Federal Ministry
Republic of Austria
Sustainability and Tourism

Long-Term Strategy 2050 - Austria

Period through to 2050

pursuant to Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action

as per Decision 1/CP.21, paragraph 35 in accordance with Article 4, paragraph 19 of the Paris Agreement

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THE VISION – A climate-neutral Austria in 2050

A comprehensive long-term strategy needs a clear vision. The future will be what we make of it, not a given state. A long-term path requires an appealing and inspiring long-term vision. **Austria has set the goal of being climate-neutral by no later than 2050 – this is our vision.**

A strategy that includes a comprehensive transformation of both our energy supply and our consumption patterns and that includes an adapted but competitive economic system goes far beyond of merely reducing greenhouse gas emissions. It must contain all three pillars of sustainability –economic, social, and environmental aspects – as this is the only way to achieve committing to far-reaching changes by the population. Resource saving, sustainable and innovative technologies and the circular economy are key elements to achieve the goal.

The development of this vision, the design of the strategy, the definition, the implementation and review of concrete measures is a core task of politicians and public administration. At the same time, the business community is an important partner for achieving the energy and climate transformation. Our vision, which aims to facilitate an energy transformation, sustainable consumption patterns, and an inclusive economic system can only be achieved through technological progress and creative and innovative business models that allow people to benefit while using less resources. This ultimately means a structural change that will affect all aspects of our lives – but this beginning shall be an opportunity to actively shape our future and develop innovations and new ways of thinking.

1 OVERVIEW AND STRATEGY DEVELOPMENT PROCESS

1.1 Legal and political framework

1.1.1 The international framework

The Paris Agreement was adopted in December 2015 and entered into force on 4 November 2016. It is the first ambitious and legally binding agreement at global level that contains commitments for all signatory countries regarding climate action. The most important features of the agreement and the accompanying decision are:

- **Temperature goal:** Global warming should be limited to well under 2°C, and efforts should be taken to limit the warming to 1.5°C.
- **Adaptation goal:** The ability to adapt to the negative consequences of climate change should be increased and climate-resilient and low-emission development should be promoted.
- **Financing goal:** Financial flows should be brought in line with low-emission and climate-resilient development.
- **Long-term goal:** Global greenhouse gas emissions should reach their global peak as soon as possible and then decline rapidly to achieve a balance between greenhouse gas emissions and carbon sequestration (e.g. in forests) in the second half of this century. This equates to achieving zero net emissions after 2050, i.e. the comprehensive replacement of fossil fuels.
- **Long-term plans:** All signatories are encouraged to submit plans for long-term low-emission development.
- **Climate action measures:** All signatories are required to submit nationally determined contributions (NDCs) every five years, with the requirement that new NDCs shall be more ambitious than the ones they replace. Developing countries are encouraged to move towards absolute, comprehensive goals. The signatories are also urged to submit long-term low-emission strategies by 2020.
- **Evaluation of the level of ambition:** The first NDCs that were submitted are not ambitious enough to be on the 2°C target path (roughly 2.7 to 3.2°C). Hence, a regular stocktaking will be carried out. The first stocktake will be conducted in 2023 and will be

repeated every five years. The Paris Agreement shall be strengthened to guarantee a global transition to sustainable energy technologies.

The Agreement not only initiated the exit from fossil fuels, but also a global transformation of our energy systems, economy and society.

The IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission and the difference to an increase of 2°C reinforces the imperative nature of this transformation.[1]

Key global action areas addressed in the special report are:

- Reduction of the carbon intensity of electricity generation to zero and substantial reduction of total energy consumption by the middle of the century, plus an increased share of electricity to meet energy demand.
- Increase in the production of renewable energy (bioenergy, water, wind, solar) by 60% from 2020 to 2030. Increase of primary energy generation from renewable sources to 49–67% by 2050.
- Change in land use to meet the competing demands of housing development, food production, livestock farming, bioenergy, biodiversity and ecosystem functions.
- Industry emissions are 70–90% lower in 2050 than in 2010.
- Substantial emission reductions need to be achieved for transport and buildings by 2050. This will be achieved through technical measures (such as increased energy efficiency and electrification) as well as through lifestyle changes that lead to reduced energy consumption (such as using bicycles and walking).

Even a 1.5°C global temperature increase would have serious consequences, such as:

- More extreme weather events (such as heat waves, heavy precipitation, and extreme droughts).
- Negative impacts on ecosystems (up to extinction of species) and in the areas of healthcare, drinking water supply, and food production.
- A substantial and irreversible rise in the sea level.

The effects of climate change on sustainable development, on efforts to eradicate poverty and inequality can be reduced if we limit the temperature increase to 1.5°C instead of 2°C. If choices are made carefully and the respective national conditions are taken into account, adaptation strategies can be drafted in a way that they also contribute to sustainable development and

[1] https://www.ipcc.ch/sr15/

reducing poverty. Adaptations will be required in many sectors of the economy (energy generation, industry and transport systems).

The temperature increase in Austria is around twice the global average, for example as documented in the first Austrian climate status report. The temperature increase is generally greater over land than over the oceans. The average temperature in Austria is already around 2°C higher than at the end of the 19th century.

Systemic changes will be needed to mitigate the risks that global warming of 1.5°C poses to the SDGs and to fight against poverty. This includes the redirection of financial flows towards measures that reduce emissions or result in relevant adaptation. This involves various areas of policy such as energy systems and infrastructure.

Sustainable development supports or rather paves the way for fundamental social changes and system transformations which contribute to limiting global warming to 1.5°C.

1.1.2 Framework in the European Union

1.1.2.1 The EU climate and energy targets for 2030

In 2014 the European Union (EU) adopted a binding EU-wide greenhouse gas reduction target of at least 40% compared with 1990 levels for the period from 2021 to 2030. This target was also included in the EU's first nationally determined contribution (NDC) under the Paris Agreement.

The implementation in the EU is taking place through the emissions trading scheme as well as through effort sharing by the sectors not covered by emissions trading (transport, buildings, trade, agriculture, waste management, fluorinated greenhouse gases). According to the amended Emissions Trading Directive (Directive [EU] 2018/410), the facilities tracked in the system are to reduce their greenhouse gas emissions by 43% compared with 2005 levels by 2030, which means a linear reduction of 2.2 percentage points per year starting in 2021 (2013–2020: -1.74%). For sectors not covered by emissions trading, the new Effort Sharing Regulation (EU) 2018/842 requires a 30% reduction compared with 2005 by no later than 2030, with the individual Member States being required to make contributions ranging between 0 and -40%, primarily dependent upon per capita GDP. Austria's reduction target is 36%. The adoption of the LULUCF Regulation (EU) 2018/841 (Land Use, Land-Use Change and Forestry) will add the sector of land use to the EU reduction target starting in 2021, meaning that all material sectors of the economy are now covered by the climate policy.

The European Commission (EC) presented the Clean Energy Package in November 2017. This set of laws, that consists of the Energy Performance of Buildings Directive, the amended Renewable Energy Directive and Energy Efficiency Directive, and the regulation on the governance of the Energy Union and a modernised electricity market design (regulation and directive), defines targets of at least 32% energy from renewable sources and at least a 32.5% improvement in energy efficiency for the period from 2021 to 2030.

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 requires the Member States to submit a national energy and climate plan starting from 2021 to 2030 by 31 December 2019 and a long-term strategy 2050 by 1 January 2020.

1.1.2.2 A clean planet for all

On 28 November 2018, the EC presented the communication titled "A clean planet for all – A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy" together with an in-depth analysis (COM [2018] 773).

The communication presents a vision and long-term strategy (LTS) for European climate and energy policy on the basis of eight scenarios to illustrate how zero net greenhouse gas emissions can be achieved by 2050 cost effectively and with the help of a socially just transition. The eight scenarios describe the modelling of different technical solutions for cutting emissions. Six of these aim at emission reductions of 80–90%, and two present the path to climate neutrality. The strategy encompasses all key sectors including energy, buildings, transport, industry, agriculture, and land use in a broader sense and is aligned with the goal of the Paris Agreement to limit the temperature increase to well below 2°C and to continue striving to stabilise it at 1.5°C.

Austria advocated for the EU reaching climate-neutrality/zero net emissions by 2050 at the European Council in June 2019 and December 2019, though Austria rejects the contribution of atomic energy and carbon capture and storage (CCS, prohibited in Austria due to unresolved safety questions) and takes a critical view of the role of natural sinks in reaching climate neutrality.

Together with Luxembourg, Ireland, and Lithuania, Austria addressed a letter to the EC with an appeal to present a 100% "renewables" zero net scenario by 2050, as all scenarios presented by the EC to date include atomic energy. The response from the EC sees the presentation of such a scenario as interference in the rights of the Member States in terms of the free choice of national energy resources. For Austria, the presentation of such a scenario is solely intended to assess its feasibility.

1.1.3 Framework in Austria

1.1.3.1 Climate Change Act

The Climate Change Act (KSG) was passed in 2011 to facilitate the attainment of the objective for 2020 and serves as a basis for

- specifying maximum annual quantities in six sectors (waste, energy and industry outside of the ETS, fluorinated greenhouse gases, buildings, agriculture, transport),
- drafting a provincial/federal measures list in these sectors, and
- allocating costs (provinces/federal government) in the event of missed targets.

The provincial and federal governments drew up an initial concrete set of measures for the years 2013 to 2018 on the basis of the KSG.

1.1.3.2 National energy and climate plan for the period from 2021 to 2030

Austria is moving towards a transformation to a highly efficient and climate-neutral energy, mobility, and economic system along the entire energy value production chain (generation, transport, conversion, consumption), including all associated products and services. This is why it is important to draw a clear picture of how the business community and society can make the best use of the resulting opportunities.

According to Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action, all Member States are required to prepare national energy and climate plans (NECPs) for the period from 2021 to 2030.

The draft of the Austrian plan was submitted to the European Commission by the Federal Ministry for Sustainability and Tourism (BMNT) in good time, at the end of 2018. This is based on #mission2030, Austria’s integrated climate and energy strategy.

The Commission issued ten concrete recommendations for this draft on 18 June 2019, which were taken into account in the finalisation of the plan by the end of 2019.

Between July and December 2019, the BMNT incorporated the recommendations of the Commission and other updates into the plan in collaboration with the directly affected ministries (BMVIT, BMF). The public consultation on the NECP required by the Governance Regulation was held in November 2019. An impact assessment for the planned measures was also concluded as part of the final plan (scenario "with additional measures").

The Austrian national plan includes the following objectives by 2030:

- Reduction of greenhouse gas emissions by 36% compared with 2005 levels in sectors that are not covered by the EU emissions trading system;
- Increase of 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 control and balancing energy for grid stabilisation and internal electricity generation from fossil fuels in tangible goods production);
- Improvement of primary energy intensity, defined as primary energy use per GDP unit, by 25–30% compared with 2015.

Key political questions, especially those relating to necessary investments and associated public financing today and key political questions that focus on instrument selection in the future (such as financial incentives, regulatory policy, tax-related control mechanisms and the trading system) will be addressed and resolved by a new federal government as soon as possible.

1.1.4 The Austrian goal – climate neutrality by 2050

Austria is committed to becoming climate neutral by no later than 2050, without using nuclear power. This means that the unavoidable greenhouse gas emissions (for example from agriculture and production processes) will be compensated by carbon storage in natural or technical sinks. This is the guiding principle of the long-term climate strategy 2050.

1.1.5 Consultation

1. Online consultation

A public online consultation with questions on the objectives and action areas for the long-term climate strategy 2050 was held in summer 2019 (5 August to 22 September). The target group was interested members of the general public. Of the 2,768 participants, 1,060 submitted a complete or partial evaluation of the questions.

The responses indicated that there is a high level of acceptance and demand for an ambitious strategy in general.

Different objectives were assessed in terms of their "relevance for the overarching goal of climate neutrality by 2050" in the online consultation. Participants had the opportunity to rank the objectives in terms of feasibility and relevance

The objectives that were ranked highest in terms of relevance were:

- Achieve 100% renewable energy by 2050
- Ensure clean and affordable mobility
- Climate-friendly freight traffic

The criteria of time horizon, financeability, acceptance, and impacts were also assessed for a series of measures. The result showed that every measure is acceptable (but will entail effort). No measure was ranked as unacceptable.

The following measures were ranked as "quick wins" – easy to finance, achievable within the next five years, and easy to accept:

- Incorporation of climate action in the educational curriculum
- Labelling requirements for products
- Dialogue with retailers on the labelling of food
- Public relations work and information campaigns

The following measures were assigned a high priority – with the greatest impact and feasible over the long term:

- **Energy**
  - Gradual reduction of fossil fuels
  - Promotion of renewable energy sources
  - Energy efficiency as savings potential in buildings
- **Climate-neutral mobility**
  - Modal shift
  - Reduced air traffic
  - Traffic avoidance
- **Financial levers**
  - Implementation of true-cost pricing for products and services
  - Alignment of the tax system with climate-policy goals

Detailed results on the individual fields of action can be found in section 2.4 Information about specific sectors.

The questions and aggregate rankings can be found in Annex 6.2.

2. Stakeholder consultation (with three workshops)

To ensure the close involvement of the relevant stakeholders, three workshops were held with these stakeholders in addition to the extensive online consultation. These workshops especially focused on the target visions and the measures and pathways necessary to achieve them. Representatives of the relevant federal ministries and of the provincial and municipal governments, social partner representatives, members of the Federation of Austrian Industry, and representatives of civil society and science participated in these workshops.

At the first workshop in the summer of 2019, the European framework for the long-term strategy was presented by a representative of the EU commission. Sector target visions for 2050 were drafted jointly on this basis.

The second workshop in November 2019 focused on in-depth discussion of the various sectors and of the mobility system, the energy system, and overarching topics such as innovation and lifecycles and the relevance of consumption patterns. Viable economic concepts were also examined to strike the best possible balance between location security and climate-neutral business activity. This workshop included the discussion of a just transition to a climate-neutral economy and society.

The third workshop in the middle of December was used to present the results and to have in-depth discussions on the long-term strategy.

2 THE FIELDS OF ACTION

2.1 Reduction in greenhouse gas emissions and overall increase in the removal of these gases via sinks

2.1.1 Assumed reduction of emissions and increase of removals of greenhouse gases by 2050

Austria intends to achieve a climate-neutral state in terms of its greenhouse gas emissions by 2050. This means that emissions of greenhouse gases will be close to zero and that remaining emissions are to be compensated by carbon capture in natural sinks (forests, soil) and by permanent sequestration in products or technical storage.

2.1.2 National requirements for 2030 and beyond, if available, and guidelines for 2040 and 2050

According to current EU law, Austria is required to reduce greenhouse gas emissions from sectors that are not covered by the EU emissions trading system (ETS) by 36% compared with 2005 levels by 2030. The CO_2 emissions from energy-intensive industries and the energy sector are defined and limited across Europe by a linear pathway in the EU Emissions Trading Directive. The emissions covered by the ETS must be reduced by at least 43% compared with 2005 levels by 2030. There are no national requirements that apply to Member States for the reduction of greenhouse gas emissions from ETS facilities.

Furthermore the LULUCF Regulation defines reference values for the capture of greenhouse gases in forests and in agricultural soil. If these reduction targets are not met, the excess quantities are to be compensated for by greenhouse gas emission reductions from sources not covered by the ETS. Any reductions above and beyond the targets in LULUCF can be deducted from non-ETS emissions up to a limit of 2.5 million tonnes (for the ten-year period 2021–2030).

The pathways for achieving climate neutrality by the middle of this century shown in the following section require far-reaching emission reductions in all sectors as quickly as possible. A target emission range applying to all emission sources (emissions trading and non-ETS sectors) cannot be defined at present because emission reductions in the industrial sources covered by the ETS are highly dependent upon developments that can only be influenced to a limited degree at the national level. The goal to cover 100% of domestic electricity consumption from renewable sources (national, net balance, with exceptions for control and balancing energy for grid stabilisation and internal electricity generation from fossil fuels in tangible goods production) will lead to a substantial decrease in emissions from public electricity generation in any case. Remaining greenhouse gas emissions are to be offset by the removal of at least equal quantities of greenhouse gases from the atmosphere by 2050 to reach the target state of zero net emissions. Ecosystems (natural sinks like forests) can be used for this as well as technological solutions such as permanent sequestration in products and applications (CCU – carbon capture and utilisation) and the permanent storage of CO_2 in geological structures (CCS – carbon capture and storage). Austria sees substantial hurdles and uncertainties with these technological solutions in terms of domestic storage capacity and ensuring permanent and safe storage. The current legal framework is also relevant here, as the storage of CO_2 in geological structures is prohibited in Austria at least for the time being (until 2023).

2.1.2.1 Scenarios and pathways for a climate-neutral Austria

Model-based scenarios and projections make it possible to forecast future energy needs and greenhouse gas emissions based on specific assumptions about future technological developments, policy choices in terms of steering instruments, and socioeconomic parameters (population development, economic growth, energy and CO_2 prices, etc.).

2.1.2.1.1 Transition scenario

The Federal Environment Agency models energy and greenhouse gas scenarios together with a consortium of Austrian scientific institutions every two years for the BMNT, which then uses these scenarios as the basis for meeting the EU reporting obligations under the monitoring mechanism (Regulation 525/2013/EC). In addition to the scenarios "with existing measures" (WEM) and "with additional measures" (WAM), a "transition scenario" was also calculated in 2017 and is aimed at depicting the greatest possible emission reductions by 2050 on the basis of domestically available resources and technologies and taking lifestyle changes into account.[2]

The transition scenario focuses on efficiency and the greatest possible use of domestic renewable energy sources while at the same time using resources as sparingly as possible. The goal here is a highly efficient and sustainable energy system. Developments are also assumed in non-energy sectors that lead to substantial reductions in the emission of methane, nitrous oxide, and fluorinated greenhouse gases. A key assumption for the scenario is that not only

[2] Energy and greenhouse gas scenarios in 2030 and 2050, Federal Environment Agency, Vienna 2017

Austria and the EU, but also all other regions of the world take action to comply with the Paris Agreement (depending on their degree of industrialisation). The transition scenario is intended to serve as a basis for further discussions at the national level.

The most important **areas of action** in the transition scenario:

- Internalisation of the external costs for all energy sources,
- Strong "sector coupling" in terms of the generation, conversion, and use of energy, especially relating to the generation of electricity from renewable sources and the storage of this electricity,
- A change in the modal split in terms of passenger and freight traffic towards environmentally friendly transport modes and vehicles that lead to a substantial reduction in the annual distance travelled by car,
- The heavy promotion of the thermal and energy refurbishment of buildings,
- A switch to sustainable energy sources and technologies in the industry sector, which must be available in the necessary quantities (production, grids, storage), and long-lasting products designed to implement the circular economy combined with increased energy and resource efficiency; steel production will shift from the traditional blast furnace process to electricity- and hydrogen-based production over the long term,
- The energy sector switches to electricity and district heating generation from renewable sources and to the systematic use of waste heat, and
- The population switches to a more climate-friendly diet while reducing food waste; agriculture sees further efficiency increases in using nitrogen (fertiliser management) and the funding policy takes greater account of the greenhouse gas effects (Common Agricultural Policy and implementation in Austria).

Key results of the 2019 transition scenario

The 2017 transition scenario was updated in 2019. Gross domestic energy consumption falls from 1,442 PJ to 821 PJ, or around 42% compared with the base year 2017. Final energy use decreases to a comparable degree (-44%) from 1,130 PJ to 637 PJ in 2050. The share of renewable energy in gross final energy use is increased from a current 33% (2017) to around 92% (2050).

Greenhouse gas emissions (total without sinks) are reduced by close to 16 million tonnes of CO_2 equivalents by 2050 in the transition scenario, which is an 80% decrease over 1990. This would result in annual per capita emissions of 1.66 tonnes of CO_2 equivalents.

The most substantial emissions in 2050 are generated by agriculture and industry (especially processes). The energy sector and buildings have very low emissions. The transport sector operates largely without fossil fuels in this scenario.

Such a substantial reduction of greenhouse gas emissions requires far-reaching changes in mobility and energy systems and material changes in lifestyle (such as mobility patterns), diet, and other consumption patterns. Nevertheless, climate neutrality is still not achieved, and the gap is difficult to bridge with the contribution from natural sinks alone. Along with capturing carbon in natural sinks, this gap could largely be bridged by adding two further options or a combination of these options:

- The import of additional energy from renewable sources that can replace the remaining (also imported) fossil fuels. Biogenic energy sources and electricity and hydrogen imports could play a major role in this.
- Permanent sequestration in products and applications (CCU – carbon capture and utilisation) and the permanent storage of CO_2 in geological structures (CCS – carbon capture and storage). It must be noted here that secured storage capacity that is generally suitable for CO_2 is very limited in Austria. The current potential domestic storage capacity is estimated at between 400 and 510 million tonnes of CO_2, or up to 6.5 times the current annual CO_2 emissions in Austria. The transport of CO_2 to storage facilities outside of Austria can be considered as an alternative or long-term solution.

2.1.2.1.2 Selected results from the climate pathway calculator

The climate pathway calculator for Austria was developed in 2015 on the basis of the UK carbon pathways calculator, and was updated in the second half of 2019. This Excel-based instrument allows the depiction of different pathways in terms of energy and greenhouse gas emissions through to 2050, with the ability to select different ambition levels for all material action areas (for example in terms of the selection of technologies and resources, import/export relations, and behavioural patterns).

The climate pathway calculator allows the flexible depiction of results that allows a certain degree of comparison with model-based scenarios provided that the pathways and scenarios are based on comparable data sets and socioeconomic assumptions for the future trends (especially population, economic growth and structure).

Working from the model-based transition scenario described above, the Excel-based tool was used to select and calculate four different pathway options that all aim at achieving a climate-neutral state by 2050:

Pathway A is closely aligned with the model-based transition scenario and is based on the high use of renewable energy, far-reaching efficiency improvements, and substantial changes in consumption patterns (lifestyle). Remaining emissions will be compensated by natural sinks (forest) (according to reference scenario R [section 6.1.3]) and by the moderate use of CCS/CCU.

Pathway B focuses on the (somewhat lower) expansion of renewable energy and efficiency improvements as well as on the import of bioenergy and hydrogen for use in multiple sectors (industry, transport, heating). A substantially higher degree of CCS/CCU than in pathway A must be used to compensate for the remaining emissions.

Pathway C does without the import of bioenergy and hydrogen, and renewable resources in the country including forest and agricultural biomass are used to a high degree. This results in a reduction in the forest as a natural carbon sink, in accordance with scenario 1a (section 6.1.3). This means that the CCS/CCU option must be used to a relatively high degree to compensate for the remaining greenhouse gas emissions.

Pathway D assumes the needs-oriented import of bioenergy and hydrogen, as in pathway B. The use of domestic forest biomass and carbon capture in the forest are assumed as in scenario 2 (section 6.1.3). For this reason, CCS/CCU are not used.

