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Key Indicators of Climate Change and the Energy Sector in 2023. Special Topic: the European Commission's "Fit for 55" Package

Katharina Falkner, Claudia Kettner, Daniela Kletzan-Slamanig, Angela Köppl, Ina Meyer, Asjad Naqvi, Anna Renhart, Franz Sinabell, Mark Sommer, Corina van Dyck

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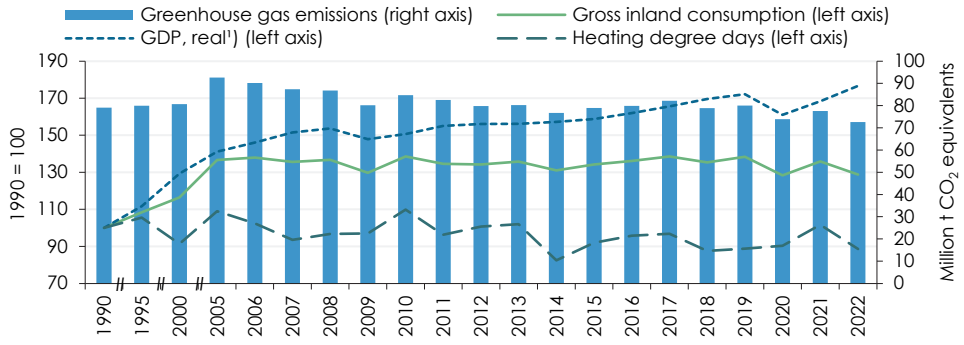
- Austria's greenhouse gas emissions increased by 4.9 percent or 3.6 million t CO_2 equivalents in 2021 after the pandemic-related decrease.
- This was due to an expansion of steel production, electricity production in gas-fired power plants, weather-related increases in heating oil and natural gas demand for heat generation, as well as a rebound in the transport sector.
- For the year 2022, a decrease in emissions of 5.0 million t of CO_2 equivalents (–6.4 percent) is forecasted. This is primarily due to the sharp rise in energy prices, especially for natural gas, as a result of the Ukraine war.
- The use of renewable energy decreased by 4 percent in 2022 due to the drought in summer and the associated lower electricity generation from hydropower (–10 percent), although energy provision by means of photovoltaics and wind energy increased by 15.9 percent.
- The majority of the legislative proposals in the "Fit for 55" package to achieve climate neutrality in the EU by 2050 were adopted, partly with more ambitious targets, by summer 2023 despite the Ukraine war and the energy crisis.

Greenhouse gas emissions, energy consumption, gross value added and heating degree days in Austria



For 2022, emission decreases are expected in all sectors; especially in small-scale consumption (buildings and services, –14.7 percent), in industry (–6.4 percent) and in the transport sector (–5.4 percent); source: Environment Agency Austria, 2023a; Statistics Austria, Energy Balance Austria 1970-2021; WDS – WIFO-Data System, Macrobond. 2022: preliminary data from the near time emission forecast "Nowcast" of the Environment Agency Austria and the Preliminary Energy Balance Austria 2022. – ¹ Reference year 2015).

"After the brief increase in the previous year, energy consumption fell again in 2022 (–5 percent to 1,355 PJ). Gas consumption decreased the most (–11 percent), mainly due to the high price increases resulting from the Ukraine war, but also due to the mild winter."

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September 2023

Key Indicators of Climate Change and the Energy Sector in 2023. Special Topic: the European Commission's "Fit for 55" Package

The year 2021 was characterised by an economic rebound (real GDP +4,6 percent) as the COVID-19 pandemic subsided, and an accompanying 4.9 percent increase in greenhouse gas emissions. In 2022 emissions fell significantly by –6.4 percent according to initial estimates, although economic output grew by 4.9 percent. The decoupling of economic growth and emissions development was primarily due to price-related energy savings. In addition, weather-conditions also influenced greenhouse gas emissions. For example, a mild winter curbed heating demand and a dry summer reduced hydropower output. The significant increase in energy prices due to the Ukraine war drove up expenditure on fossil energy imports. The capacity of the renewable energy technologies photovoltaics and wind energy was increased by 15.9 percent. This year's special topic deals with the current status of the legislative implementation of the EU's "Fit for 55" package.

JEL-Codes: Q15, Q18, Q41, Q42, Q43, Q58 • **Keywords:** Climate change, climate policy, energy policy, agricultural production, environmental indicators, "Fit for 55"

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This 16th WIFO report on the key indicators on climate change and the energy economy documents and analyses their development in 2021 and – as far as corresponding data are available – in 2022. It is based on current statistics on greenhouse gas emissions in Austria (Environment Agency Austria, 2023a, 2023b) and energy flows according to the energy balance (Statistics Austria, 2022b, 2023c).

After 2020, 2021 was also essentially characterised by the COVID-19 pandemic and the associated lockdowns and travel restrictions. The manufacturing sector nevertheless gained significant momentum and contributed again to economic growth (GDP real +4.6 percent; 2020 –6.5 percent). Greenhouse gas emissions rose disproportionately compared to economic growth, although not to pre-pandemic levels (+4.9 percent; 2020 –7.6 percent). Developments in the energy sector in 2022 were primarily shaped by the impact of the Russian attack on Ukraine. It led to turbulence on the global energy markets and volatile and sharply rising energy prices, especially for natural gas on the European markets. Inflation accelerated considerably as a result. Economic growth (2022 +4.9 percent) proved robust amid this turbulence, as did renewable energy technologies photovoltaics and wind power, which expanded by 15.9 percent (2022). Greenhouse gas emissions fell by 6.4 percent in 2022 according to the "Nowcast" of the Environment Agency Austria (2023b), not least due to significant energy savings by private households and businesses.

The developments in energy consumption, energy supply and greenhouse gas emissions are analysed in the following for Austria's economy as a whole and its sectors

regarding climate policy goals. This year's special topic is dedicated to the implementation status of the EU package "Fit for 55" and provides an overview of the instruments for achieving climate neutrality in 2050, including the interim targets.

1. Climate and energy indicators

1.1 Gross inland energy consumption in the EU 27 increased again after the COVID-19 pandemic

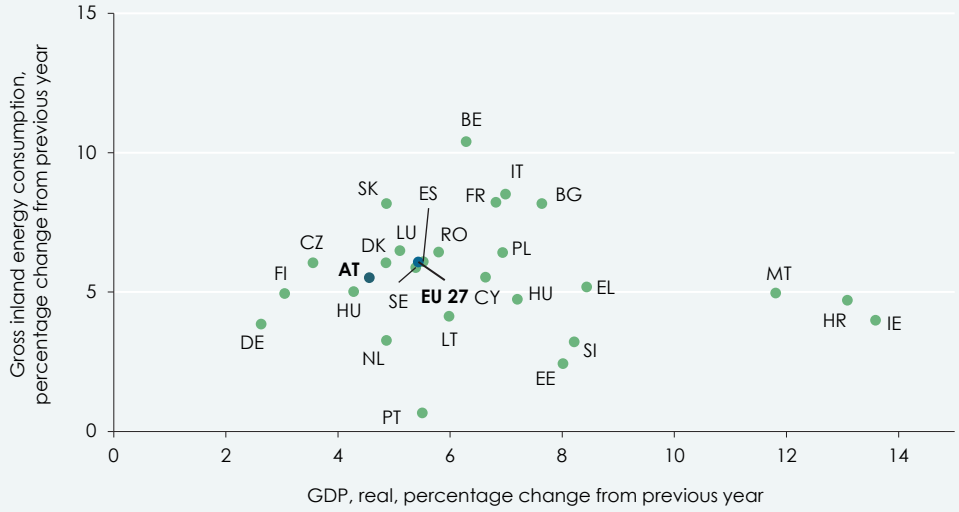
Gross inland energy consumption in the EU 27 increased significantly in 2021, reaching 59,522 PJ (+6.1 percent compared to 2020), close to the 2019 level. The increase was primarily due to the economic recovery after the COVID-19 pandemic subsided. The GDP of the EU 27 grew by 5.4 percent compared to the previous year. In Austria, GDP growth was 4.6 percent.

A comparison of the development of GDP and gross inland energy consumption in the EU 27 shows an increase in both key figures, and even significant increases for a number of countries (Figure 1): gross inland energy consumption in 2021 was above the 2020 level in all EU countries. The same applies to economic output, which increased strongly in Ireland, Malta and Croatia in particular. The use of fossil fuels increased again for the first time since 2016 (EU 27 +10.6 percent compared to 2020). The upward trend in the use of renewable energy sources also continued (+5 percent). At 21.8 percent, their share of gross inland energy consumption in the EU 27 was slightly lower than in 2020.

