 944	21 047	19 884	19 877	19 884	19 905	19 974
Residual Fuel Oil	9 114	12 812	10 233	10 690	7 089	6 103	6 200
Natural gas	11 584	13 022	12 262	12 752	13 361	14 064	15 642
Waste	6 988	6 414	6 990	6 989	6 991	6 994	7 000
Biomass	21 601	21 323	23 135	24 191	25 712	27 477	31 430
Hydropower	1 641	1 465	1 654	1 654	1 654	1 654	1 654
Wind power	0	0	0	0	0	0	0
Photovoltaics	0	0	0	0	0	0	0
Geothermal	128	179	139	144	152	161	180

Table 34: Final energy demand of industry – scenario "with existing measures" (Umweltbundesamt).

Energy [TJ]	2020	2021	2025	2030	2035	2040	2050
Coal without coke	6 467	5 614	5 210	5 426	5 457	5 568	5 613
Coke	7 292	7 108	6 729	6 679	6 681	6 683	6 685
Light Fuel Oil	1 078	1 758	908	833	874	932	1 020
Heavy Fuel Oil	1 456	874	2 676	3 192	3 247	3 325	3 156
Other petr. Products	9 827	10 929	14 540	15 001	15 474	15 969	16 491
Natural gas	110 548	115 547	115 327	117 535	117 213	118 325	110 866
Derived gas	3 686	5 077	4 143	4 092	4 037	3 982	3 875
Waste	10 507	11 267	12 550	12 472	12 465	12 318	12 575
Biomass	47 698	51 714	56 726	60 789	61 328	62 499	62 475

Energy [TJ]	2020	2021	2025	2030	2035	2040	2050
Electricity	94 937	99 355	110 069	115 281	117 632	120 869	127 535
Heat	10 205	10 592	11 068	11 584	11 775	12 058	12 075

Transport

Table 35: Energy consumption of mobile sources by fuel – scenario "with existing measures" (Umweltbundesamt).

Energy [TJ]	2020	2021	2025	2030	2035	2040	2050
Gasoline fossil	54 537	57 567	66 271	58 989	40 850	25 713	11 632
Diesel fossil	230 133	237 604	249 403	226 586	191 259	167 190	147 857
Bioethanol	2 352	2 065	2 005	1 784	1 235	776	349
Biodiesel	13 740	16 012	15 760	14 318	12 081	10 555	9 330
Vegetable oil	1 085	1 165	464	464	464	464	463
BIO ETBE			223	198	137	86	39
LPG	128	157	0	0	0	0	0
Natural gas	9 300	7 512	869	894	730	606	442
Biogas	16	15	8	8	8	8	8
H2			0	0	0	0	0
Coal	4	4	4	4	3	3	2
Electricity rail	5 198	5 256	8 808	10 043	10 285	10 496	10 986
Electricity road transport			5 326	15 945	35 134	53 012	70 473
Aviation jet fuel	13 967	17 514	35 165	42 020	43 296	43 296	43 296

Residential, Commercial & Other Sectors

Table 36: Final energy demand of residential, commercial & other sectors – scenario "with existing measures".

Energy [TJ]	2020	2021	2025	2030	2035	2040	2050
Coal	585	660	516	379	196	65	20
Oil	41 839	47 279	37 838	33 700	29 697	26 559	23 728
Natural gas	75 500	78 256	68 905	63 949	59 283	55 268	53 517
Biomass	81 079	91 561	74 567	78 962	77 181	74 044	70 523
District heat	62 086	68 200	73 862	73 337	71 061	68 480	59 860
Solar and ambient heat	24 207	25 258	22 704	30 303	37 106	43 131	52 167
Electricity	115 866	120 556	122 880	128 803	133 268	137 765	149 043
Fuels for mobile sources	14 341	14 952	13 242	13 346	13 436	13 524	13 654

Table 37: Assumptions for energy prices for households and commercial – scenario "with existing measures".

Price, real [€ 2020/MWh]		2020	2021	2025	2030	2035	2040	2050
Coal		52	54	47	45	45	45	45
Heating oil and other gas oil		76	78	129	90	90	90	90
Natural gas		74	77	149	110	110	110	110
Wood log and wood briquettes	standard	40	40	66	51	51	51	51
	cheap	28	28	47	36	36	36	36
Wood chips	standard	35	35	57	44	44	44	44
	cheap	24	24	40	31	31	31	31
Wood pellets		51	51	72	55	55	55	55
Electricity		177	177	313	210	210	210	210
District heat		87	86	133	101	101	101	101

Table 38: Assumptions on subsidy rates – scenario "with existing measures".