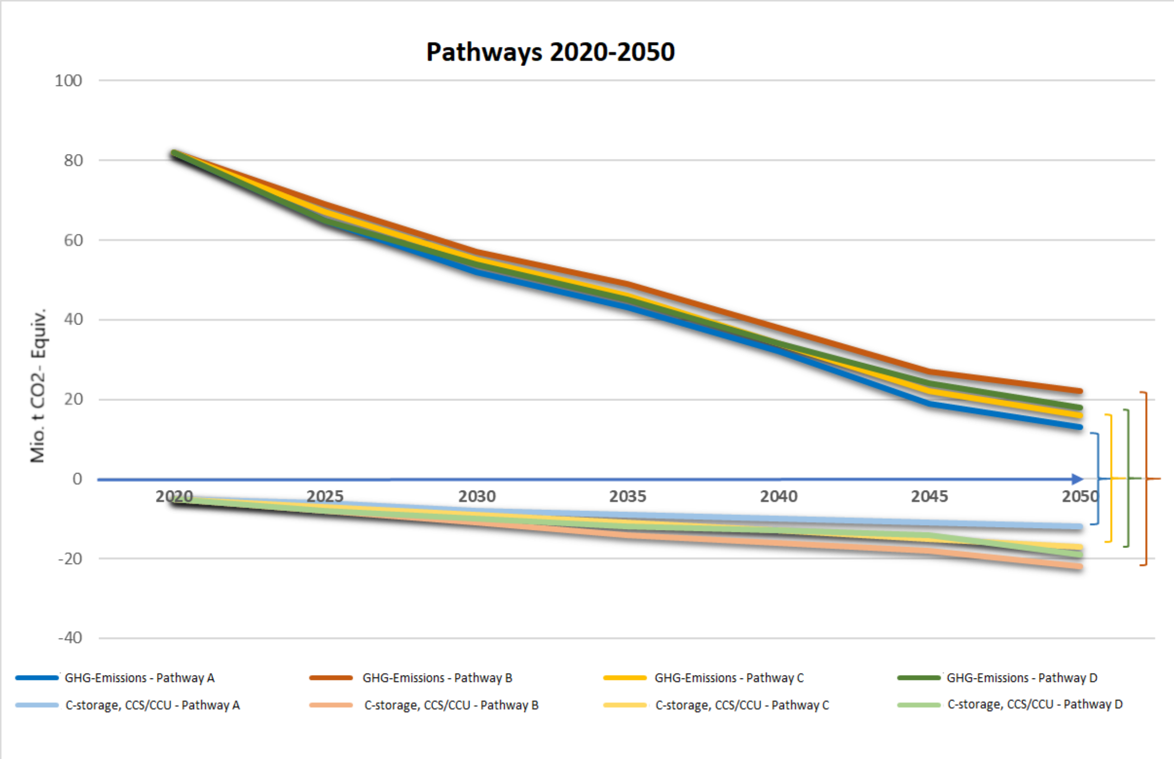

Figure 1 Possible pathways for Austria from 2020–2050 for greenhouse gas emissions and compensation through net carbon stock change and carbon capture

Table 1: Scenarios and pathways for Austria[3]

	Pathway A: "Transition – renewables, efficiency, lifestyle"	**Pathway B: "Bioenergy/H2 import and CCS/CCU"**	**Pathway C: "Bioenergy/H2 production in Austria and CCS/CCU"**	**Pathway D: "Bioenergy/H2 import and increased carbon stock in forests"**
Pathway description	Far-reaching transformation of the energy and mobility system; lifestyle changes lead to reduced consumption (mobility, freight transport, waste quantities, dietary changes), H2 use especially in industry (iron/steel production).	Less substantial transformation of the energy and mobility system than in pathway A; higher H2 use in industry and freight traffic and for heating.	Far-reaching transformation of the energy and mobility system – comparable with pathway A, but higher use of bioenergy (from forests and agriculture); "power-to-gas" plays a major role. Less substantial lifestyle changes than in pathway A.	Energy generation from renewable sources similarly ambitious as in pathway B, though biomass generation as in scenario 2 of the wood value chain project (section 6.1.3) is assumed. Substantial demand reduction for buildings/services; high use of H2 in industry and freight traffic and in heating generation.
Energy imports	No expansion of bioenergy imports; drastic reduction of fossil fuel imports; no (net) electricity or H2 imports	Bioenergy and H2 are imported as needed; drastic reduction of fossil fuel imports; no net electricity imports	Not planned; bioenergy imports also fall to zero; drastic reduction of fossil fuel imports; no net electricity imports	Bioenergy and H2 are imported as needed; drastic reduction of fossil fuel imports; no net electricity imports
Final energy use 2050	157 TWh (56% compared with 2020)	200 TWh (71% compared with 2020)	160 TWh (57% compared with 2020)	168 TWh (59% compared with 2020)
Share of renewable energy	93%	76%	91%	79%
GHG emissions 2050 vs. 1990*	-84%	-72%	-77%	-80%
CCS/CCU storage quantity 2050	-8.8 mn t CO_2-eq	-18.3 mn t CO_2-eq	-18.7 mn t CO_2-eq	Not planned
Contribution from natural sinks in 2050[4]	-3.9 mn t CO_2-eq (reference scenario "stable sink")	-3.9 mn t CO_2-eq (reference scenario "stable sink")	Contribution approaching zero by 2050 due to increased use of	-17 mn t CO_2-eq (scenario 2)

[3] The scenarios and pathways depict "what would happen if" situations for which no political decisions have yet been made.

[4] Descriptions of the scenarios can be found in section 6.1.3.

			biomass for energy (scenario 1a)	
Net GHG emissions 2050	0.5 mn t CO_2-eq	0.5 mn t CO_2-eq	+/- 0 mn t CO_2-eq	-0.5 mn t CO_2-eq

* Including air traffic, without sinks, without CCS/CCU

2.1.3 European framework

The implementation of such a far-reaching goal as achieving climate neutrality in just over 30 years is only possible for an open, export-oriented country like Austria if this is done in close alignment with the changes in the relevant EU policies in various areas such as climate mitigation, adaptation to climate change, energy, finances, industry, agriculture, research, and innovation. From this perspective, Austria welcomes the initiative of the new European Commission in the context of Green Deal.

For example, far-reaching structural changes in **mobility and energy** require corresponding changes in the internal market.

- The existing CO_2 fleet agreements should be tightened up on the basis of an early review in accordance with the decarbonisation path required by the Paris Agreement and long-term EU strategy especially to facilitate a more rapid switch to electromobility for passenger cars and light and heavy-duty vehicles after 2030 in particular. Suggestions for concrete measures include:
  - Rapid introduction of CO_2 limits for buses.
  - Create calculability for the vehicle industry by rapidly adopting reduction pathways for the period after 2030.
- Move forward with the amendment of the Eurovignette Directive to achieve true-cost pricing in road freight traffic by internalising external costs (such as taking CO_2 emissions into account, eliminating the maximum levels regarding the charging of external costs, and the requirement for all Member States to collect external costs on routes with high environmental impacts).
- Amendment of the VAT Directive, especially the tax exemption for cross-border carriage.
- In air traffic, CORSIA should be implemented in the existing emissions trading system (ETS) as far as possible or in a complementary manner to the ETS.
- The direct addition of alternative fuels in air traffic should be mandatory over the medium term.
- Completion of the Single European Sky.
- Gradual elimination of the free allocation of CO_2 emission rights (EU ETS) to airlines.
- The standards for charging infrastructure should be harmonised rapidly.

- Impediments to smooth cross-border rail travel should also be eliminated further. Measures must be taken across Europe to strengthen rail travel as the environmentally friendly mobility backbone.
- Attractive high-speed rail connections should be built between the capitals and major centres of the European Union in addition to expanding and securing regional rail connections.
- As a top priority, all Member States are urged to improve the framework for a modal shift in freight and passenger traffic from the road to the electrified rail. A Europe-wide framework should also be created (standardisation, vehicle offerings) to develop additional technological options for the decarbonisation of the remaining cross-border transit traffic on the road (alternative renewable fuels; electrification systems, fuel cells).

- A European hydrogen strategy and "gas package" 2020
  - The Commission should move forward with the development of an internationally based, European hydrogen strategy that also accounts for future global hydrogen trade. The origin should be stated for hydrogen imports, and the hydrogen should be produced entirely from renewable energy sources. The strategy should also present increased financing options for sustainable hydrogen.
  - The Green Deal should also place a focus on renewable gases. The European Commission's "gas package" should include a clear pathway for the blending of renewable gases, uniform standards, and a reliable origin certification system. The future role of grid operators should also be discussed.
  - In this context, enabling grid operators to build and operate electrolysis systems should be considered if these contribute to maintaining a reliable, high-capacity grid.
  - European requirements for the injection of a certain share of renewable gases into the gas grid and for a mandatory share of renewable gases in imports could also be evaluated.

The framework for the **effective pricing of CO_2** should be to promote competition. To this end, the following concrete action areas are being brought into the discussion:

- Further measures for more effective CO_2 pricing in air traffic and for creating a competition-neutral taxation situation in relation to other modes of transport.
- For the purposes of environmental economy, a CO_2 price with an adequate incentive and steering effect is indispensable if we are to achieve our long-term goal of zero net emissions in an economically efficient manner. The discussion could explore tax instruments as well as the expansion of the existing emissions trading system.

- In line with the long-term goals of the Paris Agreement, the principle of true-cost pricing and the "polluter pays" principle must be taken more into account in matters of EU foreign trade and customs policy. To avoid competition distortions while ensuring polluter-based CO_2 pricing for as many consumer goods and services as possible, the work on a WTO-compliant carbon border adjustments mechanism (CO_2 border tax on products from energy-intensive sectors) should be moved forward rapidly. This revenue could be paid into the EU budget as own funds, as for the customs tariffs.
- In implementing the EU emissions trading system and incorporating non-ETS sectors in the ETS scheme, the certificate price will presumably increase, which will send a decarbonisation price signal. Comprehensive carbon leakage protection must still be ensured to prevent the relocation of technology leaders as we move towards climate-friendly production.
- Auctioning certificates in the ETS generates income for the Member States that can be a key source of financing for climate action measures.

In the context of the decisions and debates about the design and implementation of the EU's multiannual financial framework (MFF) starting in 2021, Austria supports the following focuses:

- A resolution to earmark at least 25% of the MFF spending for the attainment of the climate targets starting in 2021. At the national level, it should also be evaluated here how cost-effective contributions can be made to target attainment in the non-ETS sectors.
- A Common Agricultural Policy (CAP) that is oriented more strongly towards the European climate targets, in particular a stronger focus in the CAP on (i) a reduction of the nitrogen surpluses, (ii) a reduction of emissions from livestock farming, (iii) an increase in the energy efficiency of agriculture, (iv) the preservation of permanent pasture, (v) the preservation of humus in cultivated land, and (vi) the preservation and sustainable management of the forests.
- Expansion of the financial instruments for the use of renewable energy, taking international projects into account.
- A stronger focus in the programme for rural development on cost-effective attainment of the climate targets.
- A stronger focus in EU cohesion policy on the switch to renewable energy sources, including the creation of a Just Transition Fund by reallocating existing cohesion funds.
- An increased focus in the 'Horizon Europe' research framework programme on innovation in the field of low-emission and climate-change-resilient technologies.

- The EU-wide expansion of the charging infrastructure for electromobility (including through the EFSI successor InvestEU).
- Promotion of the development of hydrogen-based fuel cell technology (e.g. through corresponding Horizon Europe and InvestEU funding windows).
- Promotion of the automation and networking of sustainable mobility through the Digital Europe programme.
- Introduction of a national contribution to the EU budget calculated from the non-recycled plastic packaging waste generated in each Member State ("plastic funds") as indicated by statistical data to create an incentive for the Member States to reduce the generation of non-recycled plastic.
- Allocation of 15% of the funds of the Connecting Europe Facility (CEF) that are earmarked for the energy segment to cross-border renewable energy projects.

2.1.4 Adaptation policy and measures

2.1.4.1 Effects of climate change in Austria

According to the Austrian climate change status report (AAR 2014), the country has seen an increase in the annual average temperature of around 2°C since 1880. This increase is markedly higher than the global temperature increase of 0.9°C (IPCC 2013). Climate change is having very clear impacts in Austria: an increase in the number of heat waves, a decrease in the number of days with sub-zero temperatures, rapid glacial melting, permafrost thawing, the increased frequency of heavy precipitation events, longer vegetation periods, the establishment of new pathogens, increased bark beetle infestation, changing water supply in agriculture, lower crop yields, etc. Climate change is having a serious impact on nearly every area of life.

Even if the Paris Agreement goal of limiting the average global temperature increase to well below 2°C compared with pre-industrial levels is met, it will only be possible to partially prevent the consequences of climate change. A further temperature increase through to the middle of the century is unavoidable because of the inertia of the climate system and the persistence of greenhouse gases. The economic effects of extreme weather events in Austria are serious and have increased over the past three decades.

The Paris Agreement places equal focus on adaptation to and mitigation of climate change. Austria has been following this two-pronged approach in its climate policy for a number of years and was one of the first EU countries to link a strategic concept for adapting to climate change with a comprehensive action plan for the implementation of concrete recommendations (Austrian Strategy for Adaptation to Climate Change, 2012; expanded in 2017).

This means that adapting to climate change is to complement the reduction of greenhouse gases, and attempts to influence the overall system from a different vector. It is based on the evidence-based fact that climate change will continue due to the inertia of the climate system even if greenhouse gas emissions are reduced substantially. This means that the challenges associated with adaptation to climate change will increase in the coming decades, regardless of the efforts undertaken and successes achieved on mitigation of climate change. Adaptation to and mitigation of climate change are thus two sides of one coin and are directly related. The more successful we are in reducing worldwide greenhouse gas emissions, the less we will need to adapt to climate change. The less effective the global climate mitigation efforts are, the more we will have to invest in adapting to climate change. But adapting to climate change has intrinsic limits, and cannot replace climate mitigation.

Adaptation - as the term is used in the Austrian strategy - refers to all efforts that contribute to allowing the environment and society to effectively prepare for the new conditions resulting from climate change. Good adaptation practice as a separate term also reflects the need to orient the practices towards the principles of sustainability. This must be observed closely as a kind of quality assurance in the planning and implementation of recommended actions. Measures that are promising only in the short term and/or from a purely sectoral perspective but that are counterproductive from a different perspective must be classified as maladaptation. The Austrian strategy for adaptation to climate change is based on the criteria of sustainable development and clearly rejects maladaptation.

It must be ensured that the measures taken to adapt to climate change and to protect the climate do not counteract each other, but that they support each other and generate synergies where possible.

The high complexity of the issue is a particular challenge and results in part from the different levels at which decisions are made and from the interactions between different areas and aspects. Adaptation to climate change is a complex, overarching issue that affects a large number of action areas and different levels of policy. This issue must be considered across all sectors, and adaptations must be made in various areas of public administration. The possible consequences of climate change must in any case be taken into consideration in a systematic manner in all relevant planning and decision-making processes from the national to the local level.

2.1.4.2 Austria's strategy for adapting to climate change

The Austrian Strategy for Adaptation to Climate Change was adopted by the Council of Ministers in October 2012 and acknowledged by the Provincial Governors' Conference in May

2013. A revised and expanded version was then approved by the federal and provincial governments in 2017. The primary goal of this strategy is to avoid adverse effects from climate change on the environment, society, and economy and to seize the resulting opportunities. The document is broken down into a strategic section (context) and an action plan with concrete recommendations for action (over 130) in 14 different fields of activity.

As the nationwide orientation framework, the strategy contributes to facilitating networking and strong partnerships between the various involved parties, and to the leveraging of potential synergies through cooperation arrangements. Its mission is to provide recommendations for action for the various areas and to provide points of reference for all parties involved in implementation. In line with the precautionary principle, it is designed to provide a basis for making decisions in due consideration of future climate effects and to promote successful implementation. A proactive approach is crucial because the ability to successfully adapt decreases and the associated costs rise as climate change progresses. The Austrian adaptation strategy is rooted in a context of sustainable development that seeks to ensure viable – in other words economically strong, socially just, and ecologically sound – conditions in the future.

Adaptation to climate change is a continuous process that requires the recurring evaluation of the significant impacts of climate change and the effectiveness of the chosen measures. For this reason, regular progress reports depicting the state of implementation in the various fields of activity are planned. The first progress report on the state of adaptation in Austria was adopted by the Council of Ministers in 2015 and was also acknowledged by the Provincial Governors' Conference. A second progress report is planned for the end of 2020.

The KLAR! funding programme shows ways in which the local effects of climate change can be handled and the resulting economic costs mitigated through regional measures. Together with the BMNT, the Climate and Energy Fund launched this pioneering climate change adaptation programme in 2016 on the basis of scientific findings in order to give regions the ability to minimise the adverse impacts of climate change and to seize new opportunities based on the current state of knowledge. The programme has been coordinated with the federal strategy and the provincial strategies and is the only nationwide programme to also address the regional level. A total of 362 towns are currently participating in the KLAR! programme, covering around 10% of the Austrian population.

The Austrian Climate Research Programme (ACRP) provides the scientific basis for many implementation measures in Austria and presents recommendations for action for decision makers and the public administration in adapting to climate change. The objective of the programme is to research the effects of climate change and to create a scientific basis for forward-looking decision making in the areas of public policy, the economy, and society. This makes the ACRP an important instrument for addressing the urgent questions that arise in dealing with climate change in a scientific manner and for making new findings and solution approaches available for policymaking and practical implementation.

The only way to avoid damage and to profit from opportunities for numerous sectors of the economy is through the forward-looking planning and implementation of adaptation measures. As the results of the COIN project on the costs of a lack of action in Austria show, the failure to implement adaptation measures will be associated with considerable costs through to 2050. This underscores the urgency of placing a greater focus on adapting to climate change and assigning it a higher priority on the political agenda.

2.2 Renewable energy

2.2.1 Introduction

The European energy system has undergone major changes since its liberalisation, especially in the **electricity market**. There is a powerful shift towards a decentralised, renewable energy supply with considerably more volatile generation characteristics in an increasingly competitive and integrated market environment.

While markets and competition have been successfully driven forward in the past, we now need to make the energy sector considerably more environmentally friendly over the medium term and decarbonise it by 2050. This poses complex challenges that call for a great need for action to more closely coordinate energy- and climate-policy goals.

The share of renewable electricity in the European Union has already increased considerably. In 2017 about 85% of the newly installed electricity generation capacity used renewable technologies, and a good third of the electricity demand was covered by renewable sources.

The decarbonisation of the energy sector is a key goal of the European Energy Union. This means making renewable energy sources an essential part of the market by further expanding their use. There is no doubt that a well-functioning and integrated energy market is key for enabling the generation of large quantities of electricity from renewable sources and integrating them into the grid in a cost-efficient manner – while maintaining competitiveness, affordability for businesses and households, and the security of the energy supply.

2.2.2 Target vision

The decarbonisation of the Austrian energy system requires a large number of coordinated measures and activities. The country needs a balanced, sustainable energy mix that consistently promotes the expansion of local renewable energy resources and that uses bridging technologies to ensure a security of supply on the decarbonisation path. This implies a rapid exit from coal, the replacement of all fossil oil heating systems and a switch to zero- and low-emission vehicles.

As we become less dependent on fossil energy imports, Austria will massively increase its own supply of local energy while the costs and risks associated with the energy supply and mobility will decrease thanks to the switch to efficient technologies.

Nuclear power is not an answer to climate change – Austria consistently takes this position at all levels and will continue to advocate that no funding be provided for nuclear power.

Sector coupling is a core element of the future energy system. This means that previously separate systems (electricity, heat, mobility, industry) will be linked. With the help of renewable energy sources that above all deliver electricity, sector coupling will allow all sectors of the economy to be decarbonised. The use of energy-efficient technologies such as heat pump heating systems and electric vehicles will also allow considerable reductions in energy consumption.

Efforts and innovation are required at all levels of the value chain to integrate renewable energy sources: in the legal framework, in technology development, in vocational training and awareness-raising, and for viable, market-based business models. At the same time, existing barriers must be removed and investments in generation, transport lines, load management, and storage must be facilitated and – if needed- promoted.

The electricity market of the coming years will be characterized by a more variable and decentralised generation, increased integration, and new technological possibilities for consumers to lower their energy costs and to actively participate in the energy market by means of load management, on-site consumption and storage of electricity.

A key question in the area of conflict between centralised and decentralised infrastructure is how security of supply can be ensured as economically as possible. In the light of increasing digitalisation, networking, market integration, and technological innovation, stronger regional value creation should be promoted in the energy sector and all flexibility potentials on the supply and demand side should be exploited.

The transformation of the energy system towards more decentralised generation (wind power, photovoltaics, biomass, etc.) can contribute to the increased importance of lower-voltage regional networks in 2050. Locally generated energy (e.g. from a wind farm) will be supplied to end users in the region, which will strengthen the regional value chain in the energy system and improve security of supply.

This also affects the relationship between the transport and storage of energy. Expanding storage capacities can also contribute to supplying end users with more regionally generated energy.

The issue of cost fairness in the construction and operation of infrastructure is also relevant, especially in terms of transit lines. For example, should increasing volumes of renewable electricity flow from the north to the south of Europe, new rules for the fair coverage of the associated infrastructure costs must be developed. Anyone who needs and uses infrastructure should also pay for it – unjustified costs for national electricity consumers must be avoided.

The decarbonisation of the energy system will bring new opportunities for market participants, but also major challenges. At the same time, technological innovations create new forms of consumer participation and cross-border collaboration.

The transformation of the energy system is also being moved forward through the decarbonisation of the gas grid by increasingly substituting natural gas with renewable gases. Hydrogen is a key technology in sector coupling, as are hydrogen-based synthetic gases and methane from biogenic sources. National production potential must be sustainably increased, and the production fed into the local grid. National gas consumption should be CO_2 neutral in net terms by 2050 while still accounting for Austria’s role as a gas hub in a tightly integrated European internal market. Austrian industry must be decarbonised while maintaining a level playing field.

2.2.3 Current situation in Austria

Natural gas represents around 22% of gross domestic energy consumption, and petroleum 37%. Austria has one oil refinery (Schwechat), two petroleum pipelines (the trans-Alpine oil line/TAL and the Adriatic-Vienna pipeline/AVP), one product line from Schwechat to St. Valentin, and 13 crude oil and product storage facilities with a capacity of over 1,000 m³ each.

Natural gas storage facilities with a total capacity of 8.2 billion m³ are located in the border region between Upper Austria and Salzburg and in Lower Austria as well as long-distance and distribution grid gas lines with a total length of over 46,000 km.

The Austrian electricity grid has a total length of over 73,000 km of overhead lines and around 186,500 km of underground lines.

In line with the international and European framework, the Austrian climate and energy strategy *#mission2030* was adopted in May 2018. It defines the climate and energy policy framework through to 2030 that aims to make our economy and energy system fit for the major challenges of climate change for the long term. Quantitative targets for 2030 form the core elements of this strategy and include:

- an increase in the share of renewable energy to 46–50% (level in 2017: 32.6%),
- a further 25–30% improvement compared to the primary energy intensity in 2015, and
- the production of enough electricity to cover 100% of the total electricity use (national balance, net) from renewable sources by 2030.

Exceptions from the 100% target were defined in that control and balancing energy for stabilising the grid and internal electricity generation from fossil fuels for tangible goods production will not be included in achieving the target. These two exceptions are expected to account for around 6 TWh in 2030.

The net addition of 22 to 27 TWh was estimated in consultation with experts and in accordance with the range of current national scenarios to ensure that the target will be reached in 2030. "Net" means that existing facilities that are taken offline before 2030 must also be replaced. The estimates for the exceptions and for gross domestic power use in 2030 were made by the Federal Ministry for Sustainability and Tourism in consultation with experts (Austrian Energy Agency, E-Control, Federal Environment Agency) in line with the targets of the Austrian climate and energy strategy *#mission2030*.

It is clear that all renewable energy technologies (those requiring raw materials such as bioenergy and those requiring no input materials such as solar and wind energy) will be needed to meet this ambitious target. The planned Renewable Energy Expansion Act (EAG) is to create the long-term framework and reliable planning certainty for future-proof, sustainable investments in renewable energy production.

2.2.4 Fields of action

- The trend towards renewable energy will continue to accelerate because this is the only way to meet the requirements of the Paris Agreement. Current decarbonisation scenarios clearly show that electricity demand will increase rapidly in relative and absolute terms by 2050 despite decreasing end energy consumption. In the context of the 100% renewable energy target for 2030 (national, net), it must be evaluated in detail how the achievement of this goal can also be secured in the years up to 2050.

- The amendment of the Green Electricity Act and its replacement with the Renewable Energy Expansion Act will lead to a substantial increase in the generation of electricity from renewable sources.
- The greater variability and decentralisation of renewable electricity generation will require more flexible market rules and regulations for grid operation.
- The creation of short-term markets should increase liquidity and make it easier for operators of volatile, renewable generation capacities to market their electricity under fair conditions and open up new business opportunities.
- For an efficient management of necessary investments, prices must signal where electricity is needed most urgently. Effective price signals should also activate existing flexibility potential on the demand side and ensure appropriate remuneration for flexible resources including load management and storage as well as the efficient use of existing generation facilities. The affordability of renewable electricity must also be kept in mind, especially for energy-intensive industry and low-income households.
- A level playing field and incentives for energy storage, participation in load management, and improving energy efficiency must also be created for all market participants.
- Innovative devices, technologies, and systems will make it possible to tap energy savings potential, to quickly react to price signals, and to thus contribute to the flexibility of the electricity grid.
- Digitalisation and Internet-based solutions will offer the ability to generate and store electricity and to participate in the electricity markets through load management solutions. Energy supply companies will turn into energy services providers.
- If the energy system becomes increasingly electrified and decentralised, this will require a suitable expansion of the grid (integrated Austrian grid infrastructure plan).
- Significantly reduced costs, especially for photovoltaic and storage systems, will enable more and more citizens to actively participate in the energy system by investing in renewable energy facilities as energy consumers and producers.
- Price incentives for the reduction or timing of energy demand will be set.
- New energy supply concepts (including at household level, decentralised groups of apartment buildings, and energy services providers) will facilitate the interplay of centralised and decentralised supply.
- An increasing share of photovoltaic systems with storage facilities (2050: 100% of the newly installed systems are to include storage).