In 2021, GDP in the EU 27 increased significantly due to the recovery from the COVID-19 pandemic. Accordingly, energy use almost returned to the 2019 level.

Figure 1: **Development of gross domestic energy consumption in relation to GDP development in the EU countries**

2021



Source: Eurostat.

1.2 Austria: Economic recovery causes rise in greenhouse gas emissions

Austria's greenhouse gas emissions[1] rose again in 2021 after the pandemic-related decline (+4.9 percent or +3.6 million t to 77.5 million t CO_2 equivalents; Figure 2).

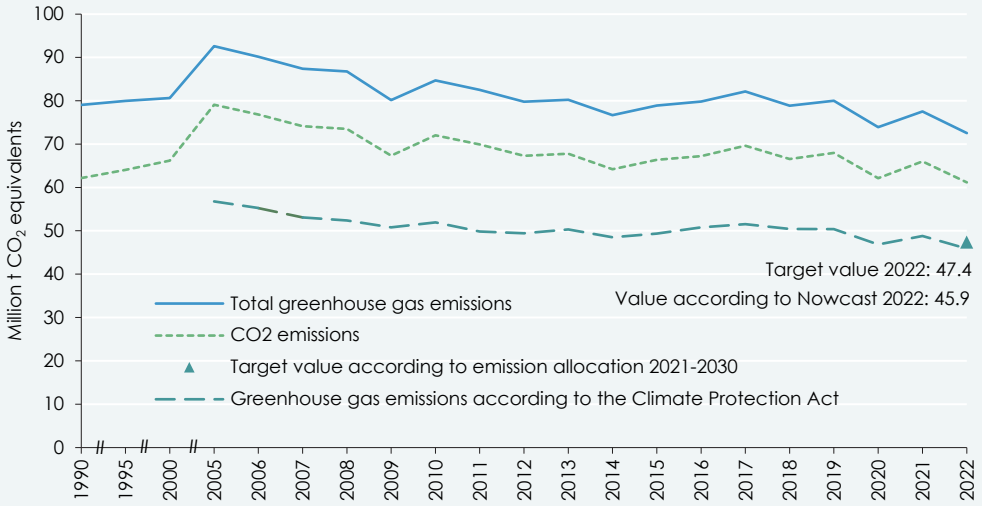
For the sectors outside emissions trading, national caps apply in the period 2021 to 2030 in accordance with the Effort Sharing Regulation 2018/842/EU. In 2021, the cap was 48.77 million t of CO_2 equivalents. The actual emissions of the sector not covered by emissions trading were slightly above the target value at 48.81 million t CO_2 equivalents. Greenhouse gas emissions in the emissions trading sector also increased compared to 2020 (+1.7 million t CO_2 equivalents or +6.2 percent) and reached 28.7 million t, of which 7.7 million t were attributable to power generation and 21 million t to industry. The additional emissions are due to the expansion of steel production and electricity production in gas-fired power plants, the weather-related additional consumption of heating oil and natural gas in the building sector, and an increase in mileage in transport.

[1] Excluding emissions from land use, land use change and forestry.

Greenhouse gas emissions and energy consumption increased more strongly than gross domestic product in 2021; a significant decrease is expected for 2022.

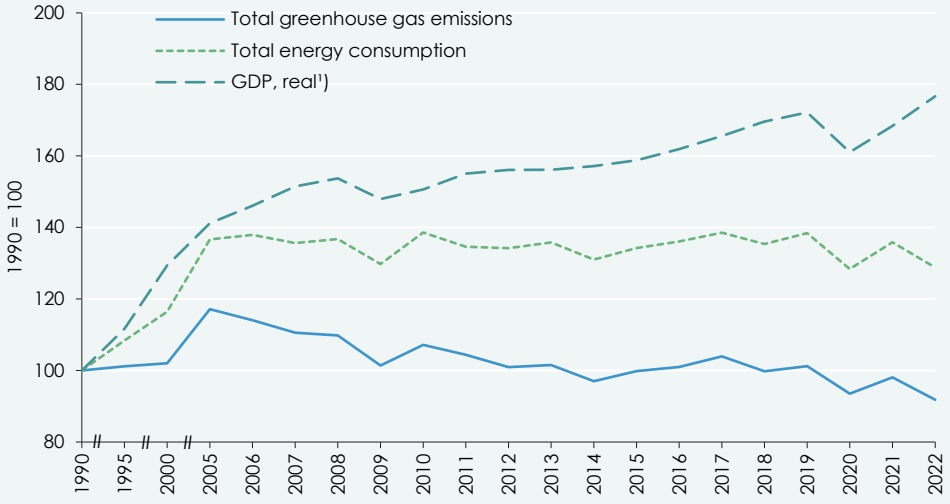
Compared to a GDP growth of 4.6 percent in real terms, the increase in energy consumption was more pronounced in 2021 (+5.8 percent). Greenhouse gas emissions grew by 4.9 percent (Figure 3). The increase was particularly strong for process-related greenhouse gas emissions (9.2 percent, see Chapter 1.4). Energy-related greenhouse gas emissions increased by only 4.4 percent in 2021, primarily due to the increased use of oil and gas. Non-energy emissions from agriculture and waste management decreased slightly by 0.3 percent.

Figure 2: **Greenhouse gas emissions in Austria and Kyoto target**



Source: Environment Agency Austria. 2022: Preliminary data from the near-term emission forecast "Nowcast" of the Environment Agency Austria and the Preliminary Energy Balance Austria 2022.

Figure 3: **Greenhouse gas emissions and economic growth in Austria**



Source: Environment Agency Austria; Statistics Austria, Energy Balance Austria 1970-2021; WDS – WIFO Data System, Macrobond. 2022: Provisional data from the near-term emission forecast. "Nowcast" of the Environment Agency Austria and the Preliminary Energy Balance Austria 2022. – [1] Reference year 2015.

1.3 Energy crisis likely to have significantly dampened greenhouse gas emissions

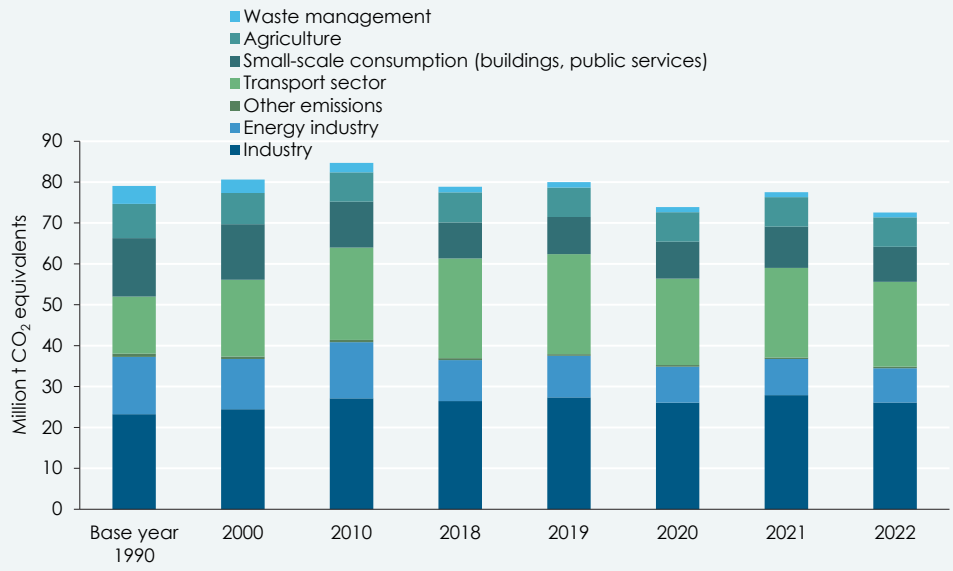
In 2021, domestic greenhouse gas emissions increased in all sectors except waste management and other emissions (Figure 4). Due to a significant increase in heating degree days, the sector buildings and services showed a particularly high growth rate of 11.1 percent, followed by industry with 7.0 percent and transport with 3.6 percent. In the sectors energy supply and agriculture, emissions were 0.6 and 0.3 percent higher than in 2020, respectively. In absolute terms,

industry saw the highest increase in emissions (+1.8 million t CO_2 equivalents) followed by the sector buildings and services (+1.0 million t CO_2 equivalents).