Subsidy rates [%]		2020	2021	2025	2030	2035	2040	2050
Coal		:	:	:	:	:	:	:
Heating oil and other gas oil		:	:	:	:	:	:	:
Natural gas		:	:	:	:	:	:	:
Wood log and wood briquettes		20	20	20	20	20	20	20
Wood chips		20	20	20	20	20	20	20
Wood pellets		23	23	23	23	23	23	23
Heat pump	high	5	5	5	5	5	5	5
	low	15	15	15	15	15	15	15
Solar heat	high	20	20	20	20	20	20	20
	low	25	25	25	25	25	25	25
District heat	high	15	15	15	15	15	15	15
	low	23	23	23	23	23	23	23

Additional federal subsidies for replacing of fossil heating systems temporarily rise subsidies to the upper limit. This bonus is expected to decline to zero until 2040.

Table 39: Assumptions for the number and size of buildings, and the number of permanently occupied dwellings – scenario "with existing measures".

Assumption	Unit	2020	2021	2025	2030	2035	2040	2050
Number of residential buildings	**[number in 1 000]**	**1.925**	**1.944**	**2.014**	**2.099**	**2.184**	**2.268**	**2.432**
with one or two apartments	[number in 1 000]	1.701	1.718	1.779	1.855	1.929	2.004	2.148
with three to ten apartments	[number in 1 000]	149	150	156	162	169	175	188
with more than ten apartments	[number in 1 000]	76	77	79	83	86	89	96

Number of commercial buildings	**[number in 1 000]**	**155**	**156**	**161**	**168**	**174**	**181**	**196**
Wholesale and retail trade, hotel and restaurant buildings	[number in 1 000]	64	64	66	69	72	75	81
Public administration, entertainment, education, hospital or institutional care buildings	[number in 1 000]	25	25	26	27	28	29	31
Other non-residential service buildings	[number in 1 000]	42	43	44	46	48	50	54
Partially and unheated halls, workshops, etc.	[number in 1 000]	24	24	25	26	27	28	31
Gross floor area of residential buildings	**[million m² gross floor area]**	**492**	**498**	**517**	**542**	**566**	**590**	**638**
with one or two apartments	[million m² gross floor area]	290	293	305	319	334	348	376
with three to ten apartments	[million m² gross floor area]	80	81	84	88	92	96	104
with more than ten apartments	[million m² gross floor area]	122	123	128	134	140	147	158
Gross floor area of commercial buildings	**[million m² gross floor area]**	**144**	**145**	**150**	**156**	**163**	**169**	**183**
Wholesale and retail trade, hotel and restaurant buildings	[million m² gross floor area]	64	64	67	69	72	75	81
Public administration, entertainment, education, hospital or institutional care buildings	[million m² gross floor area]	35	36	37	38	40	41	45
Other non-residential service buildings	[million m² gross floor area]	33	33	34	36	37	39	42
Partially and unheated halls, workshops, etc.	[million m² gross floor area]	12	12	12	13	13	14	15
Number of dwellings	**[number in 1 000]**	**4.156**	**4.198**	**4.348**	**4.533**	**4.715**	**4.897**	**5.250**
Permanently occupied dwellings	[number in 1 000]	3.982	4.008	4.112	4.207	4.295	4.380	4.497

Table 40: Final energy demand for heating, – scenario "with existing measures".

Final energy consumption	Unit	2020	2021	2025	2030	2035	2040	2050
Residential buildings	**[kWh/m².a]**	**142**	**140**	**127**	**123**	**115**	**108**	**97**
with one or two apartments	[kWh/m².a]	150	148	132	128	118	110	98
with three to ten apartments	[kWh/m².a]	143	142	130	127	120	113	103
with more than ten apartments	[kWh/m².a]	121	120	111	109	104	99	91
Commercial buildings	**[kWh/m².a]**	**139**	**138**	**130**	**121**	**112**	**104**	**92**
Wholesale and retail trade, hotel and restaurant buildings	[kWh/m².a]	148	147	139	129	120	112	98
Public administration, entertainment, education, hospital or institutional care buildings	[kWh/m².a]	167	165	156	144	133	123	109
Other non-residential service buildings	[kWh/m².a]	126	124	118	110	102	94	82
Partially and unheated halls, workshops, etc.	[kWh/m².a]	43	43	40	37	34	32	29

Table 41: Thermal renovation rates – scenario "with existing measures".