- New electricity storage technologies will be developed: chemical short-term storage, power-to-gas is sensible for seasonal storage because the existing natural gas grid can be used. This is intended to compensate for the lack of sunshine in winter.
- Large electrolysis systems for converting electricity into hydrogen and synthetic gas.
- Off-grid systems with small storage units and grids with large storage capacities will provide for robust and efficient energy and storage infrastructure (for the optimal use of renewable energy sources) in a functioning European electricity market.
- Grid stability will be ensured through a functioning European market for which the corresponding infrastructure is provided. Demand-side management (DSM) and electrolysis systems will contribute to grid stability.
- Ambient and waste heat will be incorporated.
- Seasonal electricity and heat storage will help prevent supply bottlenecks during the winter. Heat and electricity generation from renewable sources will be increased.
- Sustainable forest management including adapting the forest to climate change to increase the resilience and stability of the forest stock so that productivity can be maintained and increased in the future.
- The sustainable usable reserves of domestic bioenergy will be successively tapped.
- The generation and distribution of district heating will become highly efficient and renewable.
- Refinery capacities will change based on the processed inputs (innovative refurbishment). The national consumption of fossil fuels and heating oil will fall to virtually zero by 2050 while the use of hydrogen and synthetic fuels will increase massively. Existing refinery capacities will be converted to the use and production of non-fossil fuels (hydrogen, renewable gas).
- An international hydrogen market will allow substantial imports of hydrogen and synthetic fuels. The aim should be that the production of these energy sources abroad should be based on renewable energy sources to the greatest degree possible. "Blue" hydrogen will play a role as a bridging technology for a certain time, and "green" hydrogen will be used over the medium and long term.
- Conversion of the compressor stations to electric drives.
- Incentive effects to promote the local feed of renewable gases into the domestic gas grid.
- National gas consumption should be CO_2 neutral in net terms by 2050 while still accounting for Austria's role as a gas hub in a tightly integrated European internal market.
- The use of geothermal energy can be a valuable expansion of the Austrian energy mix because it is not only CO_2 neutral, but also has a base load capacity. This means that many problems of volatile energy sources do not apply to geothermal power to the same degree. Space requirements, storage, and availability are less problematic here than with other

forms of alternative energy. Energy collected through geothermal probes can be provided to all sectors and throughout the country.

2.3 Energy efficiency

2.3.1 Introduction

Energy efficiency is to help provide products and services, prosperity, and convenience to the population while using as little energy as possible. This is not aimed at reducing economic output or lowering the level of prosperity or convenience. On the contrary, economic and prosperity growth are to be made possible by using the technical, economic, social, organisational, and institutional possibilities to achieve this growth with as little energy input as possible.

Energy efficiency measures are also among the least economically costly means of avoiding greenhouse gas emissions and are the top priority for the Energy Union and Austria. Medium- and long-term visions for a decarbonised future are to be drafted in an integrated strategy encompassing the areas of renewable energy, energy generation, energy efficiency, and energy savings in close alignment with measures to cut greenhouse gas emissions.

In terms of efficiency, the most sustainable option is to use less energy. With this in mind, the establishment of a sustainable energy system is one of the central challenges of the coming years.

The Austrian climate and energy strategy (#mission2030) is built on the triad of supply security, competitiveness, and ecological sustainability for the benefit of the European Energy Union. Central ecological objectives for 2030 have been defined in the areas of greenhouse gas emissions, renewable energy, and energy efficiency and are to be pursued by means of effective measures.

As growth is also to be facilitated in future, Austria has set the goal of improving its primary energy intensity by 25–30% compared with 2015. If a primary energy demand of 1,200 PJ is exceeded by 2030, the energy needs beyond this limit are to be covered by energy from renewable sources.

The energy efficiency developments in the European Union also require a redefinition of the national framework for the period to 2030. The goal of this is to achieve the desired energy efficiency increase more effectively and less bureaucratic, in line with the achievement of the climate and energy targets for 2030 and the goals of the Paris Agreement so as to bring energy consumption onto the desired pathway.

2.3.2 Challenges

Despite the advantages provided by energy efficiency measures, it must not be forgotten that they often also involve costs. For companies in particular, it is not only the cost-benefit ratio of efficiency measures over the life cycle that is relevant, but also the amortisation period. Long-term measures that do not pay off for seven, ten, or more years are often not realizable for companies. There is also a certain lack of financing options for companies and households as banks and investors still have little ability to assess the financing of efficiency measures – especially where it is difficult to evaluate the risk of technically complex measures that generate no direct returns but simply cost savings.

Rebound effects – two steps forward, one step back!

Energy efficiency cuts costs. These cost savings mean that the energy consumer has more income to spend on products, travel, and energy. Efficiency measures can also suggest that not a whole lot of energy is being used anyway. This can in turn lead to changed consumption patterns and increased energy use. In this way, the savings from energy efficiency measures are partially offset by higher energy consumption.

2.4 Information about specific sectors

2.4.1 Energy storage systems

2.4.1.1 Introduction

The growing share of renewable energy and the increasing decentralisation of energy generation mean that we must adapt our energy system. In addition to a greater number of local generation facilities such as photovoltaic, wind, and biomass systems, new consumers (such as electric vehicles and heat pumps) and storage facilities must also be integrated into the energy system.

The structural change in the energy supply system will only be successful if the various elements and sectors of the system are coordinated optimally. Sector coupling, in other words the linking of electricity, heat, and mobility, is the central concept for optimally using and integrating renewable energy. The energy system of the future requires smart components that communicate with each other to allow for a secure, stable, and sustainable energy supply.

Storage potential seems to be limited at present. Storage for hydropower (pump storage), batteries, and gas storage (with hydrogen, for example) will be used, among other options, and (new) forms of storage will be successively expanded through increasing research activities until 2050.

Hydropower recently covered around 57% of domestic electricity generation (depending on fluctuating generation conditions) according to the most recent statistics, making it the most important energy source in this segment. In 2017, gross electricity generation from the more than 100 storage power plants amounted to 33.7 PJ, which was 13.9% of the total gross electricity generation of 242.8 PJ. By contrast, the generation value of the approximately 3,000 run-of-river power plants (mainly small hydropower plants) was 104.4 PJ or 43%. A further expansion of so-called **pump storage facilities** will also depend on environmental protection issues (environmental impact assessment).

- **Mined caverns as pump storage facilities:**
  Underground pump storage power plants that are located in cavities created by mining could be used as possible energy storage in future. In technical terms, this could be realised through a closed system of pump and pressure lines and watertight storage, using a substantial elevation difference between two cavities. Existing or newly mined cavities and shafts could be used for this. The mode of operation corresponds to that of a conventional pump storage power plant, but this technology could provide an extremely gentle surface utilization. These storages enable short-term bridging of bottlenecks in the daily or weekly rhythm.

The current consumption of natural gas in Austria is around 8 billion Nm^3. A gas storage capacity of around 2.5 to 3.0 billion Nm^3 with a corresponding withdrawal capacity is required to ensure security of supply with natural gas. Based on this and considering the objective of reducing gas consumption by a least 40% by 2050, a **hydrogen storage capacity** of around 3.0 to 3.5 billion Nm^3 with corresponding withdrawal capacity should be available by 2050.

The world’s first high pressure and high temperature storage facility went into operation in Simmering in the southeast of Vienna in 2013. The integration of the new storage facility into the Viennese district heating system allowed energy generation and consumption to be decoupled. The storage of excess heat (up to 980 MWh) from adjacent power generation systems reduces the use of the peak load furnaces and the resulting CO_2 emissions during periods of high heat demand.

Europe is combining its efforts to succeed on the world market for energy technologies. The Strategic Energy Technology Plan (SET Plan) forms the framework, especially for the exchange of information on research and development and the implementation of cost-efficient, low-emission, sustainable, and safe energy technologies. A key focus is being placed on increasing Europe’s competitiveness in the areas of **batteries** (source: SET Plan action 7 https://setis.ec.europa.eu/implementing-integrated-set-plan/batteries-e-mobility-and-stationary-storage-ongoing-work). Because batteries are a key technology for e-mobility and stationary storage, among other things. To be competitive in the global battery sector, European industry must be skilled in the development, production, application, and recycling of modern batteries. For this reason, these aspects were identified as focus points for future action in the SET Plan.

2.4.1.2 Target vision (using the potential of underground pore storage)

The use of natural geological zones can make an important contribution to ensuring a secure energy supply in Austria and Europe. These formations are an integral part of Austria's energy infrastructure, are currently used to store energy in the form of natural gas, and are located at a depth of around 500 to 2,300 m in exhausted natural gas reservoirs. These storage facilities have proven their ability to contain gas over millions of years and have been extensively investigated over the course of the extraction of their natural gas. Expertise gained over many years of production ensure safe storage operations.

2.4.1.3 Current situation in Austria

The geological structures that are currently used in Austria are hydrocarbon reservoirs, which have a substantially higher storage capacity than deep saline aquifers. The aquifers that are not yet used for storage offer considerable pore storage potential for different applications.
The exit from fossil fuels will change the use of these geological structures. In the context of sector coupling, underground pore storage can make important contributions to the decarbonisation of Austria's energy supply in different ways. These are:

2.4.1.4 Fields of action

- **Underground pore storage for energy storage**

  In future, other media besides natural gas can be injected into the geological formations to contribute to the storage of energy generated from volatile sources. This is already happening today, among other things, through "Power-to-Gas technology for the production of hydrogen from electricity generated by electrolysis e.g. from solar or wind energy, which is then being injected into suitable formations within the framework of pilot projects.

  The storage of compressed air produced using renewable energy sources and the storage of media heated using renewable energy can also be injected into these geological structures.

  Synthetic gas, compressed air, or a heated media could be injected into natural geological formations in the summer months so that the increased, non-continuous demand in winter (consumption peaks at different times of the day) can be covered from the reservoirs.

a) Underground pore storage and CCU

Carbon dioxide capture and utilisation (CCU) technology is designed to capture CO_2 from industrial processes (point sources) and to feed it into a technical application. The CCU process can make a contribution to the circular economy. A further application of this is the generation of synthetic methane (natural gas), i.e. within the pore structures.

To do this, the captured CO_2 is injected into a geological structure together with green hydrogen and then converted into synthetic methane by the bacteria residing there. This gas offers all the technical advantages of natural gas but is CO_2 neutral and could be used for special applications that are difficult to electrify. This could include air traffic.

In addition to renewable methane, which is the most mature technology at present, there are other concepts for the use of the captured CO_2 that have the potential to contribute to mitigation of climate change. One of these processes is the so-called "carbonation", where CO_2 is bound in the form of carbonates and could be stored for geological time periods or used as a construction material.

Another promising approach is the cultivation of microalgae that use CO_2 for their photosynthesis. This means that sunlight and CO_2 are turned into biomass for further utilisation.

b) Underground pore storage and CCS

Carbon dioxide capture and storage (CCS) technology is designed to capture CO_2 from industrial processes (point sources) and permanently prevent it from being released into the atmosphere. Such permanent carbon dioxide storage is a competitive use that prevents the alternate use of underground structures. CCS projects are only viable when long-term safety and environmental protection can be guaranteed.

There are currently no CCS projects in Austria as a moratorium on this technology is in force under the "Federal Act on the Prohibition of the Geological Storage of Carbon Dioxide". This Act will be re-evaluated every five years, taking the experiences gained around the world into account. The current evaluation report states that further research and development work is needed for such projects, with a focus on the national geological conditions and the effects on the environment.

The possibility of new research findings by 2050 should not be ruled out. A possible contribution of CCS technology to climate mitigation should be approached with a certain openness, as it permanently removes CO_2 from the carbon cycle. This is an interesting advantage that CCS technology has over CCU technology.

c) Making approval processes more efficient

Many of the measures are linked to investment projects for which permits must be obtained. The approval processes are to be designed efficiently while maintaining environmental and participation standards. The actual duration of the process is needs to be aligned with the legal requirements. In any case, the public's interest in climate action and security of supply must be given high priority.

2.4.2 Industry

2.4.2.1 Introduction and target vision

The goal is to create a competitive, modern, and climate-neutral economy in Austria. The various sectors of the economy will undergo substantial changes to achieve this. Policy makers will create a framework that enables industrial sectors to transition to climate-friendly technologies at their Austrian sites. In doing so, the policy makers will not expose industry to excessive CO_2 costs that would impair its competitiveness.

The top priority for European policy is to establish a global CO_2 price for key sectors to effectively combat the problem of relocation.

Austrian industry is a driver of innovation and a front runner in key technologies. The development and implementation of innovative and sustainable energy technologies contributes to stimulating economic growth and industrial development while also furthering decarbonisation. Policymakers rely on cooperation and partnerships with the business community. The prerequisite of major investments for the technology transition is the predictability of framework conditions over the entire amortisation period.

The goal is clean growth, in other words decarbonisation, driven by sustainable economic expansion and a higher degree of technological innovation. This will create the necessary conditions for the domestic economy to secure Austria as an attractive industrial location even in a decarbonised environment. Particularly energy-intensive sectors often operate in a highly competitive global market, and suitable framework conditions are to be created so they can continue to succeed in the future (for as long as there is a cost disparity between the EU and third countries).

In a first wave, coal and other particularly harmful fossil fuels will likely be replaced, and industrial processes will then be powered by electricity and green gas/hydrogen in a second wave, for which research will be conducted on an ongoing basis.

Renewable hydrogen will play a central role in the decarbonisation of industry, especially in energy-intensive sectors. Hydrogen is used not only as a raw material in industrial processes, but can also replace natural gas as a source of energy if the production process cannot be electrified.

Here, the greatest CO_2 reduction potential can be realised by substituting the use of fossil-fuel based hydrogen and by developing new hydrogen applications and process modifications, especially for high-temperature operations, combined with a corresponding upscaling and changed energy and raw materials management.

Industry is already testing possibilities for substantially reducing CO_2 emissions by using renewable hydrogen. Renewable hydrogen is expected to play an especially important role in the long-term decarbonisation of the steel industry.

The EU's flagship project H2FUTURE for steel production at voestalpine in Linz is the largest pilot hydrogen system of its kind in the world with a connected load of 6 MW. This project is allowing research into the potential for the use of renewable hydrogen for steel production and is laying the groundwork for further expansion to an industrial scale.

However, the cost-efficient supply of all domestic industries with renewable hydrogen produced using green electricity from Austria at competitive prices is not certain at this time. It will be necessary to cover part of the future hydrogen needs for industry, mobility, and other sectors via imports over the long term. This means that the hydrogen economy must be promoted and structured not only at a national level, but at the European and global level to ensure that future industrial hydrogen applications are internationally competitive. Flourishing international trade will ensure the supply of hydrogen as a fuel for Austrian industry beyond the national production capacity by 2050, which will require energy partnerships with other (neighbouring) economic areas.

In addition to these key challenges, the switch to hydrogen also entails technological challenges that are currently impeding the broader use of hydrogen for industrial applications. The switch to hydrogen also creates new requirements for process safety that must be addressed. Technological feasibility and sufficient financial incentives for breakthrough technologies are prerequisites for solving the current bottlenecks in the renewable energy supply.

Target visions from the industrial transition scenario:

- The objectives of the circular economy will be reached. The consumption of resources will be taken into account in the (ecological) balance to allow the recycling of precious metals and rare-earth metals in an economical manner.
- Materials will be chosen based on recyclability. There are only few composite materials that cannot be separated.

- The changed use of long-lasting, high-quality products (sharing economy, leasing, re-use, upgrading, recycling) and the resulting changes in the production processes will lead to the highly efficient use of the required energy and resources (improved recycling).
- Planned obsolescence will be avoided through suitable measures.
- Falling ancillary wage costs and rising transport, energy, and material costs will lead to more products being repaired instead of replaced.
- Products will no longer be designed to deliver 100% optimum performance but to achieve a compromise between performance and re-use. Modular designs will permit upgrades and component replacement, meaning that only defective or non-functional components will be replaced.
- This will increase the value and life of the products.
- Technological advances and technical revolutions will lead to lower energy input per produced unit.
- The EU Ecodesign legislation will address not only energy, but also sparing resource use, long life, repairability, and guaranteed warranties.
- Important criteria for electrical devices will be both low energy consumption and protection of the data they contain against external attacks.
- CO_2 labelling will be introduced for consumer goods (such as food) at least EU-wide. A good competitive framework and strong internal market will be created in the EU for the development of new technologies that will play a central role in decarbonisation and the energy transformation.
- Fertiliser use and production will be reduced by avoiding food waste. The lower volume of waste will also have effects on the food industry.

2.4.2.2 Current situation in Austria

The industrial output ratio in Austria in 2018 was 18.9% measured by the share of the manufacturing and processing sectors in total gross value added.
Based on the entire secondary sector (mining, goods manufacture, energy and water supply, construction), industry contributed 25.75% of nominal GDP in 2018, and mining and manufacturing of goods alone contributed 17.24%.

The manufacturing sector´s share accounted for 29.1% of final energy use in 2018. The structure of the final energy use in the manufacturing sector (2017) according to energy sources showed the following picture:

- Gas: 33.5%
- Electricity: 31.6%
- Biogenic energy: 16.8%
- Petroleum products: 5.7%
- Coal: 5.2%

- Waste incineration: 3.7%
- District heating: 3.5%
- Ambient heat: 0.1%

Final energy use in manufacturing by sector (2017):		Share of fossil fuels by sector:
Paper/printing:	22.5%	31%
Chemicals/petrochemicals:	13.4%	46%
Iron and steel:	11.1%	74%
Stone, soil, glass:	10.9%	50%
Mechanical engineering:	8.9%	42%
Food and beverages:	8.6%	56%
Wood processing:	7.9%	11%
Construction:	5.2%	74%
Non-ferrous metals:	2.8%	56%
Mining:	2.3%	35%
Vehicles:	2.1%	33%
Textiles/leather:	1.0%	55%
Other:	3.4%	21%

Note: Fossil fuels consist of coal, petroleum products, and natural gas

Does not include electricity and district heating produced with fossil fuels

The share of coal in the final energy use of manufacturing is low at 5.2%. Of these 17.5 PJ in total, 10.7 PJ are used for iron and steel production, 3.2 PJ for paper/printing, 2.2 PJ for stone/soil/glass, and 1.1 PJ for chemicals/petrochemicals.

Marginal quantities are used in the sectors of non-ferrous metals, food and beverages, and mining (0.3 PJ in total).

The consumption of coal in the energy sector itself (coking plants, blast furnaces, power plants) is significantly more substantial at around 70 PJ.

2.4.2.2.1 The role of hydrogen

Hydrogen is currently produced primarily from natural gas by means of steam reforming and is used as an input for a wide range of processes in the chemical industry. The greatest national potential for the use of hydrogen has been identified in the steel, chemicals (ammonia and methanol production), mineral oil, and brick industries. Especially high-temperature processes will still depend on gaseous, molecular fuels for which there are not yet any alternatives in many areas.

2.4.2.3 Fields of action

- Further development of EU emissions trading and the associated reduction in the supply of certificates combined with the implementation of effective carbon leakage protection for companies, for example through continued free allocations
- Examination of further steps to ensure location security and competitiveness of industry in Austria and Europe, e.g. by earmarking the auction proceeds for investments in technology transformation and carbon border adjustment measures to prevent climate dumping.
- Preserving and expanding the competitiveness of domestic industry through research and the use of innovative technologies.
- Promotion of carbon capture and utilisation (CCU) in industry as this bridging technology will make an important contribution to the decarbonisation of industry, especially in the transitional phase.
- Pan-European value chains, especially in the hydrogen segment, will be set up with Austria playing a central role and will contribute to the competitiveness of Austria as a place to do business.
- Technological feasibility and sufficient incentives for breakthrough technologies are prerequisites for solving the current bottlenecks in the renewable energy supply.
- Suitable investment promotion for hydrogen-based decarbonisation technologies, renewable hydrogen production technologies, and infrastructure innovations to secure the power supply (e.g. IPCEI hydrogen).
- Permanent availability of a sufficient quantity of renewable electricity at competitive costs and ensuring the comprehensive international competitiveness of domestic industry.
- In order to counteract global locational disadvantages, it is crucial to push Austria's initiatives at European and international level for a competitive hydrogen application, especially for initiatives after 2030.
- The topic of hydrogen management must be promoted beyond national strategies at the European and then global level to ensure the competitiveness of future industrial hydrogen applications.

2.4.2.4 Bio-economy

Bio-economy stands for an economic concept that intends to replace fossil resources (raw materials and fuels) with renewable raw materials in as many areas and applications as possible. It covers all industrial and economic sectors that produce, process, or use biological resources. Bio-economy offers a great opportunity to meet global challenges such as progressing climate change, food and water scarcity, and growing pollution levels while also strengthening economic development.

The conversion of the current fossil economic system was anchored as a lighthouse project in the #mission2030 in 2018 and has been implemented by the Austrian bio-economy strategy since 2019. The bio-economy strategy provides orientation for all areas in need of actions and is intended to help counter potential conflicts and optimise synergies at an early stage by coordinating with the Sustainable Development Goals made binding in the Agenda 2030.

Bio-economy is also a source of many new opportunities for Austria as a business location especially in connection with the use of regional, renewable raw materials. The competitiveness of Austria's economy will be improved, the supply of quality food guaranteed, jobs created in rural areas, negative environmental effects minimised, greenhouse gas emissions reduced, and a general change in thinking set in motion. And it will make a key contribution to reaching the objectives of the Paris Agreement.

Bio-economy in Austria

Austria can build on a variety of strengths thanks to its natural resources, innovative companies, and respected research institutions. The associated bio-economy-relevant value chains form an excellent basis.

Research, development, and innovation are key drivers of the development of bio-economy. In addition to technological development, the systematic connection of technical/scientific, economic, political/social, and ethical aspects is a key success factor for the reorientation of our future economic system. Especially the humanities, social and cultural sciences can lay the foundation for solutions to major social challenges such as advancing climate change. Therefore, the further strategic development of the framework conditions envisages and increased participation of these disciplines.

In addition to efficiency measures, sufficiency measures and lifecycle concepts are important pillars for the transformation of the economic system through the Austrian bio-economy strategy. Especially cascading utilisation options must be increasingly taken into account to first achieve a sustainable economy and eventually a circular economy. However, it will be necessary to place a greater focus on consumer behaviour than on concrete production and conversion measures since only a change in consumer behaviour can lead to a sustainable transition in the economic system.

In terms of resources, Austrian agricultural and forestry operations provide a wide range of raw materials for the bio-economy. For a sustainable transformation of the economic system, however, it is necessary to increase the added value per hectare, apply new innovative production technologies and achieve the most efficient and sustainable use of raw materials (resource efficiency).The direct substitution of all fossil materials with biogenic materials would result in additional land requirements. However, the use of renewable raw materials will increase compared to the total use raw material. This will require efficiency and output increases, and there is substantial potential for the use of waste, residual materials, and by-products in addition to traditional raw materials from agriculture and forestry. New concepts such as urban farming, greenhouses, and closed production systems will also become increasingly important for expanding the raw materials base.

The potential for biogenic products is as broad as the variety of available raw materials. Working from its existing strengths, Austria should position itself as the technology leader in pulp and fibre products and in sawmill and timber products in Europe, for example. The aim is to support the founding and settlement of companies in the bio-based industry, to strengthen the market for these products, to promote the creation of new jobs, and to adapt the educational system.