For the year 2022, the near-term forecast of Environment Agency Austria (2023b) expects a 6.4 percent (–5.0 million t) decrease in emissions to 72.6 million t CO_2 equivalents. This decline despite a GDP growth of 4.9 percent reflects effects of the Ukraine war and the associated strong increase in energy prices. Compared to the previous year, emissions are expected to decrease in all sectors, especially in buildings and services (–14.7 percent or –1.5 million tCO_2 equivalents), industry (–6.4 percent or –1.8 million CO_2 equivalents) and transport (–5.4 percent or –1.1 million t CO_2 equivalents). Major drivers of this decline are the sharp increase in energy prices and, for buildings and services, also a lower number of heating degree days.

Due to the energy crisis, Austria's greenhouse gas emissions fell significantly in 2022. The sectors buildings and services and industry, which saw the most significant emissions increases in 2021, are expected to have notably lower emissions in 2022.

Figure 4: **Sources of greenhouse gas emissions in Austria**



Source: Environment Agency Austria. 2022: Preliminary data from the near-term emission forecast "Nowcast" of the Environment Agency Austria and the Preliminary Energy Balance Austria 2022.

1.4 Strong increase in industry emissions in 2021

In 2021, the industrial sector accounted for 27.9 million t of CO_2 equivalents (+7.0 percent), 36.0 percent of total emissions (Figure 5), further increasing its share steadily (+4 percentage points since 2010). 17 million t were accounted for by process emissions, which increased by 9 percent year-on-year. Energy consumption by industry rose by 5.0 percent to reach 318 TJ. The increase in emissions and energy consumption is a consequence of the 9.6 percent higher gross value added of industry after the pandemic-related decline in 2020.

Despite the increase in economic activity, the industrial sector again showed a relative decoupling of emissions (emissions intensity, –2.3 percent) and energy consumption per unit of production (energy intensity, –4.2 percent) after 2018.

In terms of industry gross value added (+9.6 percent), the development of emissions and energy consumption decoupled in 2021 (+7 percent and +5 percent respectively).

1.5 Emissions from the transport sector increased at a below-average rate

In transport[2], emissions[3] rose again by 3.7 percent in 2020 after the sharp decline of over 13 percent. Despite this rebound effect, the increase was weaker than in the overall economy (+4.9 percent) and also weaker than GDP growth (+4.6 percent).

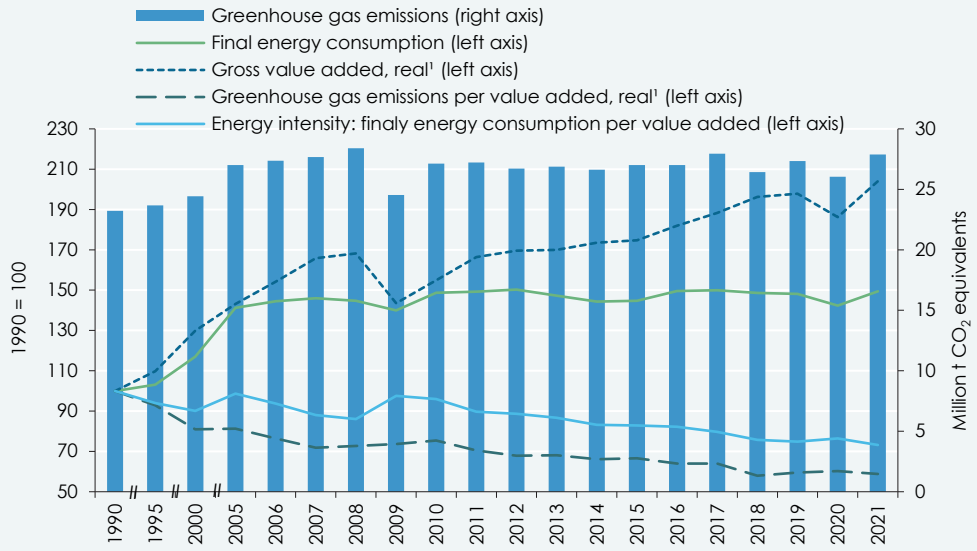
The final energy consumption of the transport sector increased by 4.4 percent to 351 PJ in 2021 and was thus at the same level as in 2003. The discrepancy between the development of emissions and final energy consumption is due to the fact that the consumption data include international air traffic, while the emissions data do not.

Emissions in transport increased by 3.7 percent in 2021 after the slump in the previous year.

[2] Energy consumption and emissions of the transport sector are generally calculated on the basis of the quantities of fuel sold in Austria.

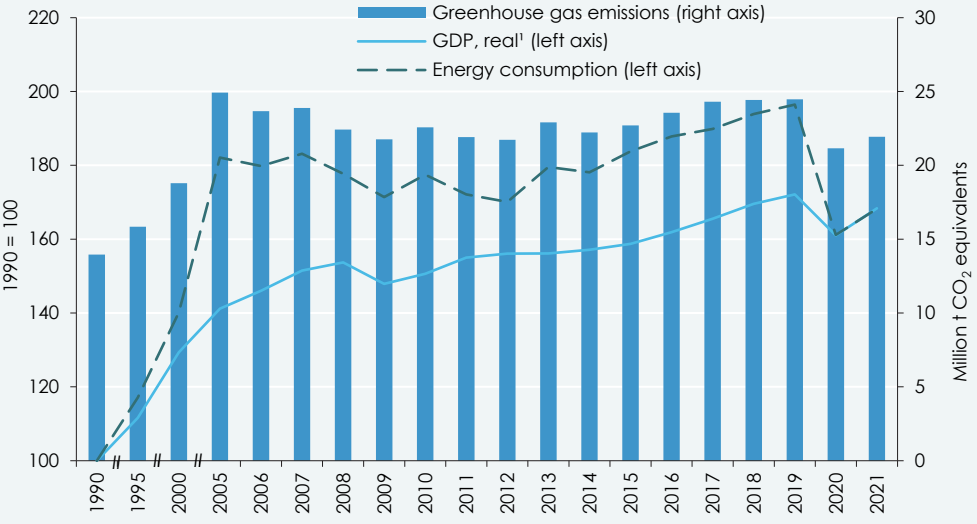
[3] Emissions according to the Environment Agency Austria excluding international air traffic and including transport in pipelines (around 0.05 million t CO_2 equivalents).

Figure 5: **Greenhouse gas emissions, energy consumption and gross value added of industry**



Source: Environment Agency Austria; Statistics Austria, Energy Balance Austria 1970-2021; WDS – WIFO Data System, Macrobond. – [1] Production of material goods including mining, at basic prices, reference year 2015.

Figure 6: **Greenhouse gas emissions, energy consumption of the transport sector and economic growth in Austria**



Source: Environment Agency Austria; Statistics Austria, Energy Balance Austria 1970-2021. – [1] Reference year 2015.

1.6 Greenhouse gas emissions from small-scale consumption significantly higher than in 2020

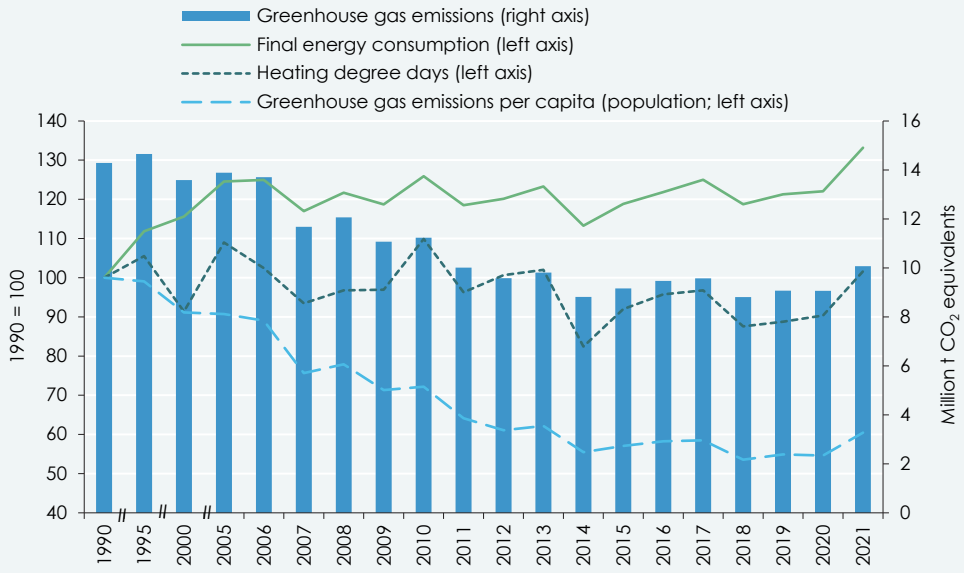
Due to the higher number of heating degree days (+12.5 percent) and cyclical factors, energy demand and emissions in small-scale consumption increased in 2021.