Thermal renovation rate	Unit	2020	2021	2025	2030	2035	2040	2050
Residential buildings	**[%]**	**0.8**	**0.8**	**1.0**	**1.1**	**1.4**	**1.5**	**1.3**
with one or two apartments	[%]	0.7	0.7	1.0	1.1	1.4	1.6	1.3
with three to ten apartments	[%]	0.7	0.7	1.0	1.0	1.2	1.4	1.2
with more than ten apartments	[%]	0.8	0.8	1.1	1.2	1.4	1.6	1.3
Commercial buildings	**[%]**	**0.3**	**0.3**	**0.8**	**0.7**	**0.7**	**0.7**	**0.5**
Wholesale and retail trade, hotel and restaurant buildings	[%]	0.3	0.3	0.8	0.7	0.7	0.7	0.5
Public administration, entertainment, education, hospital or institutional care buildings	[%]	0.4	0.5	1.1	0.9	0.9	0.7	0.5
Other non-residential service buildings	[%]	0.3	0.3	0.7	0.6	0.6	0.6	0.5
Partially and unheated halls, workshops, etc.	[%]	0.3	0.3	0.5	0.5	0.7	0.6	0.4

Thermal renovation rate expressed as proportion of new renovated gross floor space to total gross floor space in the year in which the measures are performed.

Table 42: Boiler exchange rates – scenario "with existing measures".

Boiler exchange rate	Unit	2020	2021	2025	2030	2035	2040	2050
Residential buildings	**[%]**	**2.0**	**2.1**	**2.4**	**2.5**	**2.7**	**2.6**	**2.2**
with one or two apartments	[%]	NE	NE	NE	NE	NE	NE	NE
with three to ten apartments	[%]	NE	NE	NE	NE	NE	NE	NE
with more than ten apartments	[%]	NE	NE	NE	NE	NE	NE	NE
Commercial buildings	**[%]**	**1.4**	**1.5**	**1.7**	**1.9**	**2.3**	**2.2**	**2.0**
Wholesale and retail trade, hotel and restaurant buildings	[%]	NE	NE	NE	NE	NE	NE	NE
Public administration, entertainment, education, hospital or institutional care buildings	[%]	NE	NE	NE	NE	NE	NE	NE
Other non-residential service buildings	[%]	NE	NE	NE	NE	NE	NE	NE
Partially and unheated halls, workshops, etc.	[%]	NE	NE	NE	NE	NE	NE	NE

Boiler exchange rate expressed as proportion of gross floor space with boiler exchange to total gross floor space in the year in which the measures are performed.

Fugitive Emissions from Fuels

Table 43: Fugitive activities for calculation of fugitive emissions (Umweltbundesamt).

	2020	2021	2025	2030	2035	2040	2050
Gas pipeline length [km]	7 230	7 203	7 330	7 330	7 330	7 330	7 330
Gas distribution network [km]	30 569	30 591	30 817	30 817	30 817	30 817	30 817
Natural gas production [million m^3]	724	648	676	479	431	320	319
Refinery crude oil input [PJ]	334	368	378	344	351	365	365
Natural gas storage [Mio m^3]	3 070	5 747	5 317	5 100	6 668	5 479	5 479

Agriculture

Table 44: Livestock population cattle 2021 and projections 2025–2050– scenario "with existing measures" (Umweltbundesamt).

Year	Population size [heads]	
	Dairy (WEM)	Non-Dairy (WEM)
2021	526 461	1 343 639
2025	500 425	1 261 087
2030	469 564	1 155 652
2035	473 797	1 153 340
2040	478 031	1 151 028
2050	461 324	1 093 473

Table 45: Livestock population other animals 2021 and projections 2025–2050 – scenario "with existing measures" (Umweltbundesamt).

	Population size [heads]					
Year	Swine	Sheep	Goats	Poultry	Horses	Other
2021	2 479 172	402 345	100 601	19 749 825	130 000	38 299
2025	2 271 865	362 457	82 399	18 904 077	120 432	38 919
2030	2 062 739	268 534	51 323	16 283 209	91 729	32 975
2035	1 850 215	258 588	50 885	15 287 468	86 985	32 584
2040	1 637 691	248 642	50 447	14 291 726	82 241	32 193
2050	1 158 200	205 165	47 553	11 863 542	63 918	29 373

Table 46: Milk production and mineral fertiliser use for 2021 and projections (2025–2050) – scenario "with existing measures" (Umweltbundesamt).

	Ø milk yield per dairy cow (kg/yr)					
Year	2021	2025	2030	2035	2040	2050
Ø milk yield per dairy cow (kg/yr)	7 249	7 655	8 024	8 393	8 762	9 500
Mineral fertiliser use (t N/year)	111 080	109 069	111 184	114 358	117 532	115 429

ANNEX 3: USE OF NOTATION KEY “IE”

In the following section the use of the notation key ‘IE’ within the submitted ‘GovReg_Proj_T1a_T1b_T5a_T5b template is explained.

1B/1B2 (N_2O): allocated to 1 A 1 c Petroleum Refining

2C/2C1 (CH_4, N_2O): allocated to 1 A 2 a Iron and Steel