Political instruments must be integrated and coordinated at all levels of government to provide optimal support for the implementation of the bio-economy in Austria. This will be the only way to ensure a cost-effective transition to a bio-based economy and achieve the objective of decarbonisation.

2.4.3 Transport

2.4.3.1 Introduction and target vision

During the public consultation in summer 2019, measures targeting the decarbonisation of the transport sector were rated as being particularly effective and have thus been assigned a high priority. Substantial reductions in greenhouse gas emissions can be achieved by reducing traffic volumes, effecting a modal shift to public transport (for passenger and freight traffic), active mobility, and by transitioning to electric vehicles powered by renewable sources.

In the target vision a turnaround in transport has been achieved in 2050, and the transport sector in Austria has been largely decarbonised. Emissions from passenger and freight traffic have been reduced to the absolutely necessary minimum. The population and companies are profiting from substantially improved environmental and health conditions.

Local economies, intelligent land use planning, and expanded town centres enable short travel distances that can be covered actively, on foot or by bicycle. The population is an active part of the mobility transformation and is aware of the benefits, especially in the form of a higher quality of life. Public transport forms the strong backbone of the transportation system in urban areas and on regional and long-haul routes outside of cities. In part because public transport has been promoted through regulatory measures and has become the lower-cost means of transport due to fiscal measures. As a result of the transformation mobility opportunities are now more fairly distributed throughout Austria, and there is also a free choice of different forms of mobility in rural areas. This diversity of mobility offers will play an important role in making rural areas a particularly attractive place to live for all generations.

Individualised mobility concepts have been created by more and more companies, communities, and associations in Austria. As a result, more employees travel to work by bicycle or public transport, and business trips are done with public transport or by carpooling in an electric vehicle. Flights within the EU have become substantially less attractive thanks to modern video conferencing systems and a convenient EU-wide night train system, and are much less in demand.

At the same time, the transformation will be supported by technological developments such as electric and fuel cell vehicles powered by electricity or hydrogen from renewable sources and equipped with user-friendly information technologies. The implementation of innovative transport and mobility solutions has improved access to climate-friendly mobility for all groups of population and ensures the efficient connection of all businesses in a decarbonised transport system. The transition of the mobility sector to largely renewable energy produced in Austria will strengthen the domestic economy and increase national value creation.

2.4.3.2 Current situation in Austria

Road transport was one of the main sources of greenhouse gas emissions in Austria in 2017 at close to 29%. Passenger traffic is responsible for 64% of emissions in road transport, and freight traffic for 36%.[5] The greenhouse gas emissions from the transport sector (including fuel exports) rose by around 80% between 1990 and 2005, before a trend reversal could be observed in the following years, particularly through the addition of biofuels, innovative projects for climate-friendly mobility management as well as changed economic conditions. However, greenhouse gas emissions rose again for the third time in a row in 2017 to reach 23.6 million tonnes of CO_2 equivalents.[6]

The current transport system is strongly characterized by individual motorised transport on the road, both for passenger and freight transport. This system is supported by infrastructural and fiscal conditions that cause an imbalance in mobility costs because not all external costs have yet been internalised for all modes of transport. If these conditions are not changed, passenger traffic volume would increase by around 25% between 2017 and 2050, and freight traffic by around 35%.[7]

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[5] Federal Environment Agency (2018): Climate Mitigation Report 2018. Federal Environment Agency, Vienna. P 108

[6] Twelfth State of the Environment Report. Environmental situation in Austria. P 126

[7] Ebenda. P 123

A switch to more climate-friendly and efficient modes of transport and technologies is needed to reduce energy consumption and greenhouse gas emissions. Transport choices should be made based on the principles of "avoid, shift and improve."

2.4.3.3 Legal and political framework in the transport sector

The transport sector must make its proportionate contribution to greenhouse gas reductions in order to meet the objectives of the Paris Agreement. In light of the greenhouse gas reductions required by 2030, ambitious reduction targets were developed for new passenger cars, light commercial vehicles[8], and heavy-duty vehicles[9] during Austria's presidency of the EU Council of Ministers in the second half of 2018. The CO_2 fleet targets require automobile manufacturers to reduce the average emissions of their new passenger cars and light commercial vehicles by 15% from 2025 and by 37.5% from 2030 (31% for light commercial vehicles) compared with 2021 levels. The achievement of existing fleet targets is an important milestone on the way to decarbonisation.

Another element of the transformation that was set into motion during the Austrian Presidency of the EU Council of Ministers is the Graz Declaration[10]. This declaration was adopted at the informal meeting of the environment and transport ministers in Graz. The document contains the fundamental strategic requirements for the decarbonisation of the transport sector in Austria. The Graz Declaration states "A holistic transformation policy approach is required, combining actions and making use of synergies…"[11]. This approach is to be supported by corresponding incentives and infrastructure and requires measures that are aimed at behavioural changes, effective mobility management, and technological innovation in the areas of vehicles and fuels, and the promotion of active mobility without losing sight of social aspects of the transformation of the transport sector.

With *#mission2030*, Austria presented an ambitious climate and energy strategy in June 2018 . Transport plays a key role in this strategy. *#mission2030* recognises the importance of mobility as a basic human need and stands for an open economy.

To this end, *#mission2030* identifies the central aspects of the mobility transformation: E-mobility on the basis of renewable energy sources; fuel cell vehicles with hydrogen as a

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[8] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles

[9] Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO_2 emission performance standards for new heavy-duty vehicles

[10] Graz Declaration – "Starting a new era: clean, safe and affordable mobility for Europe"

[11] Graz Declaration P 2

renewable energy source for the applications that are difficult to electrify; alternative drives and fuels; increased use of public transport; active mobility (bicycle and foot traffic) promoted by corresponding infrastructure and made accessible by attractive mobility services; shift in freight traffic to rail and expansion of combined transport. This will provide additional value for the affected citizens and for companies because the new forms of mobility are environmentally friendlier and healthier. The Cycling Master Plan[12] aims to double the share of bicycle traffic from 7% to 13% by 2050. The Walking Master Plan[13] creates incentives for walking.

This is to be supplemented by the "*creation of suitable economic conditions and target-group specific offerings and measures for freight and passenger traffic*"[14] together with a supportive legislative framework as a "*central requirement for attaining a sustainable and decarbonised transport system*".[15]

2.4.3.4 Fields of action

2.4.3.4.1 A holistic approach for the transformation of the transport sector

The transformation of the transport sector towards decarbonisation can only succeed through a holistic approach[16] and an increased level of environmental awareness among all actors involved. In addition to technological innovations and improvements on the supply side, this holistic approach must also include measures on the demand side and behavioural changes and make optimum use of synergies between them. The social impacts of various measures must also be taken into account and mitigated by accompanying measures where necessary.

The fundamental objective is to shift to clean, climate-friendly modes of transport, improve capacity utilisation in freight and passenger traffic, and avoid traffic. At the same time, a holistic framework for the mobility transformation will be created through consistent investments, supporting conditions and incentives, and continued research and innovation. The ultimate goal of the transformation of the transport sector must be to make mobility more climate-friendly, in other words continuously reducing the share of fossil fuels used. This will require the conversion of the associated physical and especially digital infrastructures. One driver of decarbonisation is the progress being made in battery technology, which makes batteries and electric motors smaller and cheaper. Such a progress replaces fossil-fuel drives

[12] BMLFUW (2015): Cycling Master Plan 2015–2025.
[13] BMVIT (2015): Walking Master Plan – Strategy for promoting foot traffic in Austria.
[14] Mission2030 P 43
[15] Ebenda.
[16] Graz Declaration

with electric drives systems. Research is not only aimed at improving the technologies, but also at understanding how mobility needs change over time (the social science level). The key focus of this research is how traffic and transport volumes in the system can be sustainably reduced. Researchers and policymakers are working hand in hand to achieve a broad consensus through effective awareness-raising programmes.

The transformation will also rely on improved offers in local and regional transport, traffic flow optimisation to make more efficient use of infrastructure, mobility management for companies, towns, and tourism, and the use of digitalisation for mobility services such as car and ride sharing, as well as on improved pedestrian and bicycle infrastructure.[17] The bicycle as a climate-neutral vehicle closes the crucial gap between public transportation and the "last mile" in a decarbonised transport system. The bicycle is an ideal complement to public rail transport especially in urban areas thanks to its flexibility, and is a good alternative to a motor vehicle thanks to the little space that it requires. The positive effects that active mobility has on health are also important in this context, and are economically relevant. The transformation of the mobility system will lead to the increased use of active mobility forms (walking and bicycling). This will reduce the number of sick days of people, and will increase their life expectancy.

The economic conditions, especially investments by and contracts from public agencies, public funding, and the tax system have a major influence on mobility behaviour and the volume of traffic. The selection of where to live and work and the quality and energy consumption intensity of the chosen means of transport are based on the economic conditions. The elimination of counterproductive financial measures, especially the sending of correct price signals to market participants, is a key prerequisite for achieving a sustainable and decarbonised transport system.[18] If these goals are to be reached, it will also be necessary to coordinate strategies and areas of action between the federal, provincial, and municipal governments, to identify and eliminate regulations that are counterproductive for decarbonisation, and to coordinate the legal framework between the regional authorities to facilitate the implementation of a decarbonised transport system.[19]

[17] Mission2030 P 37

[18] Mission2030 P 43

[19] Mission2030 P 49

2.4.3.4.2 Reducing traffic by the scheme "avoidance, modal shifts, and improvement"

The mobility transformation will be achieved by following these principles.

- **Avoidance**

The increased digitalisation of work is bringing the workplace and home closer together again, and mobility management will help to avoid unnecessary travel. The previously long commutes to work will be replaced by short trips close to home. This trend will increase the potential for the use of bicycles as a quick mode of transport for short distances. The town structures in rural areas will have a higher density in 2050, which will make walking more attractive and will shift a certain share of transport to foot and bicycle traffic. Accompanying measures will revitalise town centres, this is shown e.g. by the fact that there are more small shops and grocers in towns. This will shorten the distances that need to be covered, and traffic will be effectively avoided.

Modern urban and land use planning will focus on minimising the use of resources and avoiding traffic. For example, the requirement for developers to provide parking spaces for cars when erecting new residential buildings has been replaced with measures for accessing public transport. These and further measures (such as zones with combined motor vehicle, bicycle, and foot traffic) are leading to a reduction of motorised traffic in cities.

Global goods transport is increasingly being replaced with regional economies, and a resource-efficient circular economy is the norm. There is no more planned obsolescence in 2050, all products and goods are designed to be long-lasting and repairable. Society demands more sustainable products and services in general.

- **Modal shifts**

Individual motorised traffic is less common in 2050 than today – the modal split has shifted to public transport and active mobility. This has been effected above all by increased environmental awareness among the population thanks to targeted measures. Innovative, holistic mobility solutions will also cover the last mile, for example tailored mobility management, on-demand buses, electric taxis, car sharing, and the massive expansion of public transport.

Public transport intervals are considerably shorter, and customer-friendly service planning and information provision make rail and bus travel more attractive.

Freight transport by rail has profited from the reduction of regulatory hurdles. The external costs of all modes of transport will be internalised during the mobility transformation. This means that the most environmentally friendly modes of transport are also the cheapest. This will cause a preference for these modes of transport. The volume of individual motorised traffic and short-haul flights has decreased considerably.

- **Improvement**

The objective is to strive for the highest possible energy efficiency and a switch to renewable energy sources. In practice, this means that vehicles powered by electricity from renewable sources and green hydrogen are used on the roads while vehicles powered by fossil fuels are a thing of the past in 2050. For passenger cars and light commercial vehicles, this will primarily be achieved by a switch to electric vehicles powered entirely by electricity from renewable sources. Increasing electrification is also being pursued for heavy-duty vehicles. Fuel cell vehicles using hydrogen from renewable sources are an important option especially for applications that are difficult to electrify (such as heavy goods vehicles for long-haul transport). Electric vehicles and fuel cell vehicles offer the possibility to use 100% renewable energy and are also considerably more efficient than petrol and diesel vehicles. Eco-driving training teaches drivers how to use and operate their vehicles as efficiently as possible.

The rail infrastructure is 100% electrified and powers the trains entirely with electricity from renewable sources. The majority of freight transport has been shifted to the rails, and the remaining goods transports are handled with non-fossil drives (electromobility, in part with overhead-line lorries, and with hydrogen). The role of inland shipping, which is to switch to renewable energy, has increased considerably.

E-fuels produced in the EU through new and innovative technologies and second-generation biofuels will especially be used in aviation.

The time required for the relevant approval processes (especially for passenger and freight transport by rail) is to be shortened so that the efficiency gains can be realised rapidly enough.

2.4.3.5 Lifestyles in 2050: People and companies profit from the mobility transformation

Future land use planning can substantially reduce mobility pressure. The surface space required in cities for vehicle parking and traffic has been decreased substantially through a wide range of measures (expansion of public transport, sharing offers, etc.), which has been very well received by the population. There is more green space, and this has made cities more resilient against the increasing number of heat waves and nights with high temperatures. The air and noise pollution from traffic has been drastically reduced.

Rural areas are well serviced by an intelligent combination of micro public transport systems, intermodal interfaces in larger towns, and a robust public transport network.

All in all, the expenses for mobility services have declined without the population feeling restricted in their mobility.

Examples of mobility and transport patterns in different areas of life with a largely decarbonised transport sector in the year 2050 are described in the Annex (section 6.3).

2.4.4 Buildings

2.4.4.1 Introduction and target vision

The building sector (residential and commercial buildings) generated greenhouse gas emissions of 8.3 million tonnes of CO_2 equivalents, or 10% of the total emissions, in 2017. Even though greenhouse gas emissions from buildings have been reduced substantially over the past decades, there is still great savings potential in this sector. The federal government's #mission2030 climate and energy strategy and the draft of the National Energy and Climate Plan contain the goal of saving roughly 3 million tonnes of CO_2 equivalents compared with 2016 in the building sector in a socially and economically compatible manner. The sector is to be decarbonised to the greatest extent possible by 2050.

The **target vision** for 2050 is therefore buildings that are heated and cooled virtually free of CO_2 emissions, and that are also supplied with hot water exclusively via renewable energy sources. The planning through to 2050 includes not only development areas for different uses such as residential, leisure, industry, and commercial, but also power supply infrastructure for these areas that only makes use of renewable energy. This involves the consideration of power supply and sustainable mobility criteria during the planning and zoning of these areas. Spatial planning, zoning, and development planning have had the effect that sealing of areas has been reduced and the demand for heat condensed, waste heat potentials can be used very effectively and a large share of heating and cooling in buildings can be effected with grid-bound energy sources such as district and local heating and renewable gas.

Buildings constructed over the past decades consume very little energy themselves and play an active role in the provision of energy through rooftop photovoltaic and solar collectors as well as the storage of energy. In concrete terms, this means that only low-energy buildings (NZEB) and plus-energy buildings are constructed. Public agencies have been acting as role models in this, and all new public buildings have been low-energy buildings since 1 January

2019. In 2050, the majority of the buildings erected since 2020 have been built in conglomerations where they form plus-energy neighbourhoods. Newly constructed buildings that cannot be heated and cooled with grid-bound energy sources only use renewable energy and are built as plus-energy buildings that generate more energy than they need.

Existing buildings have been upgraded to a modern thermal and energy standard by 2050. This means that heating and cooling of these buildings will only need a fraction of the energy needed today. These remaining energy needs will be covered by grid-bound energy sources using renewable sources. Decentralised renewable generation facilities and heat pumps will be used where no grid-bound heating supply is possible. Fossil fuels will only be used in exceptional cases if alternatives are technically not feasible or would be inefficient based on material economic costs and benefits.

The need for cooling energy has risen substantially resulting from climate change and urban heat islands. Building designs are being adapted to avoid summer cooling loads, or if this is not feasible, passive and active measures in buildings shall protect against overheating in the summer. Many buildings have smart storage facilities such as component activation as well as green roofs and facades.

The involvement of other sectors such as low-carbon manufacturing of products and the circular economy also contributes to the decarbonisation of the building sector. Buildings are also used as greenhouse gas sinks by selecting sustainable construction materials (for example from renewable raw materials).

In order to ensure the sustainable use of buildings over long periods, these must provide sufficient flexibility in their use. "Multi-generational buildings" allow for rapid and low-resource changes in the use of buildings, which limits and prevents extensive land use as well as oversizing.

District heating plays a central role in urban areas with high heat absorption densities combined with close proximities to capable suppliers of waste heat. Local bidirectional (low temperature) grids improve the ability to store heat, distribute heat in an energy-efficient manner, efficiently incorporate renewable heat, and to use different waste heat sources, respectively locally from geothermy and seasonally stored geothermal heat.

Due to the use of heat pumps, electrical energy accounts for a large share of the total energy demand for space heating, hot water supply and cooling of buildings. Efficient heat pumps and biogenic energy sources combined with solar thermal collectors dominate the decentralised provision of heating energy. Nearly all suitable roof surfaces are used for photovoltaics, and the share of facade surfaces used to collect energy (such as solar thermal and photovoltaic elements) is increasing rapidly.

These positive developments were made possible in part by convincing building users and owners, neighbours, investors, and other stakeholders of the usefulness and necessity of these changes. Through targeted information provision and involvement of affected stakeholders, acceptance was created even for measures that have disadvantages on individual groups.

2.4.4.2 Current situation in Austria

Around 82.3 million tonnes of CO_2 equivalents were emitted in Austria in 2017. The building sector (residential and commercial buildings) generated greenhouse gas emissions of 8.3 million tonnes of CO_2 equivalents, or 10% of total emissions, in 2017. Emissions fell by 4.5 million tonnes of CO_2 equivalents[20] between 1990 and 2017.

Per capita living space consumption was 23 m² in 1970 and 37 m² in 1990, and has now almost doubled to nearly 45 m²[21] in a period of 40 years according to the most recent statistic. The population of Austria grew by around one million people in the same time period[22]. Despite this trend which resulted in a substantial increase in the total conditioned space, greenhouse gas emissions in the building sector (excluding greenhouse gas emissions from the generation of electricity and heat of the energy industry) have decreased by around 4.8 million tonnes of CO_2 equivalents since 1990[23].

[20] Part of this is simply the result of the shifting of emissions to emissions trading by switching energy sources to district heating and electricity. Source: Federal Environment Agency: Greenhouse Gas Inventory 2017

[21] Wolfgang Amann, Klaus Lugger: *Österreichisches Wohnhandbuch 2016*; P 9.

[22] Eurostat; accessed on the Internet on 4 July 2019: https://ec.europa.eu/eurostat/de/web/population-demography-migration-projections/population-projections-data

[23] Federal Environment Agency: Climate Mitigation Report 2018; P 125.

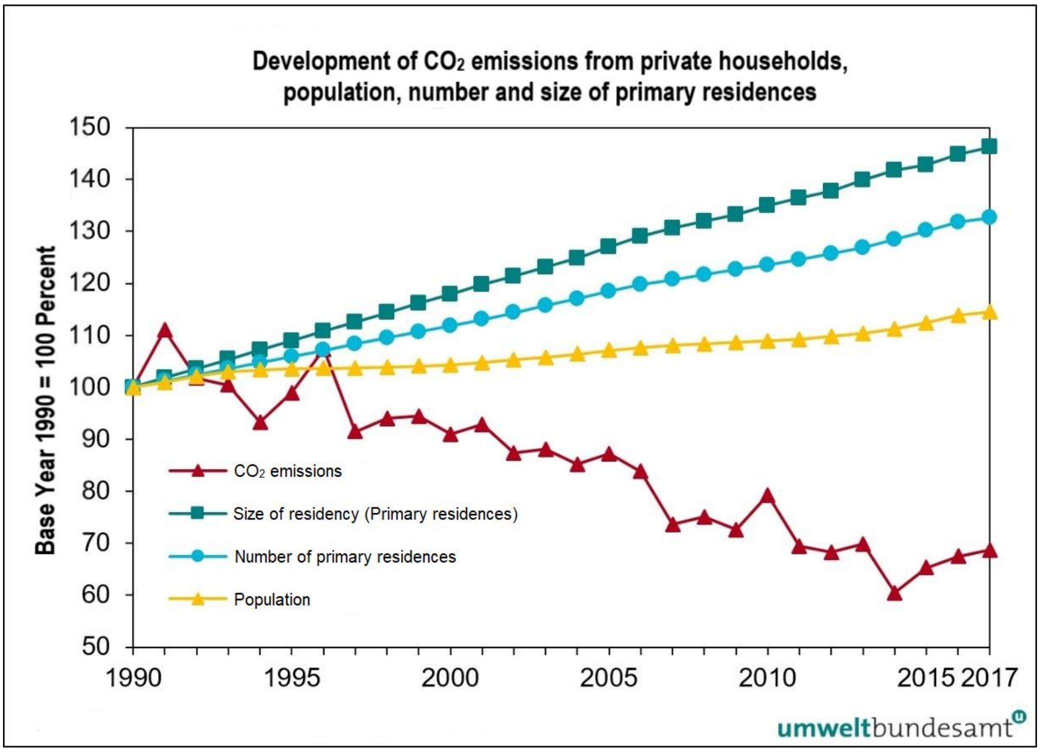

Figure 2 Household carbon dioxide emissions compared with population growth and number and size of primary residences

Space heating and cooling account for nearly 27% of the total energy demand in buildings[24]. About four fifths of the energy consumed by households is used for space heating and around one fifth for water heating;[25] if efficiency improvements in building envelopes are promoted, it is likely that the share of energy for water heating will increase. Heating systems operated with fossil fuels (heating oil, natural gas) still play a substantial role despite the fact that the share of renewable energy sources has increased in recent years (see the figure below). Natural gas is an important source of energy in Austria and is delivered through a dense distribution grid.

[24] Energy Quantity Statistics Austria 2017, energy quantity for category "space heating and air conditioning".

[25] Source: STAT, Energy Quantity Analysis 2017: roughly 240 PJ for space heating (195 PJ), water heating (39 PJ), and cooking (7 PJ) in households.

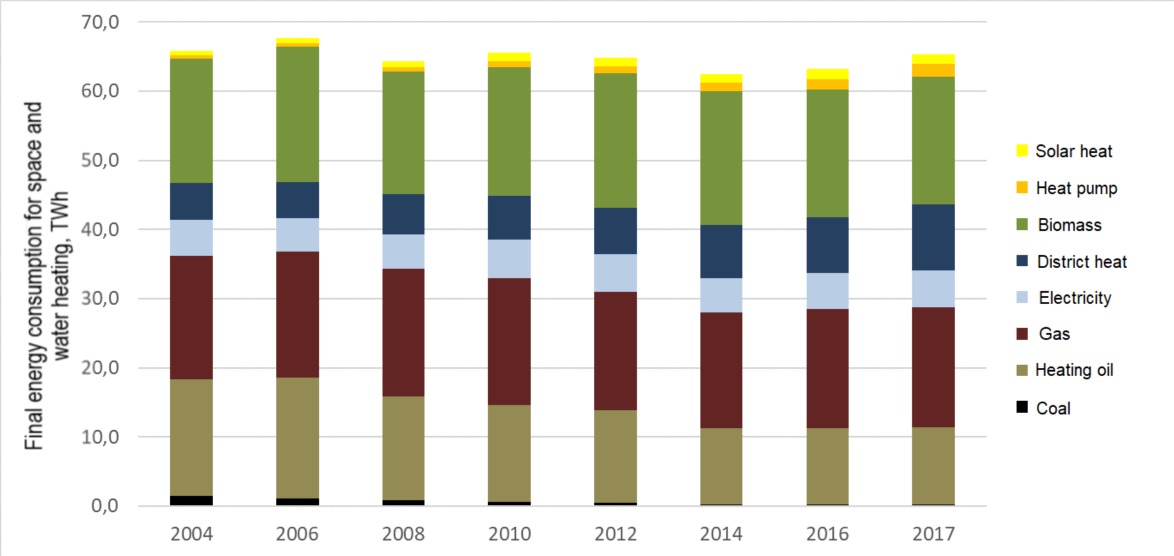

Figure 3 Energy consumption from all sources for space and water heating in all households

Source (Statistics Austria, 2019)

2.4.4.3 Results of the online consultation

As shown by the online consultation (see 1.2.4.1.), the objective of making the building sector climate neutral is feasible with reasonable effort and has high priority.