In the sectors private households, services and agriculture, both final energy consumption and greenhouse gas emissions increased significantly in 2021: at 453 PJ, final energy consumption was 38 PJ (9 percent) higher than in the previous year. At 34 PJ, the majority of the additional consumption was accounted for by space heating, for which significantly more energy was used due to the higher number of heating degree days. By energy source, the use of natural gas (+9 PJ), firewood (+7 PJ), district heating (+6 PJ) and gas oil for heating purposes (+5 PJ) increased in particular. Consequently, greenhouse gas emissions from small-scale consumption went up by 11.1 percent (Figure 7).

In 2021, the useful energy category "indoor climate and hot water" accounted for

78 percent of final energy consumption in the private household, services and agriculture sectors (excluding transport). The categories "stationary motors" (9 percent) and "lighting and EDP" (6 percent; Statistics Austria, 2022a) follow at a large distance.

Figure 7: **Greenhouse gas emissions of buildings, energy consumption of private households, services and agriculture and number of heating degree days**



Source: Environment Agency Austria; Statistics Austria, Energy Balance Austria 1970-2021; WDS – WIFO Data System, Macrobond.

1.7 Stagnation of greenhouse gas emissions from the provision of electricity and district heating

After the significant decline in the previous year, greenhouse gas emissions from the provision of electricity and district heating grew slightly in 2021 (+0.6 percent to 8.85 million t CO_2 equivalent), but the energy input used for this decreased by –0.4 percent (Figure 8).

The reason for this discrepancy is on the one hand the lower electricity generation from hydropower due to the drought, and on the other hand the higher number of heating degree days in 2021. The increased electricity consumption (+5 percent) was consequently covered by net imports (+19 PJ) as well as electricity from renewable energy sources and natural gas, the higher district heating demand with biomass and natural gas. Electricity imports reduce domestic energy use, while the combustion of natural gas increases emissions. The decline in electricity and district heating generation from coal, on the contrary, dampened the rise in emissions.

1.8 Rise in gross domestic consumption characterised by the increased use of fossil energy sources

The crisis year 2020, with a decline in gross domestic energy consumption to 1,350 PJ (–7.3 percent), was followed by an increase to 1,426 PJ (+5.6 percent) in 2021. This was based on the economic upturn and the relatively cold winter. Nevertheless, the pre-crisis level of 2019 (1,456 PJ) was not reached.

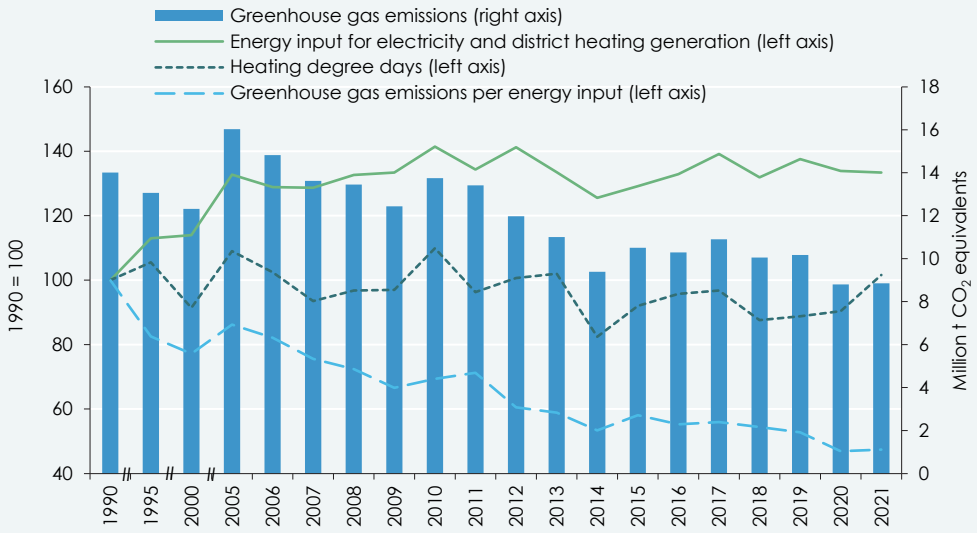
The additional consumption was mainly covered by fossil energy sources. Although the consumption of both fossil energy (+6 percent) and renewable energy (+2 percent) increased in terms of volume, the share of renewable energy sources fell by 1 percentage point to 31 percent compared to 2020. A long-term comparison shows a similar picture. While the average annual growth rate of renewable energy sources was 3.6 percent in 2000-2010, it was only 1.0 percent in the period 2010-2020. There is thus a great need for action to achieve the Austrian goal of climate neutrality by 2040 and the European climate goals.

Electricity generation declined again in 2021 (–3 percent), most significantly from hard coal (–75 percent) and hydropower (–8 percent). In contrast, the provision of district heating increased slightly (+9 percent).

The economic recovery increased gross domestic energy consumption in 2021.

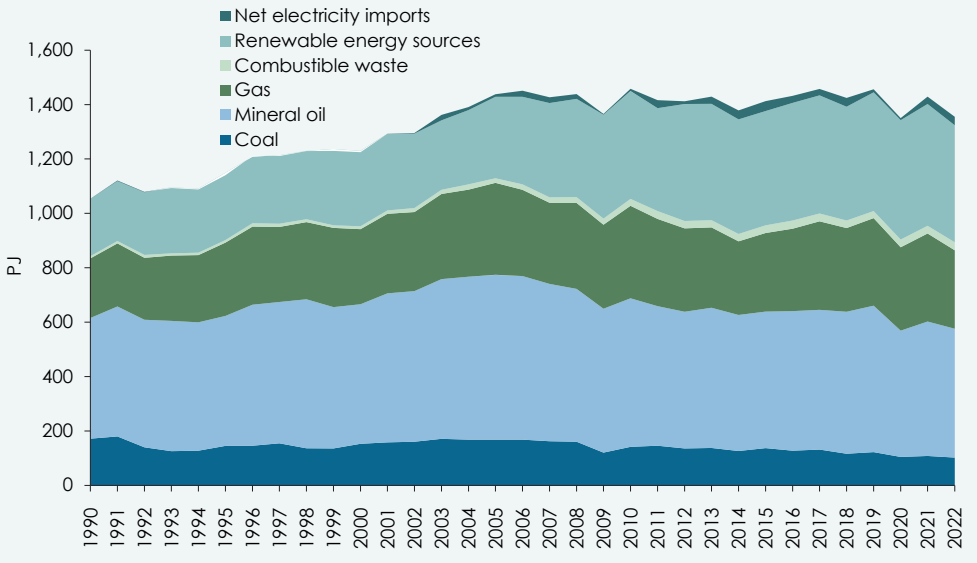
Austria has been a net importer of electricity since 2001. In 2021, over 27 PJ more were imported than exported, a good 19 PJ more than in 2020. At that time, electricity demand had fallen due to the economic slump and net imports of electricity had reached a low.

Figure 8: **Greenhouse gas emissions and energy use for electricity and district heating generation by energy utilities**



Source: Environment Agency Austria; Statistics Austria, Energy Balance Austria 1970-2021; WDS – WIFO Data System, Macrobond.

Figure 9: **Gross domestic consumption by energy source in Austria**



Source: Statistics Austria, Energy Balance Austria 1970-2021. 2022: Preliminary Energy Balance Austria 2022.

1.9 Selected developments according to the preliminary energy balance 2022

The war in Ukraine and the drought in summer led to a decline in energy consumption in 2022 via higher prices.

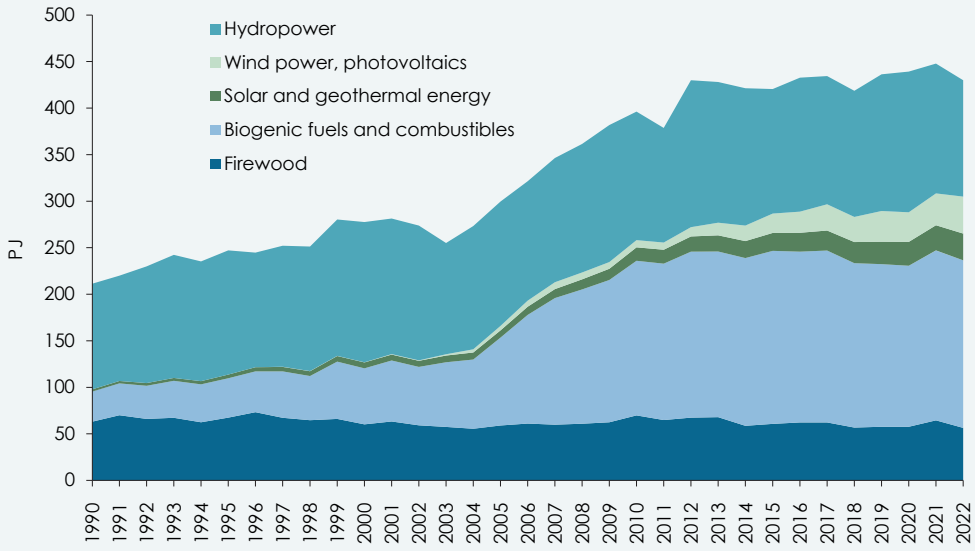
After the short-lived increase in 2021, energy consumption decreased again in 2022 according to the preliminary energy balance (–5 percent). The forecast value of 1,355 PJ corresponds roughly to the level of 2020.

One trigger for the downward trend in 2022 was the energy crisis.

In 2022, the shortage and rising cost of energy dampened both the consumption of fossil fuels (–6.6 percent) and their share in the energy mix (from 64.9 to 63.8 percent). Gas consumption decreased the most (–11 percent), mainly due to the high price

increases resulting from Russia's invasion of Ukraine, but also due to lower gas demand for space heating due to the mild winter. The share of renewable energy in total consumption increased slightly (+0.3 percentage points) according to preliminary data, but a decrease was recorded in absolute quantities (–4.0 percent). The reasons for this were mainly the drought in the summer of 2022, which dampened electricity generation from hydropower (–10 percent), and a lower use of firewood (–13 percent) due to the mild weather in winter. Biogenic fuels remained the most important renewable energy sources in 2022 with a share of 42 percent, ahead of hydropower with 29 percent and firewood with 13 percent. The increased ambition to become independent of fossil fuels is reflected in the growth rates of solar and geothermal energy (+6.6 percent) as well as wind power and photovoltaics (+15.9 percent).

Figure 10: **Gross domestic consumption of renewable energy sources**



Source: Statistics Austria, Energy Balance Austria 1970-2021. 2022: Preliminary Energy Balance Austria 2022.

1.10 Expenditure on net energy imports up by almost a third in 2022

Austria's high dependence on fossil fuels is reflected in a high dependence on imports. The associated increased financial outflows are particularly evident in the current energy crisis with drastically increased energy prices. Expenditure on energy imports rose by almost 28 percent in 2022, although the volume of imports fell by around 25 percent (Table 1).

In addition to the financial expenses, the security of energy supply is a pressing argument for reducing dependence on imports and diversifying sources of supply. To achieve this, greater attention must be paid, on the one hand, to improving energy efficiency, and thus to reducing the demand for energy. On the other hand, the capacity of energy production from renewable sources must be increased swiftly taking climate mitigation into account.

The strongest growth in nominal import expenditure in 2022 was recorded for electricity (+136.4 percent or +2.6 billion € compared to the previous year), followed by natural gas (+15.9 percent or +658 million €). Expenditure on oil imports also increased significantly (+5.6 percent or +191 million €). However, the additional expenditures do not correspond to an increase in volume, rather the import volumes of natural gas (–39.3 percent), crude oil (–32.1 percent) and coal (–32.2 percent) decreased considerably. In contrast, imports of heating oil (+20.4 percent), petrol (+44.0 percent) and diesel (+13.3 percent) as well as electricity (+8.2 percent) increased significantly. The dependence on the rising and volatile energy prices is thus most obvious for natural gas.

Austria's revenue from energy exports was 3.8 billion € in 2022, 11.7 percent higher than in 2021. Higher prices also had an impact on exports, i.e. exported volumes fell by almost 15.5 percent or 37 PJ, mainly for petrol (–39.6 percent), diesel (48.4 percent) and heating oil (–27.1 percent).

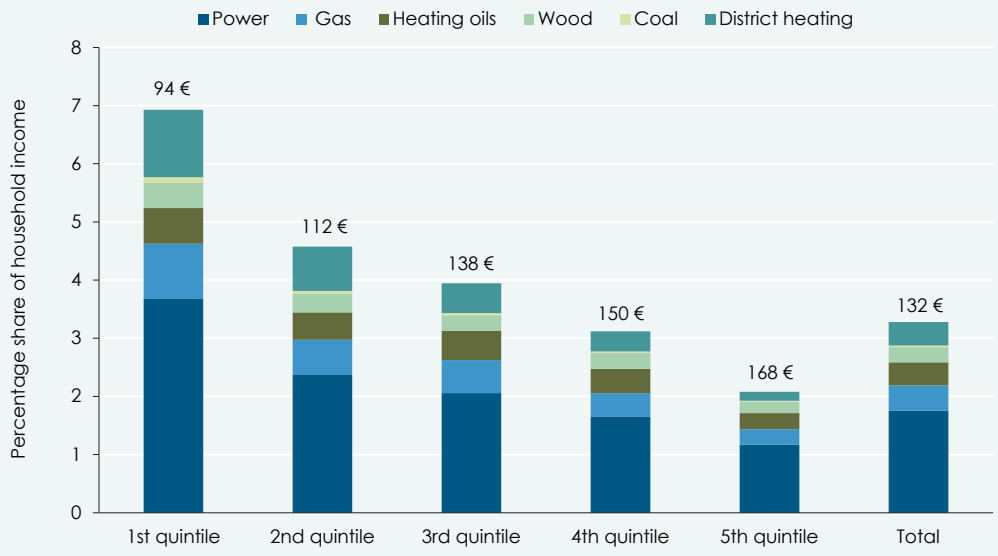
Austria spent significantly more on energy imports in 2022 (+28 percent). The increase in expenditure was price-driven, while import volumes declined by about 25 percent.

Table 1 **Foreign trade in energy sources**

	Exports				Imports				Balance			
	2015	2020	2021	2022	2015	2020	2021	2022	2015	2020	2021	2022
	Million €											
Coal	2	1	2	2	475	462	501	539	– 472.7	– 460.6	– 499.1	– 537.1
Crude oil	0	0	0	0	3,097	2,174	3,434	3,625	– 3,097.3	– 2,174.5	– 3,434.3	– 3,625.2
Heating oil	121	0	0	0	33	15	22	23	+ 88.1	– 15.1	– 21.9	– 22.7
Petrol	476	370	596	618	499	244	396	425	– 22.7	+ 125.4	+ 200.8	+ 193.1
Diesel fuel	478	453	792	810	2,177	2,030	2,927	3,086	– 1,698.9	– 1,576.9	– 2,135.6	– 2,276.2
Natural gas	315	348	438	576	2,701	1,995	4,131	4,789	– 2,386.7	– 1,647.0	– 3,693.2	– 4,212.4
Power	857	1,121	1,20	1,846	1,103	884	1,935	4,574	– 245.8	+ 237.5	– 315.0	– 2,727.8
Total	2,249	2,294	3,448	3,853	10,085	7.805	13,346	17,061	– 7,836.0	– 5,511.2	– 9,898.3	– 13,208.2
	PJ											
Coal	0.3	0.0	0.0	0.0	119.4	102.3	108.0	73.2	– 119.1	– 102.3	– 108.0	– 73.2
Crude oil	0.0	0.0	0.0	0.0	344.6	319.8	321.6	218.3	– 344.6	– 319.8	– 321.6	– 218.3
Heating oil	21.6	19.5	15.4	11.2	0.5	2.8	1.3	1.6	+ 21.1	+ 16.7	+ 14.0	+ 9.6
Petrol	38.6	39.0	39.0	23.6	33.3	22.1	22.5	32.4	+ 5.3	+ 17.0	+ 16.5	– 8.9
Diesel fuel	34.0	39.5	48.6	25.1	155.6	165.5	167.7	190.1	– 121.6	– 126.0	– 119.1	– 165.0
Natural gas[1]	49.4	91.4	69.8	72.1	454.4	636.2	524.6	318.6	– 405.0	– 544.8	– 454.9	– 246.4
Power	69.6	80.4	68.0	71.6	105.8	88.3	95.2	102.9	– 36.2	– 7.9	– 27.2	– 31.3
Total	213.4	269.8	240.8	203.6	1,213.6	1,337.0	1,241.0	937.2	– 1,000.2	– 1,067.2	– 1,000.1	– 733.6

Source: Statistics Austria, Energy Balance Austria 1970-2021, Preliminary Energy Balance 2022, Foreign Trade Statistics; WDS – WIFO Data System. – [1] In the current energy balance, natural gas transit through Austria is no longer shown. The values printed here for the import and export of natural gas are taken from the foreign trade statistics and include transit.