The further questions pertained to various measures (see below). The following were ranked as measures with substantial effects:

- more stringent approval criteria in order to realise savings potential in buildings,
- energy efficiency as savings potential in buildings, and
- the promotion of renewable energy sources and gradual reduction of fossil fuels.

Measures with moderate to major effects:

- regulations for climate-adapted/climate-neutral land use planning,
- climate-friendly adaptation of development planning, and
- use of sealed areas for savings potential in buildings.

2.4.4.4 Fields of action

The following fields of action are planned for the building sector:

2.4.4.4.1 New buildings

Buildings must at least meet the nearly zero-energy building standards, use little energy for heating and cooling, and play an active role in the provision of energy through rooftop photovoltaic and solar collector systems and through energy storage (e.g. via component activation). In 2050, the majority of the buildings erected since 2020 need considerably less energy for heating and cooling and are generally built in conglomerations where they form plus-energy neighbourhoods. Newly constructed buildings that cannot be heated and cooled with grid-bound energy sources only use renewable energy and are built as plus-energy buildings that generate more energy than they consume. Sustainable, renewable raw materials are used for buildings wherever possible and reasonable.

2.4.4.4.2 Thermal and energy refurbishment of existing buildings and efficiency improvements for heating systems

- The existing buildings will be brought up to future-proof thermal and energy standards by 2050. Existing buildings will then need considerably less energy for heating and cooling, which will substantially cut operating costs while significantly increasing living comfort.
- A complete renovation concept will be drawn up for each existing building. This renovation concept will define a future-proof thermal and energy standard which is to be reached by 2050. This future-proof standard will be defined based on technical possibilities and economic efficiency, whereby the essential economic costs and benefits are taken into consideration when determining the economic efficiency. The complete renovation concept comprises the steps necessary to achieve the future-proof thermal and energy standard, whereby the reduction of the need for cooling energy plays an important role. All of these steps must be gradually implemented and completed by 2050.
- The share of total residential units being completely renovated is to be increased from the present 1% to an average of 2% in the period from 2020 to 2030 according to #mission2030. Maintaining this renovation rate and converting the heating systems to renewable energy sources will allow all Austrian buildings to be decarbonised by 2050. Comprehensive renovation projects can also be completed in stages within the framework of the complete renovation concept. The future-proof standard will be achieved after the completion of all stages.
- A coordinated mix of measures will be used to improve the thermal and energy standards of the existing buildings. This can include socially compatible amendments to housing law to facilitate renovation measures, for example a streamlined decision-making process for legally establishing condominium ownership. Targeted funding for the renovation of buildings in the form of investment grants and/or tax reliefs will be

provided, and legal requirements for the implementation of renovation measures with a short amortisation period will be enacted for changes of ownership.

- Information and awareness-raising activities as well as consulting (neutral, government funded, and public) are being planned, the quality of the energy certificate is to be improved, and data on existing buildings and the technologies used for heating and cooling will be collected in a structured manner (for example the register of buildings and apartments).

2.4.4.4.3 Exit from liquid fossil fuels

- New buildings are to be run without the use of fossil fuels, if possible. Oil heating systems are no longer to be used in new buildings by 2020 at the latest. A corresponding federal law has already been passed. Some provinces have already implemented this goal.
- According to the climate and energy strategy (#mission2030), around half of the roughly 700,000 oil heating systems currently in use are to be replaced with innovative, renewable energy systems or efficient district heating by 2030. All oil heating systems are to be replaced with renewable alternatives by 2040. One concrete measure for this will be the "renewable requirement", which means that only heating systems based on highly efficient alternative energy sources are to be used as replacement for liquid fossil-fuel furnaces starting in 2021. Deviations from this requirement shall only be possible in justified exceptions. The existing heating systems powered by liquid fossil fuels will be successively replaced with systems powered by renewable energy sources or climate-friendly district heating starting in 2025.
- No liquid fossil fuels are to be used in buildings owned by the federal and provincial governments by 2030.
- A coordinated mix of long-term anticipated instruments consisting of legal requirements (such as a prohibition on oil heating systems in new buildings, renewables requirement when replacing oil heating systems, etc.), incentives in the form of digressive funding, especially to mitigate social impacts, as well as fiscal measures, needs to be implemented in order to achieve an exit from fossil fuels.

2.4.4.4.4 Switch to renewable gas

- The natural gas grid for space and water heating purposes shall not be expanded any further if possible. The addition of new connections for space and water heating is still possible in exceptions if justified by the unavailability of district heating.

- Fossil gas shall no longer be used in new residential and services buildings starting in 2021. Exceptions should only be granted in justified cases which require effective compensation measures in the form of the generation of renewable energy or energy savings.
- When gas heating systems are replaced, fossil gas is only to be used again if there is no technically or economically feasible option for the use of renewable energy sources or if the use of a heating system powered by renewable energy sources[26] would not be economical, with the economic costs and benefits being taken into account in determining the economic efficiency.
- Fossil gas will be increasingly replaced with renewable and synthetic gas in order to ensure a CO_2-neutral gas supply by 2050.
- To achieve the exit from fossil gas by no later than 2050, a coordinated mix of long-term anticipated instruments is needed. These consist of incentives in the form of funding for renewable heating systems which shall also mitigate social impacts, fiscal measures, and especially requirements and funding for the replacement of fossil gas with renewable gas.
- Decentralised hydrogen production and consumption, such as in energy collectives, will allow for an efficient integration and use of locally generated renewable energy and will bolster local supply security.

2.4.4.4.5 Energy spatial planning

- Criteria for climate-friendly energy supply and generation as well as for climate-friendly mobility must be taken into account in spatial planning, zoning, and development planning.
- Areas should be defined in a way that buildings can be supplied with space and water heating energy and cooling energy from renewable sources to the greatest extent possible. In areas that are or will be equipped with heating/cooling energy grids (such as district heating), the heating consumer density should be increased through spatial planning/zoning/development planning.
- The construction of buildings in existing residential areas, incorporating different functions into residential areas, and the supply of these areas with public and climate-friendly transport options will be indispensable. Local construction codes and parking space regulations are also important instruments in ensuring climate-friendly mobility.

2.4.4.4.6 District heating/cooling and waste heat

- Supplying buildings and businesses with efficient district heating generated from renewable sources will continue to play an important role, especially in urban areas.

[26] This does not mean "green gas tariffs".

- In addition to the generation from different renewable sources (biomass, ambient heat, solar thermal collectors, etc.) as well as combined heat and power generation, feeding waste heat from businesses and homes into the system will also play an important role. In this regard, there is still extensive untapped potential in Austria. Seasonal heat storage will replace heating plants in some cases.
- In the future, instruments of spatial energy planning, subsidies and legal requirements (obligation to purchase waste heat, obligation to feed waste heat into the grid) shall be used to set strengthened impulses for waste heat utilization.

2.4.4.4.7 Buildings as part of the power supply infrastructure

- Buildings shall not only meet high energy standards, but above all play an active role in the provision of energy and the storage of energy for self-supply. Therefore, suitable spaces on buildings shall be used for rooftop and facade installations, and integrated photovoltaic systems are to be used to the greatest degree possible (especially for new construction and renovation projects). The expansion of photovoltaic infrastructure combined with storage technologies – especially at the building level – will make a contribution to reducing the burden on the transmission and distribution grids (Lighthouse 6 in *#mission2030*: 100,000 rooftop photovoltaic systems and local storage programme).

2.4.5 Agriculture and land use, land-use change and forestry (LULUCF)

2.4.5.1 Introduction and target vision

Globally, human nutrition is one of the largest sources of human-made greenhouse gas emissions, amongst other things through induced land-use changes. Consequently, there is immense potential in climate action in extending and expanding climate-friendly food supply, which should also be labelled uniformly and comprehensively for consumer throughout the EU according to its origin and greenhouse gas footprint.

As one of the most directly affected sectors, Austrian agriculture and forestry must increase its resilience and adaptability in order to continue to uphold the supply of food and raw materials as well as to provide ecosystem functions in the future. Simultaneously, the sector is an indispensable part of the solution and can make important contributions to achieving the climate and energy targets. For this purpose, the rising social demands for sustainable and resource-conserving management regarding animal protection, biodiversity, soil, water, and climate and the maintenance of functioning ecosystems must be met.

2.4.5.2 Current situation in Austria

Agriculture and forestry are assigned an important role in the EU's LTS 2050. The potential for greenhouse gas emission reductions in agriculture and forestry is regarded as limited when compared with other sectors, however, the sectors' ability to store carbon has been emphasized.

On the one hand agriculture and forestry are sectors heavily impacted by climate change, on the other hand they also contribute significantly to climate change. Greenhouse gas emissions from agriculture accounted for around 10% of total Austrian emissions in 2017. The forests and soil in Austria are a net sink for greenhouse gas emissions. This sink accounted for 4,906 thousand tonnes of CO_2 equivalents in 2017. To reduce emissions from agriculture, especially the greenhouse gases methane (CH_4) and nitrous oxide (N_2O) resulting from livestock farming and fodder cultivation must decline. Meat consumption in Austria is currently above average. Climate-friendly innovations in the production of animal products and feed combined with a greater focus on high quality food as well as on seasonal and regional products will reduce the carbon footprint of food substantially. The production of plant-based foods also plays an important role as it does not only have the potential to reduce emissions through climate-friendly farming methods, but can also be used for the targeted capture of CO_2.

2.4.5.3 Results of the online consultation

The following target visions were defined for Austrian agriculture and forestry through the online consultation (see 1.2.4.1.):

- Austrian agriculture and forestry is part of the solution on climate action and must be adapted more effectively to climate change in order to secure food production in the future, preserve grassland, and to provide a livelihood for the agriculture and forestry workers over the long term.
- The soil fertility of cultivated land and grassland is to be maintained and the carbon content increased further.
- Regional and seasonal products are climate-friendly; the supply of regional and seasonal products for the population is to be ensured.
- The forests are to be converted into potential natural forest communities with tree species adapted to climate change.
- The forests are to continue supplying raw materials for the decarbonisation of the economic system in the future and maintain and expand their function as a stable carbon sink.

Soil is an important carbon reservoir. The increasing frequency of extreme weather events (such as heavy rainfall and heat waves) is exacerbating the problem of increased land use. Land consumption should be reduced through sensible spatial planning. Annual land use is to be drastically reduced and currently sealed areas are to be restored to a natural state.

Spatial planning in rural areas shall prevent further urban sprawl and fragmentation of areas. City centres are to be strengthened, local supply as well as the connection to public transport shall be ensured. In this way, mobility constraints can be avoided.

The results of the consultation show that the target visions are of high relevance for achieving the goal of climate neutrality in 2050. It should be possible to achieve the necessary activities with a financial effort approximately in the next 10 to 20 years.

2.4.5.4 Fields of action

A central element of Austrian agricultural policy is the support of a competitive, environmentally friendly, resource-saving, comprehensive agriculture, which is often based on family farms.

The EU's Common Agricultural Policy will continue to support agriculture which is oriented towards climate action, including both mitigation and adaption, in part through the continued expansion of agri-environmental and climate measures.

Climate-friendly livestock farming that ensures animal wellbeing can contribute to the production of climate-friendly products when combined with lower-nitrogen feeding techniques (such as optimising feed quantities and feed quality). This especially pertains to locally adapted area-related livestock and location-oriented fertiliser quantities, pasture grazing, and the reduction of concentrated feed and silage maize in dairy farming.

Specific measures such as the reduction of the use of mineral nitrogen fertilisers through optimisation of the whole fertiliser chain, as well as the optimisation of humus and soil carbon content (e.g. through consistent recycling of harvest residues, cultivation of greenery catch crops, environmentally sound crop rotation, mulch and direct sowing) also make a key contribution to reducing greenhouse gas emissions. The share of organic farming and measures for sustainable conventional agriculture (such as precision farming) should also be increased substantially. Digitalisation and smart technologies form the basis for precision farming resulting in the optimised use of fertilisers and pesticides.

Agriculture can also make an important contribution to the energy transformation through the fermentation of additional agricultural residues and waste to produce biomethane. Fermenting manure before spreading it on fields not only substitutes fossil energy but also saves greenhouse gas emissions from manure storage. (BMNT, final NECP, 2019)

The system transitions needed to reach the climate goals in the Paris Agreement are unprecedented in scale according to the IPCC special report[27]. In addition to the impacts of climate change on agriculture and forestry output, the planned expansion of renewable energy ("greening the gas") and bio-economy will bring significant changes to agriculture and forestry. The competition for resources (land, arable soil, water, biomass, etc.) is therefore likely to increase. Against this background, the objectives of ensuring food security, of providing renewable raw materials, and of protecting the environment as well as combating climate change must all be coordinated. It is important to emphasize that the Alpine region is particularly affected by climatic changes, which is progressing faster here than in lowlands. This affects not only the mountain agriculture and forests, but also tourism is particularly negatively affected. The loss of land and changes in land use are highly climate relevant. As rising emissions in the future and a reduction in storage in the LULUCF sector lead to deficits, the carbon sink function of these areas will increase in importance. If land loss in Austria continues and the ability of the soil to store carbon decreases due to rising temperatures, maintaining the current quantity of carbon stored in Austria's soil will become increasingly challenging.

- The containment of greenhouse gas emissions to a declining emission level will be achieved as outlined in the transition scenario. This is based on assumptions about further efficiency increases in the use of nitrogen, the increased keeping of dual-purpose cattle, optimised use of manure, and changes in dietary habits that have an impact on livestock farming. Greenhouse gas aspects will be taken more into account in national funding and funding under the EU's Common Agricultural Policy (CAP).
- Very ambitious measures will be taken to prevent nitrogen losses.
- Dual-purpose cattle (milk and meat) and increased pasture grazing will be promoted.
- Organic farming will be expanded further.
- Agricultural production is adapted optimally to the local and environmental conditions and a circular economy has been established.
- Optimal use of manure (e.g. through liquid manure markets) and substantial reduction of mineral fertiliser use.

[27] IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

- The population has changed its dietary habits which are now based on high-quality plant foods and reduced meat consumption. Alternative protein sources with substantially lower CO_2 intensity (such as algae) will be used for animal feed and other applications.
- Food waste will be reduced substantially.

2.4.5.5 Fields of action in forestry

Austria's woods and forest policy is based on the principle of multi-functionality, through which all functions of the forest are to be considered in a balanced way. The various forest policy activities are discussed and coordinated through the Austrian Forest Dialogue, which was launched as an open, continuous, and participative policy development process in 2001. The first Austrian forest programme was adopted in 2005. Supported by the close coordination of forestry policy measures, the use of wood has significantly increased in recent years, whereby the total loss according to the current ÖWI amounts to 88% of the growth. The Forest Programme 2020+ was drawn up on the basis of the original Austrian forest programme in 2018 and comprises the forest policy cornerstones for the coming years. The Austrian Forest Strategy 2020+ accounts for political requirements from current national and international forest-related strategies, programmes, and processes. This includes the Austrian Biodiversity Strategy 2020+[28], the Austrian Strategy for Adaptation to Climate Change[29], the EU Forest Strategy, the Forest Europe process, and the United Nations Forest Forum (UNFF), the Convention on Biological Diversity (CBD), the UN Sustainable Development Goals (SDGs), and especially the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) as well as the Paris Agreement. The contribution of forests to climate action has been assigned to a separate action area in the Forest Strategy 2020+ in order to effectively address the relevance of forests for the global climate system. This was also confirmed with the goals of the Paris Agreement, which sets out a long-term emission pathway to maintaining the 2°C or 1.5°C target by achieving a balance between emissions by sources and removals by sinks in the second half of the century.

Through the implementation of *#mission2030*[30] the bio-economy strategy[31] was developed in 2019 with the intention of initiating and supporting processes for the transition from the current fossil economical system and of significantly contributing to achieving the climate

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[28] https://www.bmnt.gv.at/umwelt/natur-artenschutz/biologische_vielfalt/biodivstrat_2020plus.html
[29] https://www.bmnt.gv.at/umwelt/klimaschutz/klimapolitik_national/anpassungsstrategie/strategie-kontext.html
[30] BMNT, 2018: #Mission 2030, The Austrian climate and energy strategy
[31] https://www.bmnt.gv.at/umwelt/klimaschutz/biooekonomie/Bio%C3%B6konomie-Strategie-f%C3%BCr-%C3%96sterreich.html

targets. The concept of bio-economy covers raw materials as a source (agriculture and forestry, water management, and waste) on the one hand and the use of these biogenic raw materials (food and feed, chemicals, materials, and energy) on the other.

This shows that a wide range of requirements are placed on Austria's forests, which are implemented through the framework of a sustainable management strategy. This should ensure that the raw materials for the bio-economy and the transition to renewable energy are provided and that the ecosystems are adapted to the climate crisis with the goal of improving the stability and productivity of Austria's forest stock. As measures for reducing emissions and measures for adapting to climate change are often closely related in agriculture and forestry, such measures must be implemented in accordance with the recommendations for action in the Austrian Strategy for Adaptation to Climate Change.

- Only a holistic approach can ensure that an optimal contribution is made to reaching the goal of national climate neutrality by 2050. This approach encompasses sustainable forest management including an adaption of the forest to climate change in order to increase resilience and stability of the forest stock so that productivity can be maintained and increased in the future. Carbon capture in the forestry sector has declined from around 11 million tonnes of CO_2 to around 4 million tonnes of CO_2 from 1990 to 2017, corresponding with an increase of around 38% in logging since the beginning of the 2000s. Independent of this, forest area is increasing continuously and amounts currently to over 4 million hectares. This is being offset by emission reductions in other sectors due to the replacement of other raw materials and fuels with a considerably larger carbon footprint. The use of wood prevents around 12.5 million tonnes of CO_2 emissions per year. The results of the CareForParis project also suggest that the effect of avoiding fossil CO_2 emissions (substitution effect) is at least twice as high as the effect of climate measures from capturing CO_2 in forests.

2.4.5.6 SCENARIO STORYLINES from the wood value chain project in 2015[32]

The long-term effects of different forms of forest management on the national greenhouse gas balance were presented through various projects commissioned by the Climate and Energy Fund in 2012, starting from a reference scenario that is oriented towards the current forest management conditions. Representatives of the forestry and wood industries and of the Ministry of Agriculture, Forestry, Environment, and Water Management drew up four further management scenarios in April 2013. These variants are intended to show possible effects of

[32] BFW, 2015: Climate mitigation in forestry, future management scenarios for Austrian forests and their effects on the greenhouse gas balance

different management extremes on the state of the forest and permit reactions to as yet unforeseen changes in the framework conditions under other scenarios. The scenarios in the wood value chain project show that the type of forest management is decisive for the future greenhouse gas balance.

The forest is capable of capturing more carbon than it actually does under the current management system. However, such consideration which solely focuses on the forest is far too short-sighted, as from a systemic perspective the use of wood for the provision of raw materials for the bio-economy and the transition to renewable energy sources has a positive effect on the greenhouse gas balance over the long term.

Building on the results from the 2015 wood value chain project, the Austrian Research Centre for Forests (BFW), the University of Natural Resources and Life Sciences (BOKU), Wood K plus, and the Federal Environment Agency conducted further analyses in the follow-up project CareForParis. The project is in finalisation as of the end of 2019. Once the final results are available, the statements and scenarios above may be updated on the basis of the latest findings.

2.4.6 Consumer behaviour and lifestyle

2.4.6.1 Introduction and target vision

The report of the Intergovernmental Panel on Climate Change (IPCC AR 5) states that our current behaviour and lifestyle, which are associated with high greenhouse gas emissions, have a substantial impact on climate change, which has already reached an advanced stage. The report also stresses that it will be difficult to reach the goals in the Paris Agreement without serious changes to our energy and goods consumption, diet, leisure-time, and mobility choices.

The changes needed to lead towards a climate-friendly lifestyle are a process that affects society as a whole. Even though the responsibility of each individual is becoming more important, consumption patterns cannot be changed by one person alone. These result from the interplay of personal consumption decisions, habits, social and economic norms, the offered infrastructure, and the prevailing policy framework.

The impending effects of climate change imply an unprecedented degree of urgency to changing behaviours that are harmful to the climate in order to ensure a high quality of life for the entire population over the long term. The answers to the question of what a climate-neutral life may look like can only stem from innovative ideas, the courage to make changes and adopt new lifestyles, and should not be perceived as a restriction, but as a new opportunity.

2.4.6.2 Current situation in Austria

According to a mid-level scenario of Statistics Austria, around 9.5 million people are expected to live in Austria in 2050, over 600,000 more people than today.

The emissions under a consumption-based calculation model (which reflects the greenhouse gas emissions of the consumer goods which are consumed in Austria) are well above those under a product-based model (which indicates the quantity of greenhouse gas emissions caused by the production of consumer goods in Austria). This means that in addition to the greenhouse gas emissions from the inventory based on a territorial approach, the emissions caused by the consumption of the Austrian population are also relevant and must be taken into account in a comprehensive climate policy.

2.4.6.2.1 Food

Agriculture is responsible for around 10% of the greenhouse gas emissions in Austria (Federal Environment Agency, Climate Mitigation Report 2019). The coverage ratio is just under 93% according to the Green Report, taking imports and exports into account. The following can be said about the eating habits of the Austrian population:

Roughly half of the direct emissions in Austria come from the production of meat and other animal products. The average per capita meat consumption (including poultry) in Austria was 64.1 kg in 2018 (AMA, 2019). The degree of self-sufficiency is 108% according to the Green Report. Some 577,000 tonnes of avoidable food waste is produced along the entire value chain every year. Food waste is especially high in households (206,000 t) and food service (206,000 t) but is also high in production (86,200 t), retail (74,100 t), and in the category returned goods bread and baked goods (35,600 t)[33].

2.4.6.2.2 Consumption

On the one hand consumption leads to "direct" emissions through daily actions and behavioural patterns and on the other hand to hidden emissions in products ("grey emissions" from production in other countries, transport, and potentially disposal) on the other. This means that consumer behaviour plays a significant role in transitioning to a climate-friendly lifestyle. The level of emissions can be seen as a function of the quantity of consumption and the characteristics of the consumed good (acquisition, product use and disposal).

Acquisition: Consumers have the choice between more and less sustainable products, within certain limits. Products can be rented, leased, borrowed, or shared. This can reduce resource use.

[33] Hietler & Pladerer, 2017

Product use: The useful lifespan of many products can be extended by repair, maintenance, upgrades, or the replacement of defective components.

Product disposal: Consumers have different options for the handling of goods after their lifetime – re-use, upcycling, recycling, gifting.

2.4.6.2.3 Leisure and tourism

A relevant factor in measuring leisure and tourism is the number of trips taken and the means of transport chosen to reach the desired destination.

The means of transport Austrians choose to reach their holiday destinations and to get around while on holiday have changed over the past decades. Driving by car and flying have increased, the latter by 28%. This has especially reduced the use of rail transport, which accounted for only 7% in 2017 (see also section 2.4.3 Transport).

Residential

See section 2.4.4 Buildings

Mobility

See section 2.4.3 Transport

2.4.6.3 Results of the online consultation

The results of the online consultation show that strengthening climate-friendly behaviour has high priority. But it will entail considerable effort.

In this context, it was particularly emphasized that work must be undertaken to transfer knowledge (e.g. better public relations and educational work in order to better communicate measures or even uncomfortable truths and to refute false information) to and to encourage identification with the topic in the population. We need sustainable solutions that will be accepted by the population.

In particular, "steering" measures that implied the feeling of "taking away" or "forced renunciation" were mentioned as one of the greatest challenges.

2.4.6.4 Fields of action

Lifestyle changes represent a process involving society as a whole. With that in mind, the fields of action presented here must be seen as a set of areas for action which must be coordinated and implemented together.

Comprehensive and transparent information is the foundation for lifestyle changes and must be provided in a suitable manner for all age groups and education levels, including stronger integration into school curricula. It can be empirically demonstrated that information alone as a sole field of action is necessary but insufficient as a definite discrepancy can be seen between "environmental knowledge" and sustainable consumption. This means that further measures and incentives must be employed to aid the decision making of each individual, and to force certain decisions where necessary. Such measures will include bringing very different actors together as well as comprise financial incentives such as internalising external costs in order to come closer to the desired objective – the achievement of the long-term goals in the Paris Agreement.