Figure 11: **Share of energy expenditure on housing in household income 2021**



Source: EU-SILC.

The lower income quintiles would benefit more from investments in energy-efficient buildings, as they spend higher shares of their income on residential energy.

The implicit import price calculated from volumes and expenditures for a notional imported energy volume was 4.6 million € higher in 2021 than in 2020, at 10.8 million € per PJ, and rose further to 18.2 million € per PJ in 2022 (+7.4 million € per PJ).

The nominal foreign trade balance for energy deteriorated by about 3.3 billion € in 2022 to –13.2 billion €, while the quantitative balance improved by about 334 PJ.

1.11 Energy expenditures burden low-income households the most

The energy expenditure of Austrian households for housing (mainly for space heating, hot water, cooking) averaged 132 € per month in 2021 and was thus similar to the two previous years (Figure 11). In the lowest income quintile, the expenditure of 94 € per month was the lowest in absolute figures and 74 € lower than in the 5th income quintile. Measured in terms of household income,

however, the burden on the lowest-income households (1st quintile) was more than three times as high as on the highest-income households (6.9 percent compared to 2.1 percent in the 5th quintile).

Energy expenditure on housing is largely determined by factors such as the size of the dwelling, the building fabric and the type of heating, but also by the availability of financial resources for energy-saving investments (e.g., building renovation, heating system replacement) and individual behaviour. Increasing the energy efficiency of buildings is not only of high importance in terms of climate policy, but would also lead to financial relief, especially for low-income households.

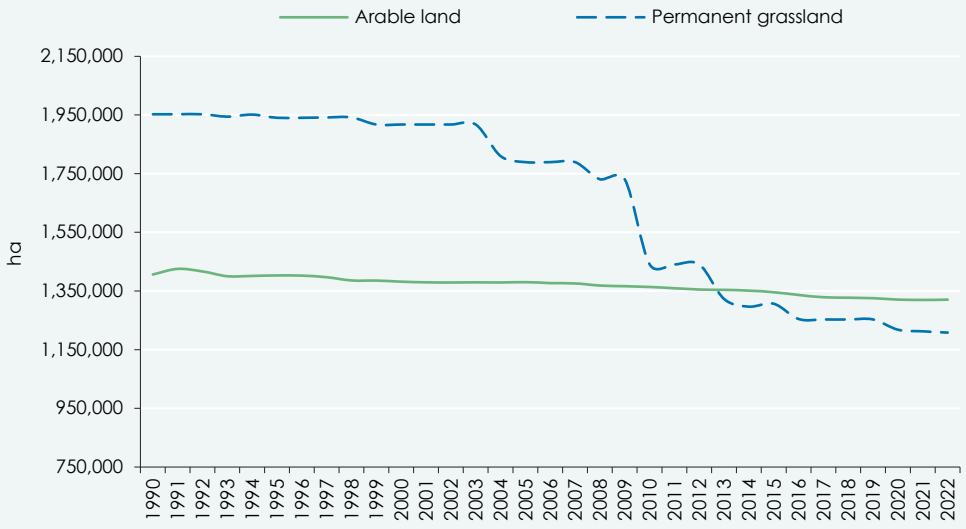
2. Agricultural production and nitrogen balance in Austria

Since 1990, agricultural land has been steadily decreasing. The increase in yields per hectare cannot compensate for the decline in area. Production has been stagnating for decades.

Agriculture plays a central role in food security while simultaneously contributing to climate and biodiversity protection. For example, biomass binds carbon from the atmosphere (Meyer et al., 2023). Between 1990 and 2022, arable land in Austria shrank by 85,800 ha, permanent grassland (including alpine pastures) by as much as 744,400 ha (Figure 12; Statistics Austria, 2022c). Per capita, the available utilised agricultural area decreased from 4,485 m² (1990) to 2,867 m² (2022). In addition to the decline in agricultural land, this effect is also due to a rising population (Statistics Austria, 2023a).

The production of biomass on arable land does not follow the decreasing trend of arable land due to increasing yields per hectare. However, the agricultural production has been stagnating for decades, with considerable annual fluctuations, which are mainly due to weather conditions (Figure 13). Against the backdrop of increased demand from a growing population and without a demand-side change in dietary behaviour, domestic agriculture is thus contributing less and less to food security.

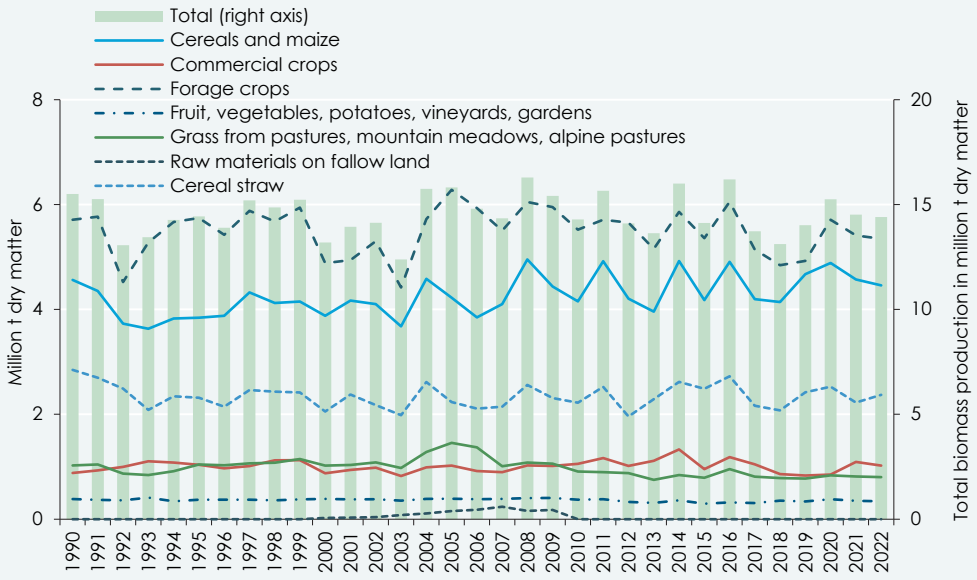
Figure 12: **Development of arable land and permanent grassland in Austria since 1990**



Source: Austrian Central Statistical Office (1992); Statistics Austria, (2022c); Statistics Austria, Cultivation on arable land – field crop and permanent pasture production, various years (https://www.statistik.at/statistiken/agriculture-and-forestry/crop-cultivation/arable-cultivation-permanent-grassland); Statistics Austria, Agricultural structure survey – land use, various years (https://www.statistik.at/statistiken/land-und-forstwirtschaft/betriebs structure/land-use); STATcube of Statistics Austria, field crop production from 1970; STATcube of Statistics Austria, Agricultural structure survey 2020 – land use.

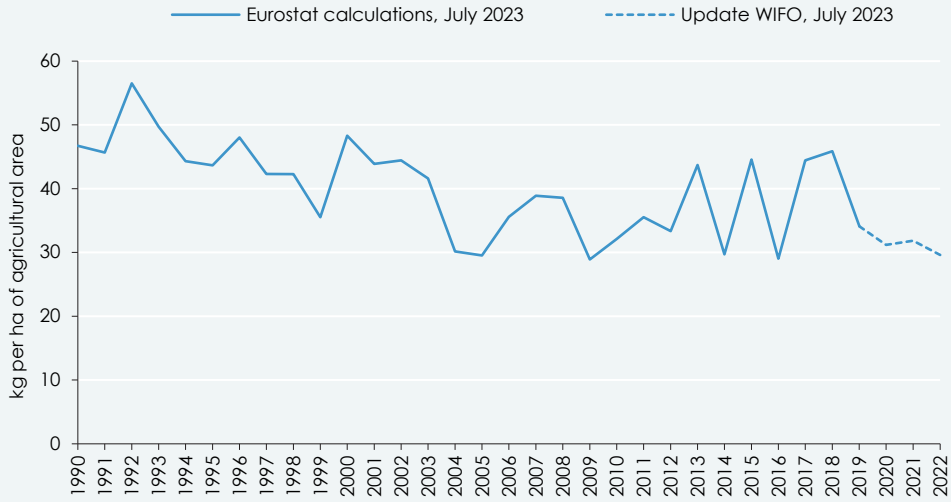
For the production of biomass, which serves as food and feed or as raw material for industrial applications, nitrogen is indispensable as an essential component of proteins. With the removal of the harvested crop, nitrogen is removed from the soil and its replacement with nitrogen fertiliser a prerequisite for high crop yields. Easily soluble mineral fertilisers and organic fertilisers (e.g. farm manure, compost) are available to agriculture for this purpose. However, nitrogen is also a source of greenhouse gases. Nutrients that are not taken up by plants can enter the groundwater or are emitted to the atmosphere in gaseous form.

Figure 13: **Production of economically usable biomass by agriculture in Austria**



Source: WIFO calculations based on Buchgraber et al. (2003); DLG feed value table; Resch (2007). Straw is a by-product of cereal production (excluding maize); a uniform grain-straw ratio of 1 : 0.9 is assumed. Loss factors for fodder management according to Buchgraber et al. (2003), supply balances according to Statistics Austria (2023b).

Figure 14: **Nitrogen balance**



Source: Eurostat, Gross Nutrient Balance 1990-2019 (data retrieved on 18. 8. 2023, data status 21. 7. 2023); WIFO calculations. Until 2012, the data were determined by the Environment Agency Austria using the OECD method. The Eurostat and OECD methods differ with regard to the areas and sources covered (e.g., atmospheric deposition). Explanatory notes are provided by Kletzan-Slamanig et al. (2014).

Nitrogen (fertiliser) is necessary for the production of biomass and the achievement of high yields, but at the same time it is also a significant source of greenhouse gases.

The nitrogen balance according to the method developed by the OECD and modified by Eurostat (Figure 14) accounts not only for fertilisers but also the synthesis of atmospheric nitrogen by the root system of some plants (especially legumes) and atmospheric deposition. The sum of the nutrient amounts of all nitrogen sources is compared to the removal by the crop. A positive balance means that more nitrogen has been added to the agricultural cycle than has been removed. As the balance surplus increases, so does the risk of undesirable inputs into groundwater or greenhouse gas emissions. On the one hand, the annual fluctuations (Figure 14) are due to the nutrient requirements of crops, which are not yet foreseeable at the time of fertilisation. On

the other hand, the statistics record the quantities sold on the market and not the quantities actually applied to the crops. Overall, the amount of nitrogen fertiliser applied has been slightly decreasing since 1990 – a trend that is also reflected in the nitrogen balance.

3. Special topic: state of implementation of the "Fit for 55" package

3.1 European Commission proposals to achieve climate neutrality in the EU

With the European Green Deal (European Commission, 2019), the EU member countries set the target of achieving climate neutrality by 2050. In 2021, this goal was enshrined in the European Climate Law (European Commission, 2021c), with the interim target of reducing greenhouse gas emissions by at least 55 percent by 2030 compared to 1990.

In line with the goal of climate neutrality by 2050, the European Commission (2020) presented in July 2021 the "Fit for 55" package (European Commission, 2021a), a comprehensive set of legislative proposals to reduce greenhouse gases by 55 percent by 2030. In addition to amending the current energy and climate legislation, it also provides for the introduction of new legislation (for an overview see Kettner & Feichtinger, 2021).

To address the long-term challenge of climate change and achieve the goal of climate neutrality, the legislative package includes a wide range of policy instruments, including:

- price instruments for greenhouse gases,
- instruments for setting targets, and
- standards and supporting measures.

Regardless of the policy instrument, the narrow timeline of 2030 and the ambitious emission reduction target pose major challenges for implementation and set the framework for long-term structural changes.

The directives and regulations proposed in the "Fit for 55" package are now at different stages of the legislative process. The discussion has gained momentum due to the energy crisis resulting from the Ukraine war. This is reflected in the "REPower-EU" plan (European Commission, 2022). Based on the "Fit for 55" process, the Commission therein proposed, among other things, an increase in the energy efficiency target for 2030 from 9 to 13 percent and highlighted in particular the potential of the Buildings Directive and the Ecodesign Directive to improve energy efficiency. In order to accelerate the phase-out of fossil fuels, an increase in the share of renewable energy sources from the agreed 40 percent target to 45 percent by 2030 was suggested. The achievement of the target is to be facilitated by accelerating approval procedures and designating preferred areas for the development of renewable energy sources, so-called "go-to" areas.

3.2 Implementation progress on the "Fit for 55" package

Table 2 summarises the measures included in the "Fit for 55" package, the original targets, the status of negotiations in August 2023 and the current status in the legislative process.

3.2.1 Price-based instruments

EU emissions trading – existing system

In May 2023, a comprehensive revision of the EU Emissions Trading Scheme (EU ETS) was adopted (European Commission, 2023b). The main changes include a higher emissions reduction target of 62 percent by 2030 (compared to 2005 emissions), raising the target originally proposed in the "Fit for 55" package by 1 percentage point. Along with this, the linear reduction factor was adjusted to 4.3 percent for the 2024-2027 period and to 4.4 percent for the 2028-2030 period. The market stability reserve is intended to balance supply and demand for CO_2 certificates. There is the possibility of permanently cancelling certificates if more than 400 million units are held in the market stability reserve. This should eliminate the high surpluses of certificates that still exist on the market. Maritime shipping is to be gradually included in emissions trading from 2024. In addition, a gradual reduction of the free allocation of allowances is planned in the period 2026-2034, accompanied by the introduction of the carbon border adjustment mechanism. Auction proceeds feed the Innovation Fund to accelerate the transformation of emissions-intensive industry.

The proposed policy instruments in the "Fit for 55" package shall ensure achieving climate neutrality by the middle of the century.

EU emissions trading – separate system for buildings and road transport

In addition to the reform of the existing emissions trading system, a second system (ETS 2) will be introduced for buildings, transport and other sectors (especially less emissions-intensive industries). Preparations for operation will start in 2025. Auctioning of allowances has been determined as the allocation mechanism. The ETS 2 will become operational in 2027, with an annual linear emission reduction factor of 5.38 percent. If the allowance price in ETS 2 exceeds 45 € for two months in a row, the supply is to be increased with additional allowances taken from the market stability reserve and which are earmarked for this purpose. The auction proceeds for ETS 2 certificates will flow into a newly created climate social fund. The funds are to be used to support private house-

Despite the energy crisis, the EU remains committed to implementing the "Fit for 55" package.

For most of the bills of the "Fit for 55" package, political agreements have been reached and final legislative texts are available. The negotiation results tend to be more ambitious than the original proposals.

holds and companies particularly affected by the CO_2 price to avoid hardship.

Carbon Border Adjustment Mechanism (CBAM)

To counter the risk of carbon leakage, a carbon border adjustment mechanism has been agreed on. It enters into force with a transition phase in October 2023 and concerns the cement, aluminium, fertiliser, electricity, hydrogen, iron and steel sectors as well as some intermediates industries. No payments are foreseen during the transition phase. With the activation of the regular system from 2026, importers of products from the regulated sectors are obliged to purchase and surrender CBAM certificates. The certificate price is based on the average weekly auction prices of the EU emissions trading system (European Commission, 2023e).

3.2.2 Instruments for setting targets

Renewable Energies Directive

With the revision of the Renewable Energy Directive (RED III; European Commission, 2021d), the previous targets (RED II; European Commission, 2018a) were raised. The new binding target is a 42.5 percent share of renewable energy in gross final energy consumption in the EU 27 by 2030 (European Commission, 2023c). This represents both a significant increase compared to the previous version (32 percent), but also compared to the original Commission proposal in the "Fit for 55" package (40 percent).

According to the preliminary agreement between the Council and the Parliament, the member countries are encouraged to increase the share to 45 percent by 2030. In addition, each member country is to set an indicative target for innovative renewable energy technologies to account for at least 5 percent of newly installed renewable energy capacity by 2030.

LULUCF Regulation

The EU Land Use, Land Use Change and Forestry Regulation (LULUCF Regulation) regulates the conversion, use and management of land and forests and the associated emissions. The sector acts as a carbon sink. It absorbs more CO_2 from the atmosphere than it emits. The revision of the regulation as proposed in the "Fit for 55" package (European Commission, 2018b) was adopted in April 2023. It envisages a reduction of 310 million t of CO_2 equivalents (instead of 225 million t previously) by 2030 (European Commission, 2023d). This corresponds to just under 9 percent of the total greenhouse gas emissions of the EU 27 in 2021 (European Environment Agency, 2023).