A climate-friendly lifestyle is possible if it is implemented gradually. Above all it can also be perceived as an opportunity for the economy and society. Our daily life is strongly shaped by habits. In order to change these, we need alternatives which are compatible with our daily life. The motivation to take action often fails due to lack of information and lack of alternatives.

The following options for fields of action are presented in different areas in the literature:

2.4.6.4.1 Food

- Deposit on disposable beverage containers
- Targeted advertisements for more "quality instead of quantity", > enhanced positioning of state quality seals, information to combat food waste
- Better-tailored campaigns
  - to support "quality from Austria"
  - to educate about the safety of expired but still edible products
  - on healthy nutrition based on the food pyramid, including the consideration of a climate-friendly diet, food offerings in public institutions and cafeterias should also be chosen accordingly
- Promotion of urban gardening spaces and initiatives

2.4.6.4.2 Goods consumption

- Gradual introduction of mandatory EU-wide product labelling highlighting the carbon footprint.
- Targeted advertisements for more "quality instead of quantity"
- Targeted information about the relationship between production, price, and product life to foster acceptance
- Information on sharing products and corresponding "sharing/renting/borrowing" services, for example as already offered by the agricultural machinery rings
- Improved campaigns to "buy local" in order to optimise online shopping patterns

2.4.6.4.3 Leisure and tourism

- Advertising for regional and sustainable holiday activities
- Internalisation of external costs for all modes of transport, including air travel
- Incentives to travel to and from school activities by public transportation
- Incentives for organisers of all events to ensure that attendees come with public transportation

Residential

See section 2.4.4 Buildings

Mobility

See section 2.4.3 Transport

2.4.7 Digitalisation and innovation

2.4.7.1 Digitalisation

Digitalisation will play a key role in a climate-neutral economy. Digital technologies can especially lead to energy and emission savings by increasing efficiency, integrating renewables, and by better matching demand and supply. However, the high energy consumption of the growing ICT sector harbours its own challenges, hence, powering it entirely with renewable electricity is essential.

Examples of contributions from digitalisation:

- Smart grids: more efficient electricity management, smart metering, sector coupling; demand side management (DSM): one and the same actor is sometimes a consumer and sometimes a producer of energy (electricity, heat).
- Smart transport systems, autonomous driving: improved traffic flow, optimised driver behaviour and routing, new mobility offerings:
    - integrated platforms for multi-modal mobility: "on the go" from the local to the national level
    - sharing platforms
    - optimised logistics/smart delivery traffic
    - smart land use and mobility planning

- Smart buildings: higher energy efficiency in buildings and neighbourhoods through automation
- Precision farming: optimised agriculture with low energy input, more efficient fertiliser, pesticide, and herbicide use, irrigation
- Greater efficiency in industrial manufacturing processes (Industry 4.0, 3D printing)
  - Efficient robotics
  - Efficient production, less production of scrap
- Green ICT: Reduced energy consumption through more efficient equipment
- Contribution to raising awareness for climate-friendly consumption: footprints and information via apps
- Open innovation and open source, commons oriented, improved information exchange "without borders": Digital tools allow new ways of communication, facilitate decentralised organisations, and make regional and local production more attractive and cheaper.

Ecological and social aspects must also be taken into account in the digitalisation strategies from the outset so that its potential is realised in full and not eroded by rebound effects which in turn cause greater energy consumption and emissions; these aspects include:

- Taking climate targets and sustainability into account in digitalisation strategies
- Strengthening standards for climate-friendly procurement in the ICT sector
- Life cycle view of products and the corresponding requirements for product design and ease of repair

Further prerequisites for climate-friendly digitalisation are social acceptance (especially relating to the use of information about consumers in accordance with the data protection regulations) and availability and accessibility for all population groups.

2.4.7.2 Innovation

Innovations will also be needed to ensure long-term decarbonisation of our economic system. To this end, the BMNT funds demonstration projects of companies presenting innovative technologies that are on the verge of market maturity and that contribute to achieving quantifiable environmental effects through the UFI domestic environmental investment funding programme. The programmes of the Climate and Energy Fund also cover innovation process from basic research to demonstration. Other federal ministries, especially the BMDW and BMVIT, also run innovative programmes such as COMET, VOIN, and Eurstars that show strong orientation towards sustainability, efficient resource use, new environmentally friendly product solutions, and green innovations.

At the EU level, the research landscape is currently being restructured through programmes such as Horizon Europe (the successor to Horizon2020). The EU Innovation Fund will promote demonstration projects for innovative technologies and ground-breaking industrial developments for reducing CO_2 emissions from 2020 to 2030. A new feature of Horizon Europe is that research questions are accompanied by mission areas that describe clear social challenges. We especially expect the implementation of measures for the mission areas defined at the EU level by no later than 2050, in part through support at the Member State level.

- Mission area 1: Adaptation to climate change, including societal transformation
- Mission area 2: Cancer
- Mission area 3: Healthy oceans, seas, and coastal and inland waters
- Mission area 4: Climate-neutral and smart cities
- Mission area 5: Soil health and food

3 FINANCING

3.1 Estimation of the required investments

According to the 1.5°C report of the IPCC, the average additional investments in energy-related reduction measures in pathways that reduce global warming to 1.5°C will amount to around 830 billion USD 2010 per year for the period from 2016 to 2050 compared with investments without new climate policies beyond those in force today (range from 150 to 1700 billion USD 2010 over six models). This stands in comparison to average total energy supply investments in 1.5°C pathways of 1460 to 3510 billion USD 2010 per year and total average energy-related investments on the demand side of 640 to 910 billion USD 2010 per year in the period from 2016 to 2050. Total energy-related investments are increasing in 1.5°C pathways compared to 2°C pathways by around 12% (range from 3 to 24%). The average annual investments in low-carbon energy technologies and energy efficiency will increase by around a factor of 6 by 2050 compared with 2015.

According to the European long-term strategy, the modernisation and decarbonisation of the EU economy will mobilise large volumes of additional investments. Around 2% of GDP are currently being invested in our energy system and the related infrastructure. This share would have to be increased to 2.8% (or around EUR 520 to 575 billion) in the EU in order to enable an economy with zero net greenhouse gas emissions. This implies very substantial additional investments of up to EUR 175 to 290 billion per year compared to the baseline.

Based on models for the national energy and climate plan and scenario extrapolations until 2050, scientific analyses were commissioned to estimate the required investments in Austria on a sectoral basis and also to explore potential for innovative financing instruments. Results will be available at some point in 2020.

Achieving the goal of climate neutrality will entail considerable investments that must include contributions from governments (federal, provincial, EU) and the private sector in accordance with the long-term objectives of the Paris Agreement (especially Article 2.1 [c]). It is important to reconcile financial flows with a development that is low in greenhouse gas emissions and resilient to climate change. The auctioning of certificates in the EU emissions trading system generates income for Member States which can be a key source for the financing of climate action measures. This is also specified in the EU Emissions Trading Directive. The expected total investment volume for reaching the objective will ultimately depend on the assumed combination of regulatory, funding, and tax policy measures. The cost-effectiveness of the climate and energy funding landscape will be just as important in driving investment as the expected effects of new regulatory requirements and/or the effectiveness of new green finance instruments. Regulatory measures in particular need not necessarily or directly trigger investment-relevant financial flows, but can also constitute directly relevant contributions to meeting the objectives of the Energy Union.

A key factor in achieving net zero emissions by 2050 will be mobilising private capital and directing financial flows towards a low-emission economy and society. Financing of necessary investments with public funds alone will not be sufficient. Consequently, we will need additional incentives and instruments to leverage private capital and strengthen the contribution of financial markets to reaching the long-term climate and energy targets.

The Federal Ministry of Finance and the Federal Ministry for Sustainability and Tourism set up a Focal Group Green Finance in February 2019. As part of the action plan of the European Commission for the financing of sustainable growth from 8 March 2018, an Austrian Green Finance Agenda will be developed in collaboration with key financial market participants in order to establish Austria as a robust green financial centre. The continuation and extension of this collaboration between public and private institutions is under consideration, so that long-term pathways and related measures will be discussed and jointly defined with financial market actors.

The dialogue between government agencies and market actors is a key instrument for ensuring the practicality and feasibility of public measures for the mobilisation of private capital and for financing the net zero emission goal. In a changing environment, it is extremely important to ensure a meaningful exchange between relevant actors as we move forward. The volatility of the market must be reduced via a stable long-term legal framework in order to facilitate investments which must be financed and implemented over the long term. To this end, existing legal impediments to the financing of zero-emission economic activities should be reviewed in detail and eliminated by taking other relevant interests into account. A common understanding of such activity will require uniform methods and standards to overcome language barriers between the financial and real economy. Their development and implementation will strongly contribute to an increase in the volume of sustainable activity. It will be particularly important to also account for the SME-oriented structure of the Austrian economy, which will require the development and refinement of instruments in order to mobilise private capital. Interfaces with projects at regional and local level must be considered for comprehensive financing to stimulate the private market.

Measures to be implemented immediately that will have long-term effects pertain to:

- the integration of fore-sighted climate risk management into economic practice

- improved transparency and data on the influence of economic activities on climate change,
- the promotion of long-term thinking in capital markets,
- structured awareness-raising in the financial sector for customers and advisers.

3.2 Awareness-raising in financial markets

Increased awareness of the relationship between financial market activities and climate-relevant effects will be highly important in achieving zero net emissions by 2050, meaning that such soft measures are also a key part of the implementation toolkit. A central element is raising awareness for green finance, starting with customer advisers who manage and sell local financial products up to the establishment of expertise in companies as to how green financial instruments can be designed and positioned on the market. This requires a definition of standards and rules for green financial products and a further development of this framework on the basis of the European Commission's action plan for the financing of sustainable growth.

At the same time, customers and investors must evaluate such products and must be informed about existing rules and standards. A key aspect is the communication of sustainable and green financing models and of the impacts that financial flows have on the climate and environment.

A constant exchange between the public administration and private investors will be important for achieving a transparent standard of awareness. Financial experts will need a clear legal framework which facilitates the operationalisation of green finance. The focal group, which was launched in Austria, can serve as a basis for an active dialogue in order to create comprehensive awareness.

4 ASSESSMENT OF SOCIO-ECONOMIC EFFECTS

4.1 Introduction

Achieving net zero emissions will require comprehensive changes in society and the economy, in particular the avoidance of fossil fuels as an energy source to the greatest extent possible. Investments in durable infrastructure originally designed for fossil fuels must adapt to these changing uses, and a focus on sustainable technologies is also required.

Investments in building renovation, energy-saving technologies, renewable electricity and gas production, and in transport infrastructure are an important source of impetus for the Austrian economy. These investments can be made in part by redirecting capital from other purposes (in the case of transport) or can be financed through the provision of already existing investment plans (power grid). In some cases investments must be supported by public funding or support measures.

Cost savings (lower heating needs, less energy consumption through electric cars, etc.) increase disposable income, which in turn has a positive rebound effect on the economy. Model-based estimates at EU level and for Austria indicate positive macroeconomic effects in terms of economic growth and employment across all sectors.

4.2 Just transition

Measures to reduce greenhouse gas emissions and to adapt to climate change must also take social effects into account – not only because of the requirement in the Paris Agreement, but also because creating a framework for a socially compatible shift to a low-emission economy and society is a fundamental necessity. According to the preamble of the Agreement, the signatories are to account for the necessity of ensuring a just transition for the workforce and to create high-quality jobs in meeting their obligations.

The transition to climate neutrality is not solely a technological challenge, but to a large degree also an economic, social, structural, societal, as well as labour-policy challenge. Social compatibility and fairness are fundamental pillars of the overall strategy. The transformation requires a far-reaching change in production and consumption patterns at the global level. The outsourcing of essential industrial production activities outside the EU is to be avoided.

Changes must be made to our economy and society even if no decarbonisation takes place. Developments over the past decades have shown that transformation takes place through technological and social trends with or without political involvement, and that these trends are accelerating. The task of policymakers and businesses is to align the changes that will result from the transition to climate neutrality with the economic and social trends as effectively as possible and to leverage the resulting synergies. The transformation costs must be shared fairly to ensure the effectiveness of the transformation and to ensure social acceptance.

The energy transformation and the shift to a zero-emission economy and society will have an impact on the labour market and also on available careers. But this process is nothing new. Professions that were common just a few years ago no longer exist (such as typesetter) because they are no longer needed. The general conditions in workplaces have changed substantially in the past. Such changes bring risks but also opportunities. Policymakers must ensure that this transformation has no grave negative social effects, but rather has positive or at least neutral effects overall. Therefore, these impacts are discussed and integrated into climate policy measures.

However, a specific consideration is needed as to which changes are caused by climate policy and which would occur anyway due to other factors. For example, it can be expected that digitization will affect many jobs, but also create new ones.

The transformation will create opportunities for new business models, especially in the areas of renewable energy production, energy efficiency, automation and digitalisation, construction (such as building renovation, flood protection, and securing infrastructure), and logistics for shared and autonomous mobility, which will also create qualified jobs. However, for all the threats posed by the consequences of climate change, there are also opportunities for the labour market through adaptation measures to increase the resilience of infrastructures and ecosystems to climate change.

It is not enough to simply consider emission reduction measures; just transition must also be viewed in the context of negative impacts of climate change and required adaptation actions. Water supply, agricultural production, and tourism will be impacted most significantly. The negative effects of climate change not only put jobs at risk, but also the prosperity and livelihood of everyone.

An in-depth analysis of the impact of the transformation and the consequences of climate change on jobs and social aspects is needed in order to take the necessary measures, and should be carried out in the coming years. Conclusions for the necessary economic, labour market and social policy measures can be drawn from this analysis and implementation can be initiated.

Investments will be made in education and vocational training to actively address changes in the labour market, both financially and in terms of adapting curricula. Perpetuating training for jobs in endangered traditional industries endangers the livelihoods of trainees in the long term; new occupational profiles are emerging, to which education and training must respond in a timely manner. Qualification for the jobs that will be important in the transformation is not only crucial for the workforce, but also for the economy so that new requirements can be met in good time.

5 GOVERNANCE

5.1 The objective

Austria is committed to becoming climate neutral by no later than 2050. The decision, whether this goal shall be legally binding, is to be taken by the federal decision makers.

5.2 Implementation of the strategy

A strategy laid out over a period of 30 years must be reviewed and updated on a regular basis to ensure that the transformation process can adapt to changing conditions and that measures that are no longer relevant or possibly even counterproductive in a changed world are not perpetuated.

Coherence with short-term action plans and the climate and energy strategy for reaching the 2030 targets will be ensured. These may not contain any measures that run counter to or slow the implementation of the transformation; lock-in effects of technologies and regulations that contradict the strategy must be identified and corrected in good time.

Legal projects at the federal and provincial level are to be subject to a mandatory climate review in order to prevent undesired adverse effects on the climate.

The progress made in the implementation of the strategy must be monitored continuously to ensure that the trajectory is correct. Key indicators are the development of greenhouse gas emissions as documented for the BMNT by the Federal Environment Agency in the Greenhouse Gas Inventory and energy statistics such as energy consumption and the share of renewable energy in the gross final energy use as recorded by Statistics Austria.

5.3 Involvement of the scientific community

The implementation of the long-term climate strategy 2050 and the regular evaluation and updates require scientific backing from a number of disciplines. So far, this advice has been obtained mainly from the fields of economics, technology, and natural sciences (climatology, biology, agriculture and forestry); however, expertise is also needed from the fields of social sciences (including sociology, political sciences, and psychology) to assess the social impact of the strategy, to adequately address the concerns, fears, and expectations of citizens, and to discuss how these concerns can best be integrated.

For example, an independent advisory committee with scientists from the above-mentioned disciplines could be set up to ensure the involvement of these sciences over the long term.

It is the responsibility of policy makers to evaluate the inputs from science and make the relevant decisions on the basis of the available information.

5.4 Involvement of the private sector and workers

Plans are in place to involve further stakeholder groups in the process to ensure high acceptance and to find the best solutions. This especially pertains to businesses and the workforce to adequately address the challenges of a changing business and working environment. The public sector will not be able to carry many of the necessary investments. New business models must be developed, and a coherent financing strategy, which is not only based on public budgets but primarily on the sustainability of financial flows of companies and that offers the necessary framework and incentives, is crucial.

Separate instruments will be developed to incorporate the knowledge and innovative capabilities of these actors.

5.5 Public participation

A successful transformation will not be possible without support for the strategy from citizens and their involvement in its implementation. This means that addressing the concerns of civil society is crucial for laying a strong foundation for the transformation.

Public involvement should

- promote the exchange of information and experiences,
- promote an understanding of other opinions and a balancing of interests,
- increase the quality and transparency of decisions,
- increase acceptance and clarity of decisions, including decisions that will not have social benefits until later,
- increase the degree to which citizens and interest groups identify with decisions and with their environment,

- strengthen trust in the political system and public administration and offer a broad base for decisions by political and administrative actors,
- provide broad access for opinion forming,
- avoid delays and additional costs in the implementation of the policies, plans, programmes, and laws and, thus, optimise resource use.[34]

Citizens shall be able to increasingly contribute their knowledge to climate policy. Therefore, a more objective, constructive and solution-oriented approach to the topic is needed.

Technical possibilities that go far beyond the transmission of comments by e-mail are also available for this purpose - depending on the purpose pursued - information dissemination, collection of opinions, discussion platform, factual inputs, etc. - different instruments are more or less well suited for this purpose. The specific instruments must be selected on a case-by-case basis.

[34] *Standards der Öffentlichkeitsbeteiligung - Empfehlungen für die gute Praxis* (2008)

6 ANNEXES

6.1 Details on the models employed (including the hypothesis) and/or on the analysis, indicators, etc.

6.1.1 Energy and greenhouse gas scenarios

The following models and contributions from the respective institutions were used to calculate the scenarios "with existing measures" and "transition":

- **CESAR/WIFO** (Center of Economic Scenario Analysis and Research and Austrian Institute of Economic Research) – Dynamic New Keynesian Model (DYNK); socioeconomic parameters and effects, conversion and final energy use.
- **IVT** (Institute for Internal Combustion Engines and Thermodynamics at the Graz University of Technology) – NEMO model, KEX module, GEORG; energy consumption and emissions of the transport sector (including off road).
- **IVV** (Institute for Transport Studies at the Vienna University of Technology) – MARS model; traffic volumes and modal split.
- **EEG/e-think** (Energy Economics Group of the Vienna University of Technology) – energy prices, INVERT/EE-Lab model; cooling, space heating, and water heating including electricity demand for households and services, district heating demand.
- **AEA** (Austrian Energy Agency) – electricity import price, model based on TIMES; public electricity and district heating generation.
- **Federal Environment Agency** – iron and steel industry; waste generation, alternative fuels, electro mobility, industrial sectors and self-producers of electricity, compressor stations, complete overviews, project coordination.

The transition scenario was based on the following socioeconomic assumptions (2017/2019):

Table 2: Fundamental parameters for the modelling of the transition scenario (sources: Statistics Austria 2016a, AEA, CESAR, EEG, e-Think, Graz University of Technology, WIFO, Federal Environment Agency)

Parameter	**2015**	**2020**	**2030**	**2040**	**2050**
GDP [bn € 2015]	337.3	362	433	523	613
Population [1,000]	8,621	8,939	9,314	9,522	9,634
Number of primary residences [millions]	3.798	3.989	4.226	4.393	4.498
Exchange rate US$/€	1.12	1.16	1.2	1.2	1.2
International oil price [US$ 2013/boe]	54	87	113	184	202
International oil price [€ 2013/GJ]	7.5	11.6	14.5	21.7	26.0
International gas price [€ 2013/GJ]	6.0	7.5	8.8	12.6	15.1
International coal price [€ 2013/GJ]	1.8	2.2	3.2	4.9	5.8
CO_2 certificate price [€ 2013/t CO_2]	7.5	15	40	100	200

Population growth was taken from the primary variant of the Statistics Austria projection from 2016. The international energy prices were estimated based on the assumption that noise, emissions, radiation, traffic safety, resource procurement, landscape damage, and the respective subsequent effects will be included in the prices of energy sources. This pertains to the generation in the country of origin, as well as transit, and use in the destination country. Through this altered policy prices for fossil fuels will rise despite falling global demand. Economic growth until 2050 was assumed to be on average 1.7% p.a.

The transition scenario was updated by the Federal Environment Agency in the second half of 2019 for the purposes of the Austrian long-term strategy; the key data (especially energy and greenhouse gases) on which the scenario is based were updated (2017).

6.1.2 More detailed description of selected pathways[35]

Further analyses for the evaluation of natural sinks were conducted in the CareForParis project. The project is in finalisation as of the end of 2019. Once the final results are available, the scenarios below may be updated on the basis of the latest findings.

Pathway A "Transition – renewables, efficiency, lifestyle"

A pathway titled "transition" was defined as a benchmark scenario and corresponds to the fundamental assumptions and results of the model-based scenario transition from 2019. It is based on an extensive expansion of renewable energy sources for electricity and heat generation and a high degree of efficiency in the sectors of transport, buildings/services, and industry. The majority of renewable energy will be generated domestically, and imports of bioenergy will remain approximately at the current level. Changes in consumer behaviour will lead to reduced need for mobility, a strongly dampened increase in transport volumes, decreased waste generation, and substantially lower meat production.

This will bring a reduction in greenhouse gas emissions of 80% compared with 1990 levels by 2050. The pathway calculator permits further improvements towards the target of net zero emissions by 2050. Carbon is sequestered in natural sinks by selecting a forestry reference scenario (-4 million tonnes of CO_2), and the domestic production of agricultural bioenergy will be expanded further. The option of carbon capture from industrial incineration processes and power plants is selected (close to 9 million tonnes of CO_2 in 2050) in order to compensate for the remaining greenhouse gas emissions (fossil fuel use, industrial processes, agriculture).

[35] The pathways depict "what would happen if" situations for which no political decisions have yet been made.

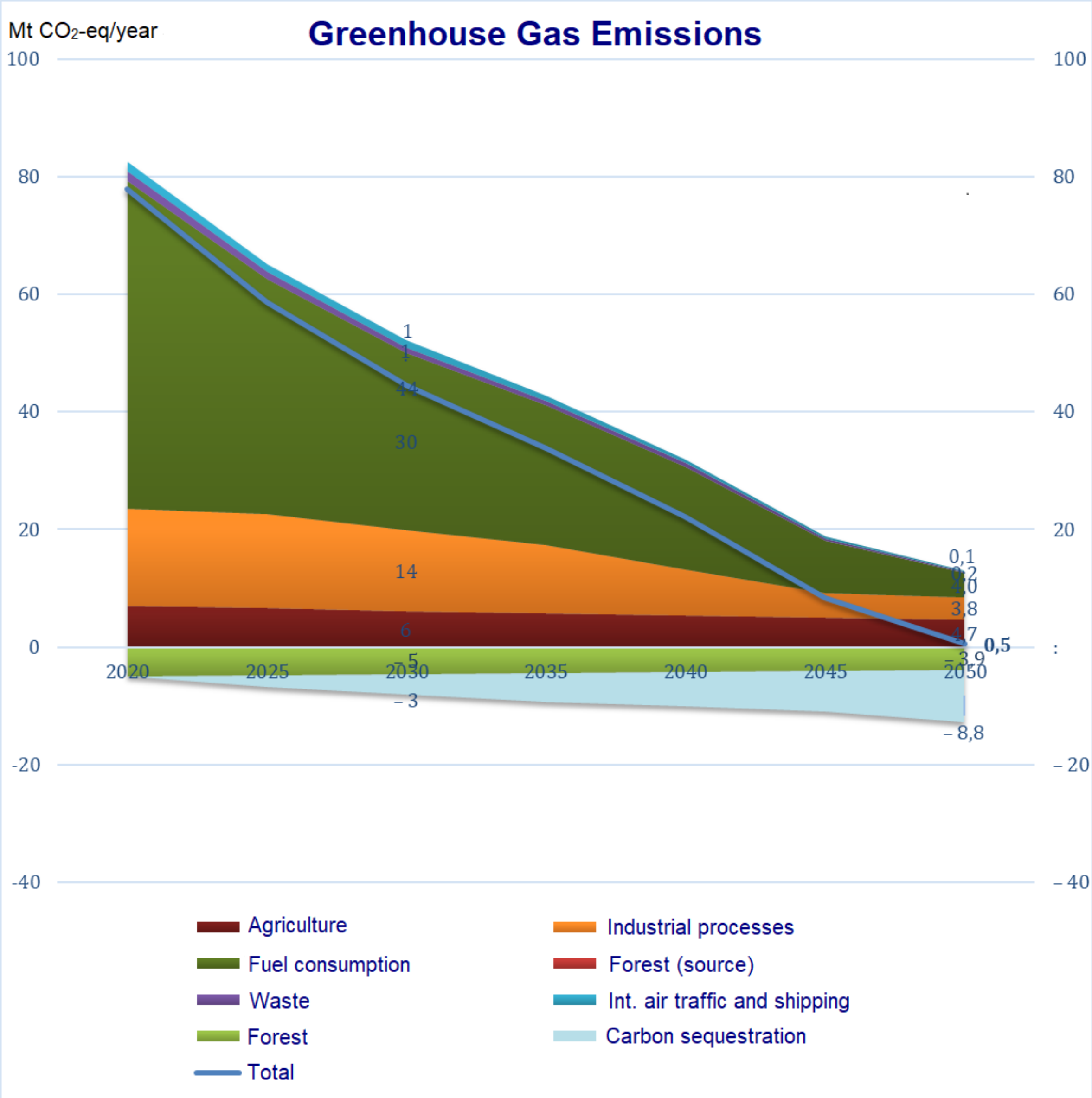

Figure4 Pathway A "Transition – renewables, efficiency, lifestyle"

Pathway B "Bioenergy/hydrogen imports and carbon capture"

This pathway is based on the decision to implement an ambitious expansion of renewable energy (electricity and heat from wind, photovoltaics/solar thermal, geothermal energy, biomass) in Austria, but does not fully exploit the technically and economically feasible limits as in pathway A (except for bioenergy). It is also based on a relatively smaller change in consumption and production patterns (passenger traffic levels remain roughly constant, freight traffic rises considerably). The changes in the building sector are also not as profound as in pathway A. Hydrogen plays a major role in transport, industry, and heating generation. The demand for hydrogen is largely covered by imports. The gap in achieving the objective (zero net emissions) is covered by carbon capture from industry and power plants as well as geological storage (CCS) or by material utilisation (CCU).

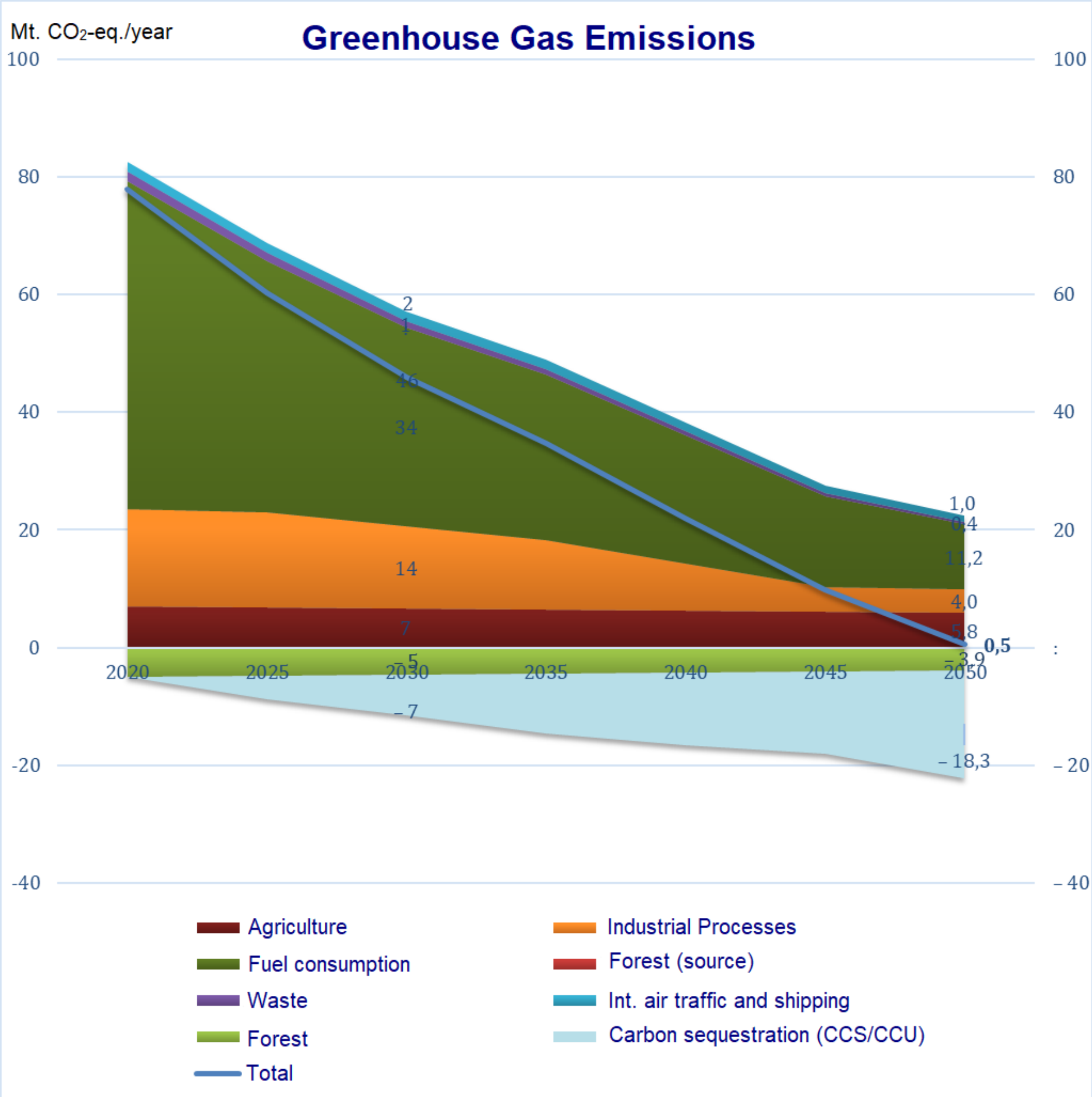

Figure 5 Pathway B "Bioenergy/hydrogen imports and carbon capture"

Pathway C "Bioenergy/hydrogen production in Austria and CCS/CCU"

This pathway intentionally avoids the import of bioenergy and hydrogen. The demand for hydrogen is focused on industrial applications, especially steel production, and on freight traffic. Domestic hydrogen production requires a substantial expansion of electricity generation capacities (similarly to pathway A). The use of bioenergy from domestic sources (forestry and agricultural biomass) will increase considerably. The use of energy will not decrease as much as in pathway A, but more than in pathway B and C.

The high demand for forest biomass will lead to a reduction of the natural carbon sink, trending towards zero by 2050. Remaining greenhouse gas emissions of around 18 million tonnes of CO_2 equivalents (from the use of combustible fuels, industrial processes, and agriculture) would have to be offset entirely by means of CCS or CCU in this scenario.

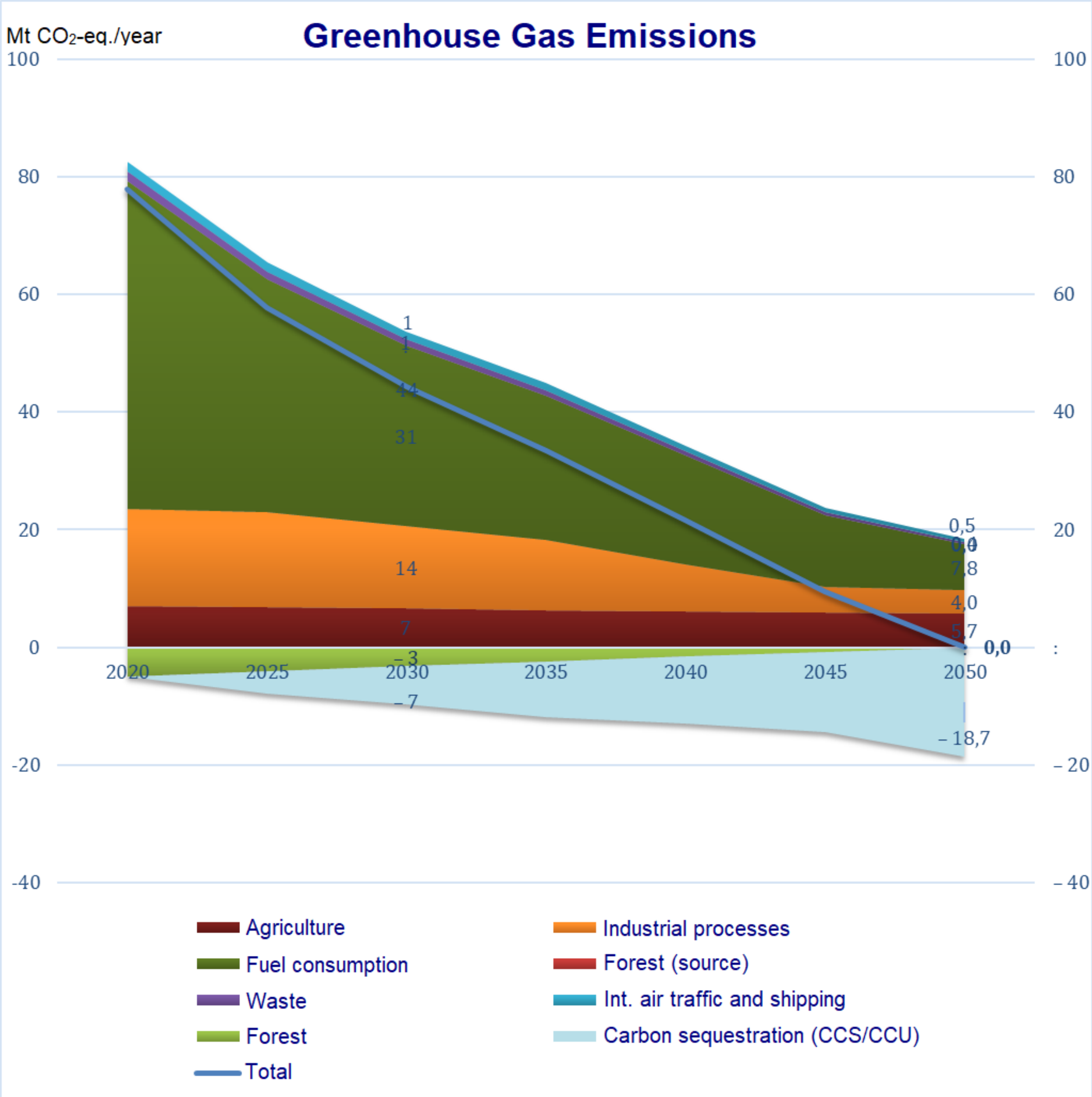

Figure 6 Pathway C "Bioenergy/hydrogen production in Austria and carbon capture"

Pathway D "Bioenergy/hydrogen import and increased carbon stock in forests"

The pathway trends in terms of energy generation and imports and in terms of structural changes are similar to those in pathway B, however, significantly less forest biomass will be used for domestic energy generation. This will enable a significant increase in forest carbon stocks by 2050. The expansion of the natural sink to around 12 million tonnes of CO_2 by 2050 will allow Austria to avoid using CCS/CCU technologies.

However, it will not be possible to maintain this high forest sink capacity over the long term, beyond 2050 (see also section 6.1.3).

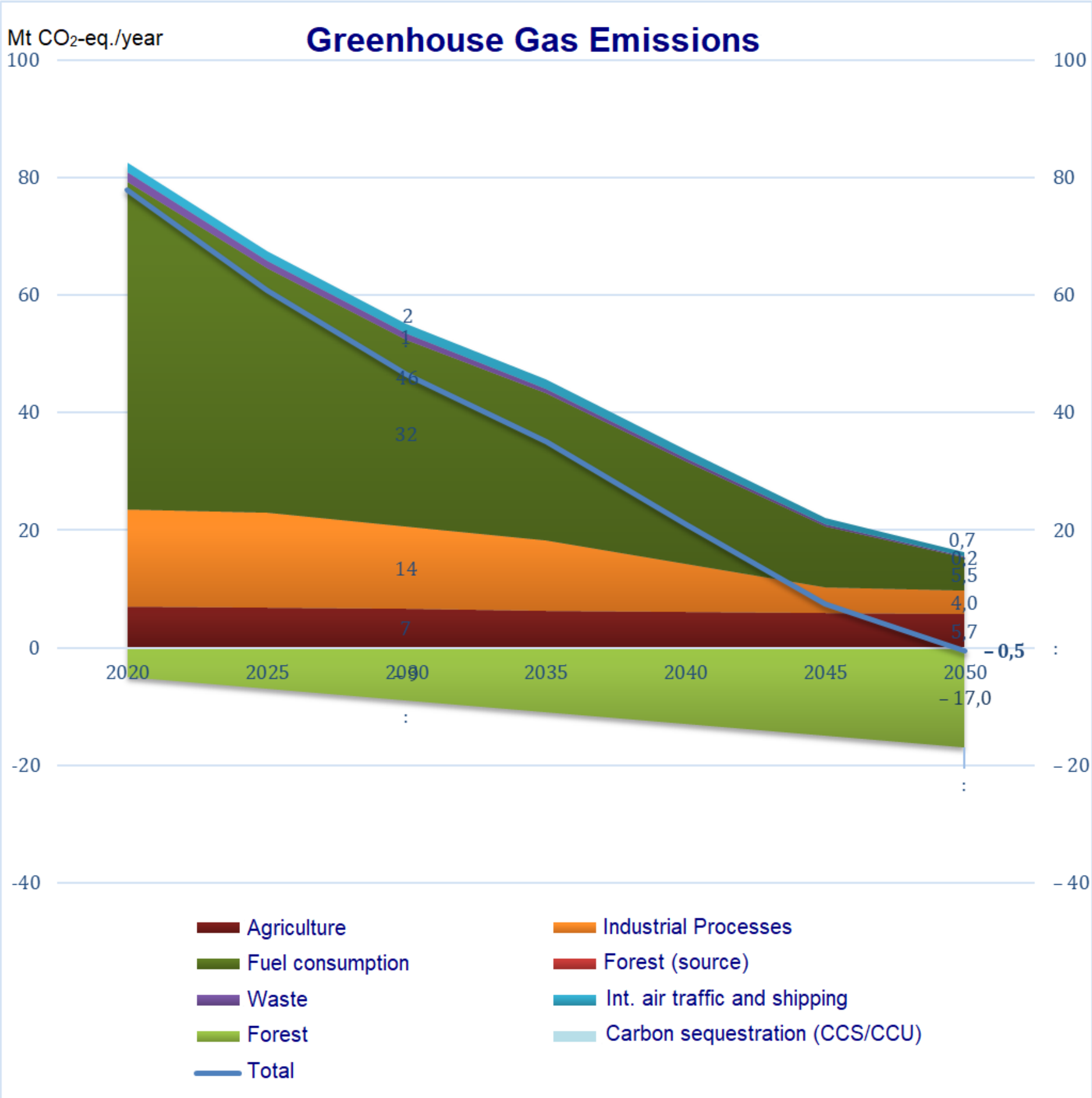

Figure 7 Pathway D “Bioenergy/hydrogen import and increased carbon stock in forests”

6.1.3 Wood value chain scenario

- Scenario R – Reference scenario

The demand for wood and the corresponding logging will follow the same trend as in the past years. The ceteris paribus assumption for the market-regulating framework conditions and the behaviour of market participants until 2020 is implemented. No further policy measures with a steering effect will take effect in the subsequent years, but rather will wood demand be driven by market conditions.

- Scenario 1a – Increased logging because of increased energy generation

The demand for felled wood for energy increases substantially due to the expansion of biomass power plants and energy transition effects. This scenario assumes that the wood harvested from forests for fuel use will increase to 120% of the reference level by 2100.

- Scenario 1b – Increased logging because of increased material use

A higher quantity of wood will be used for materials than in the reference scenario, with the import availability of raw timber following expected trends. Construction with wood and the use of wood products will be promoted through direct funding, changes in building codes, and the development of new technologies that expand the possible applications of wood and thus lead to increased wood use in construction. Promotion of and demand for direct use of forest biomass for energy generation will decrease accordingly. The prices for lumber compared with prices for fuel wood will shift to provide a stronger incentive to forest management that supplies higher-quality varieties. This leads to an increase in the amount of wood for material use to 120% of the level in the Reference Scenario by 2100.

- Scenario 1c – Increased logging because of increased material use under good import conditions

This assumes increased wood use compared with the reference scenario combined with higher availability of raw timber for import. Larger volumes of wood are available for import thanks to an expansion of the sourcing area for raw timber. The import availability for raw timber amounts to 150% of the reference level.

- Scenario 2 – Reduced use (restrictions on use and exclusion of forest areas from use through nature conservation regulations)

Incentive and support systems as well as framework conditions are created which, on the one hand, lead to a reduction in forest area under forest use and, on the other hand, to a reduction in the amount of use on the forest areas which continue to be managed. Such systems and framework conditions are based on nature conservation laws and are coupled with corresponding compensation for the loss of use and subsidies or payments for the accumulation of carbon stocks in the landscape. This scenario assumes that the share of forests not commercially managed (core zones of national and biosphere parks, Dürrenstein wilderness area, nature preserves) will increase from currently 1% to 5% of productive forest area by 2100. In the forests still managed for logging, the harvest quantities calculated under the reference scenario for the different protected areas in 2010 will be reduced by the percentages in Table 3.

Table 3: Usage reduction for scenario 2 in different protected areas. The base value is the regular harvest quantity of the reference scenario in the year 2010

Protection category	by 2020	2020–2050	2050–2100
National parks, biosphere parks (Peripheral zones), Natura 2000 areas	20%	30%	40%
Other protected areas (e.g. landscape conservation) and migration corridors	10%	15%	20%
All other commercially managed forests	5%	10%	15%

Logging

The harvest quantities vary between 18.8 and 27.6 million m^3 depending on the scenario and are all above the average harvest quantities of the last five years of 17.65 million m^3. The highest quantities are harvested in scenario 1b, which assumes increased logging due to increased material use. At the beginning of the simulation period, the harvest volume in the energy scenario (1a) is greater than in all other scenarios but then falls below scenarios 1b and 1c starting in 2040. After 2090, the quantity harvested in the energy scenario declines abruptly to below the quantities in all other scenarios. This decrease is due to the fact that the required quantity of deciduous timber can no longer be provided. Scenario 2 has the lowest wood harvest quantities, where reduced utilisation is assumed due to usage restrictions and the retirement of forest areas from commercial management (see figure).

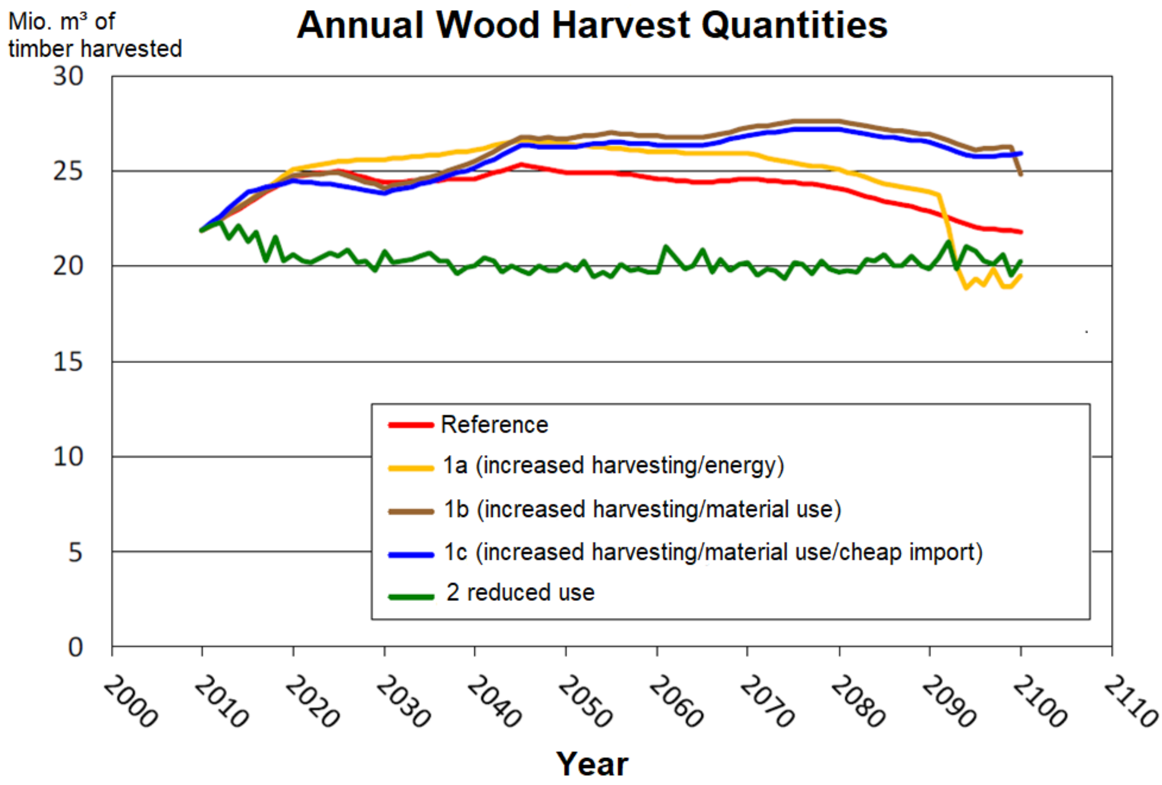

Figure 8 Estimated annual wood harvest quantities by management scenario.

Growth

The annual growth is shown in the figure below. With the exception of scenario 2, all scenarios show a slight downward trend from the beginning. It falls from 9.4 m^3/ha/year in 2010 to 8.8 m^3/ha/year in the reference scenario or to 8.3 m^3/ha/year in scenario 1c. In scenario 2, the growth until 2060 and 2070 increases to just under 10 m^3/ha/year and then declines again somewhat until the end of the simulation period. At 9.6 m^3/ha/year as of the end of the simulation period, the growth in scenario 2 is slightly above the initial level in 2010.

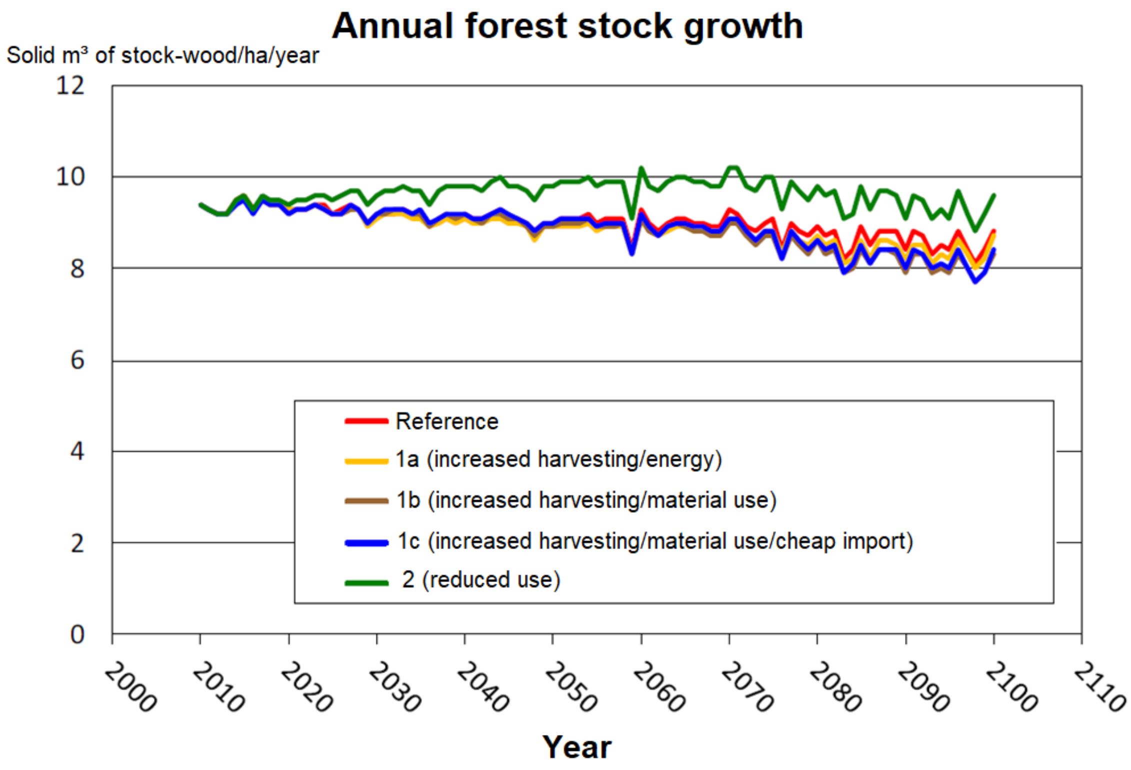

Figure 9 Annual forest stock growth by management scenario

Tree varieties

The latest forest inventory (BFW, 2018) shows that the proportion of spruce in the composition of tree species is declining (currently 57.4%), while deciduous tree species such as beech and oak are increasing.