Effort Sharing Regulation and Energy Efficiency Directive

Furthermore, the Effort Sharing Regulation and the Energy Efficiency Directive were updated in March 2023: the former sets emission targets for sectors not covered by the EU ETS, such as transport, buildings, agriculture, waste management, and small businesses. The Commission's proposed target of a 40 percent reduction in greenhouse gases compared to 2005 was reaffirmed (European Commission, 2023f). The updated Energy Efficiency Directive aims to reduce final and primary energy demand by 11.7 percent by 2030 compared to the 2020 forecast. In order to achieve this target, member countries are required to increase their energy savings annually from 2024 to 2030. The public sector is to act as a role model and faces separate targets, such as the obligation to renovate 3 percent of the building area annually (European Council, 2023a).

3.2.3 Standards and supporting measures

Toughening of CO_2 emission standards for passenger cars and light commercial vehicles

The regulation (European Commission, 2023g) sets CO_2 emissions standards for passenger cars and light commercial vehicles. By 2035, only emission-free new cars are to be introduced to the market. In contrast to the legislative proposal, e-fuels will also be permitted as fuels in the version adopted in March 2023. The details of this will be regulated in a delegated act currently being drafted, which the European Parliament could theoretically still oppose.

"ReFuelEU" and "FuelEU" – more sustainable aviation and marine fuels respectively

The two regulations set targets for the gradual decarbonisation of the aviation and shipping sector respectively. According to the preliminary agreement in April 2023, aviation fuels are to contain a minimum share of sustainable fuels from 2025 and a minimum share of synthetic fuels from 2030. The shares are to be gradually increased to 70 and 35 percent respectively by 2050 (European Parliament, 2023). These targets are more ambitious than the Commission proposal (European Commission, 2021e). In the shipping sector, according to the regulation adopted in July 2023 (European Commission, 2023a), the greenhouse gas intensity is to be gradually reduced by up to 75 percent by 2050, among other things through the use of sustainable fuels, but also through a mandatory shore-side electricity supply (European Commission, 2023a).

Table 2: **Proposed and adopted objectives of the "Fit for 55" package**

Instrument	Aims of the design	Current status	Time of the last change	Source
Price-based instruments				
Emissions trading scheme				
Revision and more ambitious targets of the existing emissions trading scheme and extension to maritime transport	Emissions reduction of 61 percent compared to 2005, adjustment of the linear reduction factor to 4.2 percent p.a.; extension to maritime transport	Emissions reduction of 62 percent compared to 2005 Maritime transport: phased introduction 2024 to 2026	Adopted April 2023	[1]
Revision of the Market Stability Reserve			Adopted April 2023 Decision March 2023	[1] [2]
Introduction of separate emissions trading for road transport and buildings	New emissions trading system for road transport and buildings: preparatory phase from 2025, surrender of allowances from 2026	Introduction from 2027 onwards Price cap of 45 € per t CO_2	Adopted April 2023	[1]
Introduction of Climate Social Fund			Adopted April 2023	[3]
Introduction of a new Carbon border adjustment mechanism (CBAM)	Importers buy emissions certificates for emissions generated in production, price as in emissions trading system	Step by step introduction Free allocation ends in 2034	Adopted April 2023	[4]
Updating the Energy Taxation Directive	Minimum tax rate on energy content No distinction between types of use Continuous adjustment of the minimum tax rate	No change and no progress compared to the proposal to update the Energy Taxation Directive		[5]
Targets				
Updating the Effort Sharing Regulation	Reduce emissions by 40 percent by 2030 compared to 2005 levels	Reduce emissions by 40 percent by 2030 compared to 2005 levels	Adopted March 2023	[6]
Updated Regulation on Land Use, Land Use Change and Forestry	EU target net reduction of greenhouse gases by at least 310 million t CO_2 equivalents by 2030	EU target net reduction of greenhouse gases by at least 310 Mt CO_2 equivalents by 2030	Adopted April 2023	[7]
Updating the Renewable Energy Directive	Increase the share of renewable energy sources in final consumption to 40 percent by 2030	Increase the share of renewable energy sources to 42.5 percent with an additional indicative increase to 45 percent	Provisional agreement March 2023	[8]
Updating the Energy Efficiency Directive	Reduce final and primary energy demand by 9 percent compared to the current target to 786 and 1,023 million t of oil equivalent, respectively.	Reduction of final and primary energy demand by 11.7 percent compared to the 2020 forecast to 763 and 993 million t of oil units, respectively	Adopted July 2023	[9]
Standards and supporting measures				
Toughening CO_2 emissions standards for passenger cars and light commercial vehicles	Newly registered vehicles must be emission-free from 2035 onwards	Newly registered vehicles must be emission-free from 2035 – use of e-fuels is possible	Adopted March 2023	[10]
Developing the infrastructure for the use of alternative fuels	Faster development of rapid charging points for electric vehicles on the most important transport corridors	Faster development of rapid charging points for electric vehicles on the most important transport corridors	Adopted July 2023	[11]
"ReFuelEU": Promoting sustainable aviation fuels	Reducing the environmental footprint of air transport	Aviation fuel must contain a minimum proportion of sustainable fuels from 2025 and a minimum proportion of synthetic fuels from 2030, which will be gradually increased by 2050.	Provisional agreement April 2023	[12]
"FuelEU": promoting more environmentally friendly marine fuels	Reduction of the greenhouse gas intensity of shipping by up to 75 percent by 2050	Reduction of the greenhouse gas intensity of shipping by up to 75 percent by 2050	Adopted July 2023	[13]
Energy performance of buildings	New buildings may no longer cause emissions from 2030, existing buildings from 2050 onwards	From 2028, new buildings in public ownership may no longer cause emissions. Threshold values for energy performance apply to existing non-residential buildings.	General Approach Council October 2022	[14]

Source: WIFO presentation. – [1] https://data.consilium.europa.eu/doc/document/PE-9-2023-INIT/en/pdf. – [2] https://data.consilium.europa.eu/doc/document/PE-5-2023-INIT/en/pdf. – [3] https://data.consilium.europa.eu/doc/document/PE-11-2023-INIT/en/pdf. – [4] https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32023R0956&qid=1693834127526. – [5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX percent 3A52021PC0563. – [6] https://data.consilium.europa.eu/doc/document/PE-72-2022-INIT/en/pdf. – [7] https://eur-lex.europa.eu/eli/reg/2023/839/oj. – [8] https://data.consilium.europa.eu/doc/document/ST-10488-2022-INIT/en/pdf. – [9] https://data.consilium.europa.eu/doc/document/ST-10697-2022-INIT/en/pdf. – [10] https://data.consilium.europa.eu/doc/document/PE-66-2022-INIT/en/pdf. – [11] https://www.europarl.europa.eu/RegData/commissions/tran/lcag/2023/04-26/TRAN_LA(2023)003058_EN.pdf, https://oeil.secure.europarl.europa.eu/oeil/popups/ficheprocedure.do?reference=2021/0223(COD)&l=en. – [12] https://www.europarl.europa.eu/RegData/commissions/tran/lcag/2023/06-16/TRAN_LA(2023)003926_EN.pdf. – [13] https://www.europarl.europa.eu/RegData/commissions/tran/lcag/2023/04-26/TRAN_LA(2023)003055_EN.pdf. – [14] https://data.consilium.europa.eu/doc/document/ST-13280-2022-INIT/en/pdf, https://data.consilium.europa.eu/doc/document/ST-13280-2022-COR-1/en/pdf.

Revision of the Energy Performance of Buildings Directive

The planned update of the Energy Performance of Buildings Directive (European Council, 2023b) stipulates that new buildings must be zero-emissions buildings by 2030. Furthermore, energy performance certificates are mandatory. By 2050, the entire building stock in the EU is to be emission-free and completely decarbonised. The levers for this are minimum energy performance standards. The Council's general approach of October 2022 also includes the obligation to construct new public buildings as zero-emission buildings from 2028. For existing non-residential buildings, energy performance thresholds have also been set for 2030 and 2034.

3.3 Conclusion

Contrary to fears that the energy crisis in the wake of the Ukraine war would push the EU's climate goals and policy into the background, the majority of the legislative proposals of the "Fit for 55" package were adopted by summer 2023, in some cases with more stringent targets. The challenge of the next few years will be the successful implementation of the adopted legal acts in order to achieve climate neutrality by 2050.

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