The development of the distribution of tree species in the different scenarios is shown in the following figure. The most substantial change occurs in scenario 2, where deciduous trees account for nearly half of the entire stock in 2100. The primary reason for the increase in the stock of deciduous trees is the reduced use.

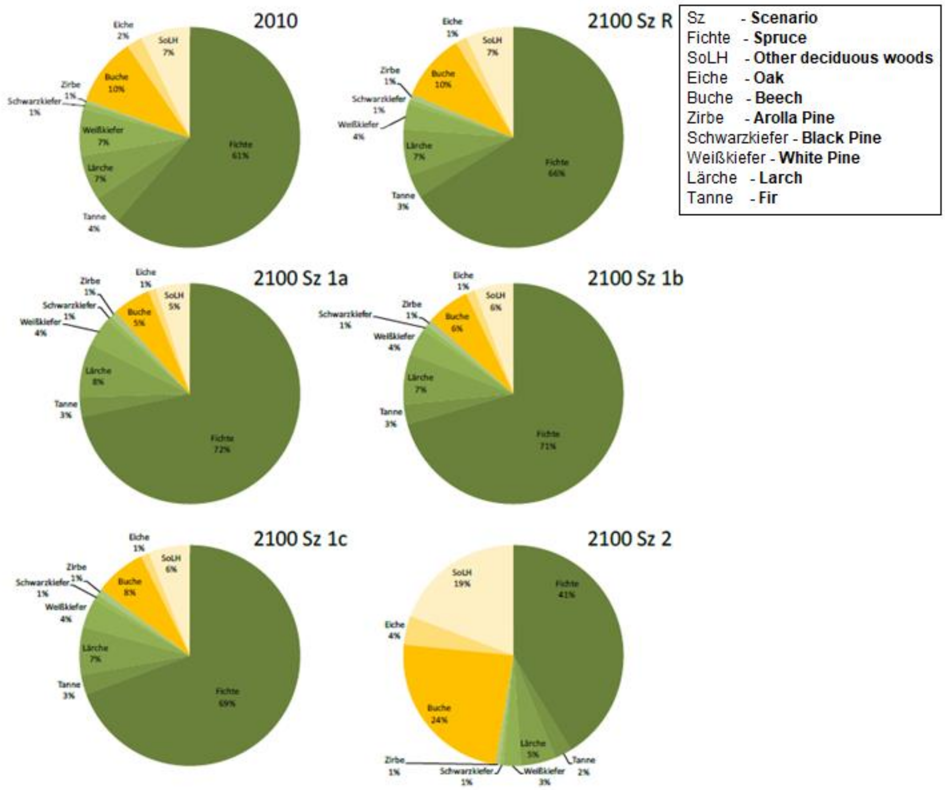

Figure 10 Development of the tree species distribution in the different scenarios

Development of the greenhouse gas balance

An examination of the changes in the total carbon stock in forests(above-ground and below-ground biomass, standing dead wood, soil carbon including lying dead wood), z which are relevant for the greenhouse gas balance, shows that the forest remains a sink until around 2040 in all scenarios. The sink function is even maintained until the end of the century in scenario 2, though the captured quantities are very low at the end of the simulation period and the forest shows a tendency towards becoming a source. In the other scenarios, the forest becomes a net source of greenhouse gases significantly earlier, between 2040 and 2060 as the carbon sink in the forest decreases due to more intensive use (see the following figure).

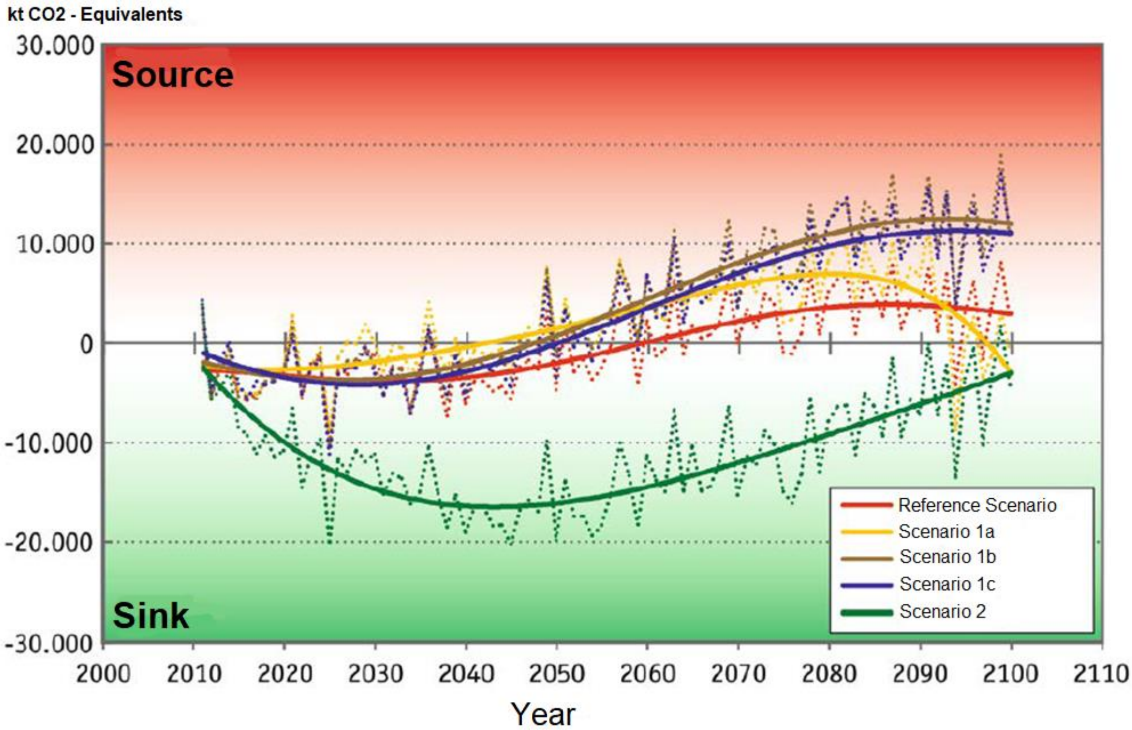

Figure 11 Net carbon stock change in the forest in the different scenarios

6.2 Online consultation for a long-term climate strategy for a climate-neutral Austria in 2050

Ideas

Achieving 100% renewable energy by 2050

Description

Fossil fuels will only be able to play a very minor role in a climate-neutral future. Total energy demand (electricity, heat, mobility) shall be covered with renewable energy by 2050.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with considerable effort

Drastically reducing final energy use

Description

Final energy use is to be reduced substantially by 2050 through efficiency measures and energy saving measures.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with considerable effort

Enabling planning certainty and competitiveness for energy-intensive companies

Description

Businesses need planning, legal, and investment certainty in order to make investment decisions, for example to transition to climate-friendly systems and to avoid being locked into fossil fuels through investments and, thus, having a negative impact on the climate. The public authorities should ensure that energy-intensive companies remain internationally competitive.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	High priority
Feasibility	Achievable with moderate effort

Enabling a just transition

Description

Job growth is generally expected in the context of the transition to a climate-neutral economy and society, even if there may be differences depending on the sector and qualification profile. Measures should be taken to avoid or at least mitigate the impacts for those negatively affected by this structural change.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	High priority
Feasibility	Achievable with moderate effort

Ensuring clean and affordable mobility

Description

A smart mix of intelligent technologies and smart mobility management is the key to clean and affordable mobility in 2050.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with considerable effort

Using new transport technologies

Description

Potentials of innovative and clean transport technologies (such as electromobility for passenger transport, hydrogen fuel cells in freight traffic) are fully exploited.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with considerable effort

Alternatives for private transport

Description

Public transport shall be the backbone of personal mobility. Demand-oriented solutions (micro-public transport) and active mobility (cycling and walking) must also be employed in order to ensure mobility in the city. Convenient and affordable alternatives will make private car traffic unattractive not only in the city, but also in rural areas. Unavoidable trips will be made with climate-friendly drive technologies.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with considerable effort

Climate-friendly freight traffic

Description

Freight traffic shall be as climate friendly as possible.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with moderate effort

Avoiding additional land use and soil sealing

Description

Soil is an important CO_2 sink. The increasing frequency of extreme weather events (such as heavy rainfall and heat waves) is exacerbating the problem of increased soil sealing. Land consumption should be reduced through sensible spatial planning. The annual soil sealing is to be drastically reduced and currently sealed areas shall be restored to a natural state.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with moderate effort

Preventing urban sprawl in rural areas

Description

Spatial planning in rural areas shall prevent urban sprawl and the fragmentation of areas. Town centres are to be improved and the supply of necessities and access to public transport ensured. This can reduce mobility pressure.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with moderate effort

Aligning agriculture and forestry more closely with climate action

Description

Austrian agriculture and forestry are part of the solution in climate action and must be adapted more effectively to climate change to a greater extent, so that food production is secured, grassland preserved, and the livelihood for employees in the agriculture and forestry sectors secured for the long term.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with moderate effort

Maintaining soil fertility

Description

Soil fertility of cultivated land and grassland is to be maintained and the carbon content increased further.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	High priority
Feasibility	Achievable with moderate effort

Ensuring supply of regional and seasonal products

Description

Regional and seasonal products are climate-friendly; the supply of regional and seasonal products for the population shall be ensured.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with moderate effort

Alternative tree species

Description

Forests are to be converted into potential natural forest communities with tree species adapted to climate change.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	High priority
Feasibility	Achievable with moderate effort

Forests as CO_2 sink

Description

Forests shall continue to supply raw materials for the decarbonisation of the economic system in the future and maintain as well as expand their function as a stable carbon sink.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with moderate effort

Making the building sector climate neutral

Description

Older buildings shall be renovated in order to improve their energy performance. In the coming decades, new buildings are to be constructed exclusively in an energy-neutral manner or as plus-energy buildings or communities. Heating and cooling systems should all be powered by renewable energy sources, including in renewable energy communities.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with moderate effort

Enhancing climate-friendly behaviour of the population

Description

The population is to be encouraged to adopt a more conscious and climate-friendly consumer behaviour in terms of products, food, services, energy consumption, mobility, and leisure-time activities, hence, not quantity but quality should have priority.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with considerable effort

Making financial flows climate compatible

Description

All public and private investments shall contribute to adaptation measures or not counter climate action activities by the middle of the century. Investments that are harmful to the environment are to be avoided in order to prevent the use of technologies that lock in fossil fuels over the long term.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	Top priority
Feasibility	Achievable with considerable effort

Adapting to climate change

Description

Adaptation to and mitigation of climate change must be seen together. Adaptation to climate change will avoid adverse social, economic and environmental impacts and seize opportunities as they arise.

Idea analysis

Assessment criterion	
Relevance for the overarching goal of climate neutrality by 2050	High priority
Feasibility	Achievable with considerable effort

Measures

Implementation of true-cost pricing for products and services

Description

The prices of products and services should reflect the costs that they cause, including the costs of the climate crisis. These costs are currently often worn by the general public. True-cost pricing promotes climate-friendly products and services, and "climate-damaging" consumption is declining as a result.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	High impact

Gradual reduction of fossil fuels

Description

Concrete time frames for the reduction of fossil fuels are to be developed.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next 20 years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	High impact

Promotion of renewable energy sources

Description

Renewable energy sources should be preferred and also promoted in an efficient manner where necessary in order to ensure market penetration of these energy sources. Supply security should be guaranteed.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	High impact

Education and training for a climate-neutral economy

Description

Climate action measures will have an impact on economic sectors and business models, which will in turn impact the labour market. For this reason, education and vocational training systems should be adapted to the requirements of a post-transformation climate-neutral economy as soon as possible.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Easy to accept
Impact	Medium impact

Adaptation of production, prices, and product lives to actual needs

Description

The production of goods should be oriented towards a long life and high quality in order to reduce greenhouse gas emissions. Overproduction and planned obsolescence (appliances with a short service life) should be avoided. Higher product prices will be offset by longer product lives.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Labelling requirements for products

Description

The climate footprint of products should made visible, example.g. through labelling.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next five years
Financeability	Easily financeable
Acceptance	Easy to accept
Impact	Medium impact

Active labour market policy

Description

Active labour market policy with corresponding training measures, such as lifelong learning and skill-building programmes.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Compensatory regional policy

Description

Regional policy with investments in regions and sectors that are affected by the restructuring.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Support for SMEs

Description

Innovative small and medium-sized enterprises should be advised and supported.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Climate-neutral mobility

Description

Climate-neutral mobility can only be achieved through the interplay of three strategies: avoid, shift, and improve. These three strategies must be accompanied by economic and social measures to ensure affordable climate-friendly mobility for the population.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next 20 years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	High impact

Traffic avoidance

Description

Measures should be taken to reduce traffic, such as efficient spatial planning, intelligent parking space management, reduction/unsealing of spaces dedicated to traffic, etc.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next 20 years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Modal shifts

Description

Measures should be taken to help shifting traffic to more climate-friendly modes of transport; e.g. expansion of (local) public transport, demand-oriented solutions (micro public transport), promotion of soft mobility, car sharing services, incentives for the population (e.g. inexpensive public transport fees), expansion of the rail network.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	High impact

Traffic improvements

Description

Promotion and improvement of non-fossil fuel based drive systems such as electromobility (including hydrogen) through various means.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Reduction in air traffic

Description

Short-haul flights should be replaced with a Europe-wide network of high-speed and night trains.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next 20 years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	High impact

Regulations for climate-adapted/climate-neutral spatial planning

Description

To counteract further area sealing and urban sprawl, efficient regulations must be developed and collaboration between the involved entities improved. Compact development structures should be promoted in rural areas and town centres strengthened to prevent land-intensive urban sprawl. Multi-storey housing solutions should be preferred and industrial/ commercial brownfield sites are returned to use.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next 20 years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Climate-friendly adaptation of development planning

Description

Building regulations should be adapted in a way that alternative, climate-friendly compensation possibilities are created (such as climate-friendly mobility concepts instead of the obligation to provide parking spaces).

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Greening and unsealing offensive

Description

More greening measures should be implemented in urban and densely settled areas. Wherever possible, sealed areas - both in the city and in the countryside - should be re-naturalised / unsealed; existing sealed surfaces should be removed and the areas planted with greenery wherever possible. Climatically valuable and highly productive soils for food and animal feed production should be protected by regulations.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Dialogue with retailers on the labelling of food

Description

Regional and seasonal products generally have a better climate footprint, as the production costs and transport distances are lower. Solutions should be found in dialogue with retailers and the food services sector to communicate the benefits of regional and seasonal products. Food in the supermarket should feature an easy-to-understand label that shows the climate footprint of the product.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next five years
Financeability	Easily financeable
Acceptance	Easy to accept
Impact	Medium impact

Support for environmental and climate action measures in agriculture

Description

The EU's Common Agricultural Policy should support agriculture that is oriented towards climate mitigation and adapted to climate change, in part through the continued expansion of measures in agricultural environmental and climate policy.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Transition to climate-adapted forests

Description

The transition to forests with potential natural forest communities (consisting of species that are adapted to climate change) should improve the stability of the forest stock and minimise climate change impacts on Austria's forests (such as increased bark beetle infestation). This should provide the raw materials necessary for the bio-economy in the future, while maintaining and further expanding the forest's function as a stable carbon sink.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next 20 years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

More stringent approval criteria to realise savings potential in buildings

Description

New buildings should only be approved if they are operated without fossil energy. Renovation work should only be approved when a significant CO_2 reduction is documented.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Energy efficiency as savings potential in buildings

Description

Existing buildings should be brought up to a higher thermal insulation standard. Fossil fuels for heating (oil and natural gas) should be replaced with renewable energy sources.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next 20 years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Use of sealed areas for savings potential in buildings

Description

Available sealed areas (such as rooftops) should be used for renewable energy generation (such as photovoltaic systems).

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Public relations work and information campaigns

Description

Information campaigns should effectively communicate the need for change aiming to

To encourage the population to adopt a more conscious and sustainable consumption behaviour, information campaigns are to promote a corresponding change.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next five years
Financeability	Easily financeable
Acceptance	Easy to accept
Impact	Medium impact

Change in consumption patterns – quality instead of quantity

Description

Information should be disseminated to allow consumers to gain greater awareness of which goods, services, and foods are particularly harmful to the climate through their production so that they are able to consume more consciously. The consumption of meat and dairy products should also be based on quality over quantity, with less but high-quality meat and dairy products from regional ecological and climate-friendly production.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Promotion of relevant digital services

Description

The promotion of digital options for relevant services should serve the aim of avoiding unnecessary motorised mobility based on fossil fuels by providing alternatives and offers (such as telework, telemedicine, the use of online education and training).

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Anchoring climate action in education

Description

Climate action topics should be incorporated throughout the entire education system in order to establish appropriate knowledge and awareness at an early stage.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next five years
Financeability	Easily financeable
Acceptance	Easy to accept
Impact	Medium impact

Regional transport and production solutions

Description

Regional options and thus shorter transport and delivery distances should be given greater consideration in the production of goods.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Orientation of the tax system towards the climate crisis

Description

Tax policy has an effect on business activity and personal decision-making, and ultimately on the implementation of climate mitigation and adaptation measures. Thus, the tax system should be evaluated in terms of its impacts on the climate and the results incorporated into the creation of a revenue-neutral tax reform.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	High impact

Shift to sustainable financing

Description

Financial products targeted at climate-neutral investment options should be expanded to promote private and public investments in climate action. This requires a clear definition of these investment options and the creation of a framework that provides investors with reliable information as to whether their investment is climate friendly.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Adaptation of tourism to climate change

Description

Tourism in the Austrian Alps is being impacted heavily by the impacts of climate change. The provision of consulting and support services for the development of climate-friendly and sustainable green tourism strategies and offerings should help winter sport regions create offerings that are not dependent on snowfall and should help to strengthen summer tourism in the Alps, for example.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Acceptable with effort
Impact	Medium impact

Preservation of ecosystems and biodiversity

Description

Preserving natural ecosystems and biodiversity is crucial for our society, food supply, health, and economy. Increased target-group oriented public relations work and awareness-raising measures relating to the importance of ecosystems and biodiversity in adapting to climate change should promote the preservation of important functions.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Easy to accept
Impact	Medium impact

Creation of a suitable framework for research, development, and innovation

Description

Sufficient human and financial resources should be made available for climate-relevant research, development, and innovation. A focus should be placed on key climate-friendly technologies.

Idea analysis

Assessment criterion	
Time horizon	Achievable in the next ten years
Financeability	Financeable with effort
Acceptance	Easy to accept
Impact	Medium impact

6.3 Storylines for individual fields of action

Various areas of life in 2050 are described as examples of mobility and transport habits in a largely decarbonised transport sector:

A family in the countryside

A couple (both employed) with two children (both attending school) lives in a house in a town with 300 inhabitants. The parents have office jobs in the next town and car-pool with neighbours to a co-working office using an electric car. The parents can work from home two days a week, which reduces the volume of traffic. The two teenagers are attending the secondary school in the provincial capital, which is about 25 minutes away from home. They make the trip by bus and train. The family takes short trips (such as shopping and running errands in town) on foot or with a (freight) bicycle. The family generates the electricity it needs to power their home and electric car with a photovoltaic system. With a storage bank of second-life batteries from electric cars, the family is almost autonomous in terms of their power supply.

Married couple in the city

Two adults live in a central district of a provincial capital, both are employees. The distance to their workplaces is only two kilometres, and they usually make the trip by bicycle. Errands are also done on foot or by bicycle, and the family owns no car. In 2050, it is common for people to form sharing communities where they own a share of an electric car fleet and reserve a vehicle via an app when needed. Depending on the application, you can choose from several vehicle models. The couple uses this option for special needs (such as moving furniture). They also use the app inter-modally to manage their personal mobility (booking a car sharing vehicle, car-pooling, public transport schedules, etc.)

Plumber

A plumbing business is being run in a small town. As is the case for most trades, the focus is now being placed on repairing existing systems and only replacing systems when absolutely necessary. The plumber is also a trained energy efficiency consultant and gives her customers tips on how to further reduce their heating costs and on how to install their own renewable energy systems. The plumber uses a freight bicycle or electric car depending on the distance. She goes to the wholesaler twice per week to buy parts, for which she uses an electric van from a sharing provider. She has a photovoltaic system on the roof of the company building that generates 100% of the electricity she needs including a battery storage bank. Modern technology (apps/video phones) often allow the plumber to get an idea of the work that needs to be done in advance, sometimes even eliminating the need to make a trip to the customer (for example the preparation of a cost estimate), reducing the volume of traffic.

SME

A carpentry shop has been set up at the edge of a small provincial capital. The mobility needs primarily pertain to travelling between the shop and customers. Business trips are also undertaken to visit foresters, sawmills and for advanced vocational training. The used wood is sourced from surrounding forests. The finished products are transported by freight bicycle. If this is not possible, the company's electric van is used. For projects outside of the region, the majority of the transport distance is covered by rail. Internal transport is handled by hydrogen-powered forklifts. The company operates a photovoltaic system, and the excess electricity is used to run an electrolysis plant to produce hydrogen. This is used to fuel the forklifts. The employees from the surrounding area travel to work on the extensive network of bicycle paths. The shop has showers for the employees. The company provides all employees with an annual pass for the public transportation system.

Large enterprise

A steel company is the world market leader in its segment thanks to its innovative products. The production facility is located along a freight corridor, therefore a connecting railway was built. The company has a major customer to which it delivers the produced steel. This customer is also connected to the rail network through a connecting railway. The company has a green hydrogen powered fuel cell truck to make deliveries to other customers. The company and all business partners have modern video conferencing facilities. Most business trips are taken by train, as the travel time can be used to prepare for meetings with customers, for example. In addition to company bicycles (including e-bikes), employees can make use of electric cars for ride sharing. Many replacement parts can be produced with a 3D printer, reducing the need for physical transport.

Tourist operation

A hotel is run as a family business and is located in one of Austria's many beautiful national parks. Active mobility management by the hotel itself and the town have led to sustainable mobility behaviour on the part of the guests. Most guests travel to and from the hotel by train. The hotel's shuttle service picks up the guests at the train station, collects their luggage, and then takes the guests to the hotel in an electric bus (covering the last mile). At the hotel, guests can rent bicycles, electric bikes, and electric cars against a small fee. These offerings are used effectively, and the feedback is very positive. Motorised private traffic has long been banned in national parks, but hikers can make use of an attractive electric bus service. These buses run along the popular trailheads for hiking and climbing routes and in the valleys where the hotels are located. The hotel's regional orientation has also strengthened the surrounding economy. It serves regional products from local organic farms, and makes use of well trained personnel and tradespeople from the area. The hotel uses the sun and a nearby river to generate electricity and produces almost no non-recyclable waste as a certified zero waste company.

Tables

Figures

Abbreviations

AR	Assessment report
BFW	Austrian Research Centre for Forests (Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft)
BMNT	Federal Ministry for Sustainability and Tourism
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
FEU	Final energy use
ETS	Emissions trading system
EU	European Union
R&D	Research and development
CAP	Common Agricultural Policy
ha	Hectare
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land use, land-use change, and forestry
MFF	Multiannual financial framework
MWh	Megawatt hour
Nm^3	Standard cubic metre
PT	Public transport
PJ	Petajoule
t	Tonne
SDGs	UN Sustainable Development Goals
TWh	Terawatt hour

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